iG Chem ALL EQ FINAL MASTER P3
2015w to 2014s Papers 32 and 33
only 2023marks

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Patrick Brannac  www.SmashingScience.org
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*a = relative atomic mass  
X = atomic symbol  
b = proton (atomic number)

*58-71 Lanthanoid series  
190-103 Actinoid series

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
How grade thresholds have changed across the years

GRADE THRESHOLDS FOR EXTENDED CHEMISTRY 0620 FROM JUN2019 TO JUN2014 A*-C WITH THE PROPORTION OF STUDENTS AWARDED AN A*

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<td>20</td>
<td>13-Jan</td>
<td>Tue 14th DL for all marks into SIMS for EOS Report Fri 17th Last Teaching day of Semester</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>20-Jan</td>
<td></td>
<td>Spring Festival</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>27-Jan</td>
<td></td>
<td>Sun 9th AM Students and teachers in for Registration, PM Students Assembly</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>3-Feb</td>
<td></td>
<td>Mon 10th 2nd Semester teaching begins Wed 13th G1, G2, PreA, IB1, AS &amp; A2 reports issued Sun 16th New spring classes in school for registration</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>21</td>
<td>10-Feb</td>
<td>Fri 21st G1, G2, PreA IB1 Parents consultation (whole day)</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>22</td>
<td>17-Feb</td>
<td>Fri 21st G1, G2, PreA IB1 Parents consultation (whole day)</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>23</td>
<td>24-Feb</td>
<td>Sun 9th AM Students and teachers in for Registration, PM Students Assembly</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>24</td>
<td>2-Mar</td>
<td>Mon 10th 2nd Semester teaching begins Wed 13th G1, G2, PreA, IB1, AS &amp; A2 reports issued Sun 16th New spring classes in school for registration</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>25</td>
<td>9-Mar</td>
<td>Fri 13th Completion of 2nd Student Survey</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>26</td>
<td>16-Mar</td>
<td>Fri 13th Completion of 2nd Student Survey</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>27</td>
<td>23-Mar</td>
<td>Fri 20th DL G2, PreA, AS and A2 syllabi completed Sun 22nd UCS Spring Concert</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>28</td>
<td>30-Mar</td>
<td>Sun 22nd UCS Spring Concert</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>29</td>
<td>6-Apr</td>
<td>Mon 3rd Guided revision starts</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>30</td>
<td>13-Apr</td>
<td>Thu 2nd Guided revision ends Fri 3rd Qing Ming Holiday</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>31</td>
<td>20-Apr</td>
<td>Mon 6th EoY EXAMS START G2, preA, AS &amp; A2) Sat 11th Making up day (EXAM day)</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>32</td>
<td>27-Apr</td>
<td>Fri 17th EoY EXAMS ENDS Fri 1st May OFF Mayday Holiday</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>33</td>
<td>4-May</td>
<td>Wed 6th DL All marks for G2, PreA, AS &amp; A2 in SIMS</td>
<td></td>
</tr>
<tr>
<td>School Week</td>
<td>Teach Week</td>
<td>Monday Start</td>
<td>Events</td>
<td>Your notes and events</td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
<td>--------------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>41</td>
<td>34</td>
<td>11-May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>35</td>
<td>18-May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>36</td>
<td>25-May</td>
<td>Mon 25 to Fri 29th EoY EXAMS for G1 and IB1</td>
<td>Sun 31st DL for payments of students tuition and dormitory fees</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fri 29th DL for Submission of Departmental Budgets</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>37</td>
<td>1-Jun</td>
<td>Mon 1st G2, PreA, AS and A2 reports issued</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fri 5th DL for inputting G1 marks</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>38</td>
<td>8-Jun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>39</td>
<td>15-Jun</td>
<td>Wed 17th CAIE Summer session ends</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fri 19th Last day of 2019 to 2020 Academic Year</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sat 20 to Mon 22 Annual Summer Trip</td>
<td></td>
</tr>
<tr>
<td>22-Jun</td>
<td></td>
<td></td>
<td>Summer Holidays</td>
<td></td>
</tr>
<tr>
<td>29-Jun</td>
<td></td>
<td></td>
<td>Summer Holidays</td>
<td></td>
</tr>
<tr>
<td>6-Jul</td>
<td></td>
<td></td>
<td>Summer Holidays</td>
<td></td>
</tr>
<tr>
<td>13-Jul</td>
<td></td>
<td></td>
<td>Summer Holidays</td>
<td></td>
</tr>
<tr>
<td>20-Jul</td>
<td></td>
<td></td>
<td>Summer Holidays</td>
<td></td>
</tr>
<tr>
<td>27-Jul</td>
<td></td>
<td></td>
<td>Summer Holidays</td>
<td></td>
</tr>
<tr>
<td>3-Aug</td>
<td></td>
<td></td>
<td>Summer Holidays</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sun 9th G1 and PreA studnets and form tutors in school for registration</td>
<td></td>
</tr>
<tr>
<td>10-Aug</td>
<td></td>
<td></td>
<td>Sun 16th C6 AS &amp; A2 students registration</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Sun 16th UCS Opening Ceremony All Staff am: G1, G2 &amp; PreA, pm AS, A2 &amp; IB</strong></td>
<td></td>
</tr>
<tr>
<td>17-Aug</td>
<td></td>
<td>17-Aug</td>
<td>Mon 17th Teaching for 2021 to 2022 year begins</td>
<td></td>
</tr>
</tbody>
</table>
Section 1 Past exam questions, not published by me before by topic

Topic Chem 1

Q# 1 iGCSE Chemistry/2015/s/Paper 32/Q2

2 The table shows the melting points, boiling points and electrical properties of five substances, A to E.

<table>
<thead>
<tr>
<th>substance</th>
<th>melting point /°C</th>
<th>boiling point /°C</th>
<th>electrical conductivity of solid</th>
<th>electrical conductivity of liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>−7</td>
<td>59</td>
<td>poor</td>
<td>poor</td>
</tr>
<tr>
<td>B</td>
<td>1083</td>
<td>2567</td>
<td>good</td>
<td>good</td>
</tr>
<tr>
<td>C</td>
<td>755</td>
<td>1387</td>
<td>poor</td>
<td>good</td>
</tr>
<tr>
<td>D</td>
<td>43</td>
<td>181</td>
<td>poor</td>
<td>poor</td>
</tr>
<tr>
<td>E</td>
<td>1607</td>
<td>2227</td>
<td>poor</td>
<td>poor</td>
</tr>
</tbody>
</table>

Choose a substance from the table above to match each of the following descriptions. A substance may be used once, more than once or not at all. Justify each choice with evidence from the table.

One has been completed as an example.

This substance is covalent and is a solid at room temperature (25 °C). .......D........

evidence  Its melting point is above room temperature. It has a low melting point and it does not conduct as a liquid, so it is covalent.

(e) This substance is a liquid at room temperature (25 °C). ............

evidence .......................................................... ..........................................................

.......................................................................................................................................................... [3]
2. Compound X is a colourless liquid at room temperature.
   (a) A sample of pure X was slowly heated from -5.0 °C, which is below its melting point, to 90 °C, which is above its boiling point. Its temperature is measured every minute and the results are represented on the graph.

   ![Graph showing the heating process of compound X.]

2. Compound X is a colourless liquid at room temperature.
   (ii) What is the significance of temperature t °C? [1]

   (iii) What is the physical state of compound X in the region EF? [1]

2. Compound X is a hydrocarbon. It contains 85.7% of carbon. The mass of one mole of X is 84 g.
   (i) What is the percentage of hydrogen in the compound? [1]

   (ii) Calculate the empirical formula of X. Show your working.

   empirical formula = .................................. [3]

   (iii) What is the molecular formula of compound X? [1]
Topic Chem 1 Q# 4/ iGCSE Chemistry/2014/s/Paper 33/Q2

(b) A liquid has a fixed volume but takes up the shape of the container. A gas takes up the shape of the container but it does not have a fixed volume.

Topic Chem 2 Q# 5/ iGCSE Chemistry/2015/w/Paper 33/Q1

(b) How could you show that a sample of water is pure?

Topic Chem 2 Q# 6/ iGCSE Chemistry/2015/m/Paper 32/Q6

6 A student is told to produce the maximum amount of copper from a mixture of copper and copper(II) carbonate.

The student adds the mixture to an excess of dilute sulfuric acid in a beaker and stirs the mixture with a glass rod. The copper(II) carbonate reacts with the sulfuric acid, forming a solution of copper(II) sulfate but the copper does not react with the sulfuric acid.

The student then

- removes the unreacted copper from the mixture,
- converts the solution of copper(II) sulfate into copper by a series of reactions.

(b) Describe how the student can produce pure dry copper from the mixture of copper and copper(II) sulfate solution.
Topic Chem 2 Q# 7/ iGCSE Chemistry/2014/w/Paper 32/Q1
1 An important aspect of chemistry is purity and methods of purification.

(a) Give an example of substances used in everyday life which must be pure.

................................................................................................................................. [1]

(b) A list of techniques used to separate mixtures is given below.

<table>
<thead>
<tr>
<th>chromatography</th>
<th>crystallisation</th>
<th>diffusion</th>
<th>dissolving</th>
</tr>
</thead>
<tbody>
<tr>
<td>evaporation</td>
<td>filtration</td>
<td>fractional distillation</td>
<td>simple distillation</td>
</tr>
</tbody>
</table>

(i) From the list, choose the most suitable technique to separate the following.

water from sea-water ..........................................................................................................

helium from a mixture of helium and methane .....................................................................

ethanol from a mixture of ethanol and propanol .................................................................

iron filings from a mixture of iron filings and water .........................................................

a mixture of two amino acids, glycine and alanine ................................................................ [5]

Topic Chem 2 Q# 8/ iGCSE Chemistry/2014/s/Paper 33/Q5
(d) The equilibrium mixture leaving the reaction chamber contains 15% ammonia. Suggest how the ammonia could be separated from the mixture.

<table>
<thead>
<tr>
<th></th>
<th>boiling point °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrogen</td>
<td>-253</td>
</tr>
<tr>
<td>nitrogen</td>
<td>-196</td>
</tr>
<tr>
<td>ammonia</td>
<td>-33</td>
</tr>
</tbody>
</table>

................................................................................................................................. [2]

Topic Chem 3 Q# 9/ iGCSE Chemistry/2015/w/Paper 33/Q6
(d) What is the formula of a magnesium ion?

........................................................................................................................................... [1]

Topic Chem 3 Q# 10/ iGCSE Chemistry/2015/w/Paper 33/Q3
3 Lithium bromide is an ionic compound. It can be electrolysed when it is molten or in aqueous solution. It cannot be electrolysed as a solid.

(a) Solid lithium bromide is a poor conductor of electricity. The ions cannot move to the electrodes, they are held in an ionic lattice by strong forces.

(i) Describe the motion of the ions in the solid state.

........................................................................................................................................... [1]
(ii) Define the term ionic bonding.

(iii) What is meant by the term ionic lattice?

---

The table below shows the elements in the third period of the Periodic Table, the number of electrons in their outer energy level, their oxidation state in their common compounds and their melting points.

<table>
<thead>
<tr>
<th>element</th>
<th>Na</th>
<th>Mg</th>
<th>Al</th>
<th>Si</th>
<th>P</th>
<th>S</th>
<th>Cl</th>
<th>Ar</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of outer electrons</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>oxidation state</td>
<td>+1</td>
<td>+2</td>
<td>+3</td>
<td>+4/−4</td>
<td>−3</td>
<td>−2</td>
<td>−1</td>
<td>0</td>
</tr>
<tr>
<td>melting point/°C</td>
<td>98</td>
<td>650</td>
<td>660</td>
<td>1414</td>
<td>317</td>
<td>115</td>
<td>−101</td>
<td>−189</td>
</tr>
</tbody>
</table>

(b) The first three elements, Na, Mg and Al, are metals.

Describe the structure of a typical metal.

(c) Explain why Na, Mg and Al are good conductors of electricity.

(d) Which element exists as diatomic molecules of the type X₂?

(e) Silicon has a similar structure to diamond.

Explain why silicon has the highest melting point in the period.
(f) Sodium chloride is a crystalline solid with a high melting point. It dissolves in water to give a neutral solution. Phosphorus trichloride is a liquid at room temperature. It reacts with water to form an acidic solution.

Suggest an explanation for these differences in properties.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [2]

(h) Draw a dot-and-cross diagram showing the bonding in magnesium oxide. Show outer electrons only.

__________________________________________________________________________ [3]

Topic: Chem 3 Q#12/ IGCSE Chemistry/2015/w/Paper 32/Q1

1 Use your copy of the Periodic Table to help you answer some of these questions.

(a) Predict the formulae of the following compounds.

(i) nitrogen fluoride .................................................................

(ii) phosphorus sulfide ........................................................... [2]

(b) Deduce the formulae of the following ions.

(i) selenide .............................................................................

(ii) gallium ............................................................................ [2]
Topic Chem 3 Q# 13/ iGCSE Chemistry/2015/s/Paper 33/Q2

2 This question is concerned with the following oxides.

- aluminium oxide
- carbon monoxide
- copper(II) oxide
- silicon(IV) oxide
- sodium oxide
- sulfur dioxide
- zinc oxide

Choose one oxide from the above list to match each of the following descriptions. An oxide may be used once, more than once or not at all.

e) This oxide has a giant covalent structure. .......................................................... [1]

Topic Chem 3 Q# 14/ iGCSE Chemistry/2015/s/Paper 33/Q1

1 Use your copy of the Periodic Table to help you answer these questions.

(a) Predict the formula of each of the following compounds.

(i) aluminium fluoride .......................................................... [1]
(ii) arsenic oxide .......................................................... [1]
(iii) silicon bromide .......................................................... [1]

(b) Deduce the formula of each of the following ions.

(i) phosphide .......................................................... [1]
(ii) barium .......................................................... [1]
(iii) francium .......................................................... [1]

(c) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound carbon dioxide.

Use x to represent an electron from a carbon atom.
Use o to represent an electron from an oxygen atom.
The table shows the melting points, boiling points and electrical properties of five substances, A to E.

<table>
<thead>
<tr>
<th>substance</th>
<th>melting point /°C</th>
<th>boiling point /°C</th>
<th>electrical conductivity of solid</th>
<th>electrical conductivity of liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-7</td>
<td>59</td>
<td>poor</td>
<td>poor</td>
</tr>
<tr>
<td>B</td>
<td>1083</td>
<td>2567</td>
<td>good</td>
<td>good</td>
</tr>
<tr>
<td>C</td>
<td>755</td>
<td>1387</td>
<td>poor</td>
<td>good</td>
</tr>
<tr>
<td>D</td>
<td>43</td>
<td>181</td>
<td>poor</td>
<td>poor</td>
</tr>
<tr>
<td>E</td>
<td>1607</td>
<td>2227</td>
<td>poor</td>
<td>poor</td>
</tr>
</tbody>
</table>

Choose a substance from the table above to match each of the following descriptions. A substance may be used once, more than once or not at all. Justify each choice with evidence from the table.

One has been completed as an example.

This substance is covalent and is a solid at room temperature (25 °C). ..........D.........

Evidence: *Its melting point is above room temperature. It has a low melting point and it does not conduct as a liquid, so it is covalent.*

(a) This substance has a giant covalent structure. ............

Evidence: ................................................................. ................................................................. [3]

(b) This substance is a metal. ............

Evidence: ................................................................. ................................................................. [2]

(d) This substance is an ionic solid. ............

Evidence: ................................................................. ................................................................. [3]
Topic  Chem 3 Q# 16/  iGCSE Chemistry/2015/s/Paper 32/Q1
1. Complete the following table which gives the number of protons, electrons and neutrons in each of the five particles.

<table>
<thead>
<tr>
<th>particle</th>
<th>number of protons</th>
<th>number of electrons</th>
<th>number of neutrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>..........</td>
<td>19</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>$^{56}_{26}$Fe</td>
<td>..........</td>
<td>..........</td>
<td>..........</td>
</tr>
<tr>
<td>..........</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>$^{70}_{31}$Ga$^{3+}$</td>
<td>..........</td>
<td>..........</td>
<td>..........</td>
</tr>
<tr>
<td>..........</td>
<td>34</td>
<td>36</td>
<td>45</td>
</tr>
</tbody>
</table>

[Total: 8]

Topic  Chem 3 Q# 17/  iGCSE Chemistry/2015/m/Paper 32/Q3
3. Ammonia is manufactured by the Haber process. Nitrogen and hydrogen are passed over a catalyst at a temperature of 450°C and a pressure of 200 atmospheres.

The equation for the reaction is as follows:

$$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$$

The forward reaction is exothermic.

(g) Draw a dot-and-cross diagram to show the arrangement of the outer (valency) electrons in one molecule of ammonia.

[2]

Topic  Chem 3 Q# 18/  iGCSE Chemistry/2015/m/Paper 32/Q2
2. (a) Define the term isotope.
(b) The table gives information about four particles, A, B, C and D.

Complete the table.
The first line has been done for you.

<table>
<thead>
<tr>
<th>particle</th>
<th>number of protons</th>
<th>number of electrons</th>
<th>number of neutrons</th>
<th>nucleon number</th>
<th>symbol or formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>12</td>
<td>C</td>
</tr>
<tr>
<td>B</td>
<td>11</td>
<td>10</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>8</td>
<td>8</td>
<td></td>
<td>28</td>
<td>O^{2-}</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td>Al^{3+}</td>
</tr>
</tbody>
</table>

[7]

Topic Chem 3 Q# 19/ IGCSE Chemistry/2015/m/Paper 32/Q1

1 For each of the following, give the name of an element from Period 3 (sodium to argon), which matches the description.

(a) an element which is gaseous at room temperature and pressure

.............................................................................................................................................. [1]

Topic Chem 3 Q# 20/ IGCSE Chemistry/2014/w/Paper 33/Q6

6 Rubidium and strontium are very reactive metals at the top of the reactivity series. Because their ions have different charges, their compounds behave differently when heated.

(a) The formulae of the ions of these two elements are Rb^+ and Sr^{2+}.

Explain why these metals, which are in different groups, form ions which have different charges.

.............................................................................................................................................. [2]

Topic Chem 3 Q# 21/ IGCSE Chemistry/2014/w/Paper 33/Q3

3 In 1985 the fullerenes were discovered. They are solid forms of the element carbon. The structure of the C_{60} fullerene is given below.

(a) (i) In the C_{60} fullerene, how many other carbon atoms is each carbon atom bonded to?

.............................................................................................................................................. [1]

(ii) Another fullerene has a relative molecular mass of 640.

How many carbon atoms are there in one molecule of this fullerene?

.............................................................................................................................................. [1]
(b) Fullerenes are soluble in liquid hydrocarbons such as octane. The other solid forms of carbon are insoluble. Describe how you could obtain crystals of fullerenes from soot which is a mixture of fullerenes and other solid forms of carbon.

____________________________________________________________________________________ [3]

(c) A mixture of a fullerene and potassium is an excellent conductor of electricity.

(i) Which other form of solid carbon is a good conductor of electricity?

____________________________________________________________________________________ [1]

(ii) Explain why metals, such as potassium, are good conductors of electricity.

____________________________________________________________________________________ [2]

Topic: Chem 3 Q# 22/ IGCSE Chemistry/2014/w/Paper 33/Q1

1. For each of the following elements give one physical property:

(b) carbon (C)

____________________________________________________________________________________ [1]

Topic: Chem 3 Q# 23/ IGCSE Chemistry/2014/s/Paper 33/Q4

(b) (i) Describe the structure of a typical metal such as iron. You may include a diagram.

____________________________________________________________________________________ [2]

(ii) Explain why pure iron is malleable.

____________________________________________________________________________________ [2]
(b) Scandium fluoride is an ionic compound. The valency of scandium in scandium fluoride is three. 
Draw a diagram which shows the formula of this compound, the charges on the ions and the arrangement of the valency electrons around the negative ions.

Use × to represent an electron from a fluorine atom.
Use ○ to represent an electron from a scandium atom.

---

(c) The structural formula of carbonyl chloride is given below.

\[
\begin{align*}
\text{Cl} & \quad \text{C=O} \\
& \quad \text{Cl}
\end{align*}
\]

Draw a diagram showing the arrangement of the valency electrons around the atoms in one molecule of this covalent compound.

Use ○ to represent an electron from an oxygen atom.
Use × to represent an electron from a chlorine atom.
Use ● to represent an electron from a carbon atom.
1. The table below gives the electron distributions of atoms of different elements.

<table>
<thead>
<tr>
<th>element</th>
<th>electron distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 + 7</td>
</tr>
<tr>
<td>B</td>
<td>2 + 8 + 4</td>
</tr>
<tr>
<td>C</td>
<td>2 + 8 + 8 + 1</td>
</tr>
<tr>
<td>D</td>
<td>2 + 8 + 18 + 5</td>
</tr>
<tr>
<td>E</td>
<td>2 + 8 + 18 + 7</td>
</tr>
<tr>
<td>F</td>
<td>2 + 8 + 18 + 18 + 8</td>
</tr>
</tbody>
</table>

For each of the following, select an element or elements from the table that matches the description. Each element may be selected once, more than once or not at all.

(b) This element forms a fluoride with a formula of the type \(XF_3\).

\[ \text{[1]} \]

(d) This element has a macromolecular structure similar to that of diamond.

\[ \text{[1]} \]

(g) This element is a good conductor of electricity.

\[ \text{[1]} \]

7. Two salts can be made from potassium hydroxide and sulfuric acid. They are potassium sulfate, \(K_2SO_4\), and the acid salt potassium hydrogen sulfate, \(KHSO_4\). They are both made by titration.

\[ \ \ \ \ \ \text{burette filled with sulfuric acid} \]

\[ \ \ \ \ \ \text{conical flask} \]

\[ \ \ \ \ \ \text{25.0 cm}^3 \text{ of potassium hydroxide solution} \]

(a) 25.0 cm\(^3\) of potassium hydroxide, concentration 2.53 mol/dm\(^3\), was neutralised by 28.2 cm\(^3\) of dilute sulfuric acid.

\[
2\text{KOH(aq)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{K}_2\text{SO}_4\text{(aq)} + 2\text{H}_2\text{O(l)}
\]
Calculate the concentration of the sulfuric acid.

number of moles of KOH used = .........................

number of moles of H₂SO₄ needed to neutralise the KOH = .........................

concentration of dilute sulfuric acid = ......................... mol/dm³

Topic Chem 4 Q# 28/ IGCSE Chemistry/2015/w/Paper 33/Q6
(c) Deduce the formula of iron(III) sulfate.

................................................................. [3]

Topic Chem 4 Q# 29/ IGCSE Chemistry/2015/w/Paper 33/Q4
(c) Hydrocarbons burn in excess oxygen to form carbon dioxide and water. 20 cm³ of a gaseous hydrocarbon burned in an excess of oxygen, 200 cm³. After cooling, the volume of the residual gas at r.t.p. was 150 cm³, 50 cm³ of which was oxygen.

(i) Determine the volume of the oxygen used.

................................................................. [1]

(ii) Determine the volume of the carbon dioxide formed.

................................................................. [1]

Topic Chem 4 Q# 30/ IGCSE Chemistry/2015/w/Paper 33/Q2
2 Choose from the following list of gases. A gas may be chosen once, more than once or not at all.
sulfur dioxide hydrogen methane carbon monoxide argon ethene butane

(b) When burned in oxygen, the only product is water. ......................................................... [1]

(e) When reacted with oxygen, the only product is carbon dioxide. ......................................................... [1]

Topic Chem 4 Q# 31/ IGCSE Chemistry/2015/w/Paper 32/Q4
4 (a) Propane reacts with chlorine to form a mixture of chloropropanes. This is a photochemical reaction.

(b) Bond breaking is an endothermic change and bond forming is an exothermic change.

Bond energy is the amount of energy in kJ/mol needed to break one mole of the specified bond.

\[
\text{H}_3\text{C}-\text{C} = \text{C}-\text{H} + \text{Cl}_2 \rightarrow \text{H}_3\text{C} = \text{C} - \text{C}l + \text{H} - \text{Cl}.
\]

Use the following bond energies to determine whether this reaction is exothermic or endothermic. You must show your reasoning.
Use the following bond energies to determine whether this reaction is exothermic or endothermic. You must show your reasoning.

<table>
<thead>
<tr>
<th>bond</th>
<th>bond energies in kJ/mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>C–Cl</td>
<td>338</td>
</tr>
<tr>
<td>C–H</td>
<td>412</td>
</tr>
<tr>
<td>Cl–Cl</td>
<td>242</td>
</tr>
<tr>
<td>H–Cl</td>
<td>431</td>
</tr>
<tr>
<td>C–C</td>
<td>348</td>
</tr>
</tbody>
</table>

(d) Propanol reacts with methanoic acid to form the ester propyl methanoate.

\[
\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{HCOOH} \rightarrow \text{HCOOCH}_2\text{CH}_2\text{CH}_3 + \text{H}_2\text{O}
\]

4.0 g of methanoic acid was reacted with 6.0 g of propanol.

(i) Calculate the \( M_f \) of methanoic acid = ........................................... [1]

(ii) Calculate the \( M_f \) of propanol = ........................................... [1]

(iii) Determine which one is the limiting reagent. Show your reasoning.

(iv) Calculate the maximum yield in grams of propyl methanoate, \( M_f = 88 \).

1 Use your copy of the Periodic Table to help you answer some of these questions.

(c) Use the following ions to determine the formulae of the compounds.

<table>
<thead>
<tr>
<th>ions</th>
<th>( \text{OH}^- )</th>
<th>( \text{Cr}^{3+} )</th>
<th>( \text{Ba}^{2+} )</th>
<th>( \text{SO}_4^{2-} )</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>compounds</th>
<th>chromium(III) sulfate</th>
<th>barium hydroxide</th>
</tr>
</thead>
</table>
The law of constant composition states that all pure samples of a compound contain the same elements in the same proportion by weight.

A typical experiment to test this law is to prepare the same compound by different methods and then show that the samples have the same composition.

Methods of making copper(II) oxide include:

- heating copper carbonate,
- heating copper hydroxide,
- heating copper nitrate,
- heating copper foil in air.

(c) The table below shows the results obtained by reducing the copper(II) oxide produced by different methods to copper.

(i) Complete the table.

<table>
<thead>
<tr>
<th>source of copper(II) oxide</th>
<th>mass of copper(II) oxide/g</th>
<th>mass of copper/g</th>
<th>percentage copper/%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CuCO₃</td>
<td>2.37</td>
<td>1.89</td>
<td>79.7</td>
</tr>
<tr>
<td>Cu(OH)₂</td>
<td>2.51</td>
<td>1.99</td>
<td></td>
</tr>
<tr>
<td>Cu(NO₃)₂</td>
<td>2.11</td>
<td>1.68</td>
<td></td>
</tr>
<tr>
<td>Cu and O₂</td>
<td>2.29</td>
<td>1.94</td>
<td></td>
</tr>
</tbody>
</table>

(ii) One of the samples of copper(II) oxide is impure.

Identify this sample and suggest an explanation why the percentage of copper in this sample is bigger than in the other three samples.

(ii) Copper(II) nitrate forms a series of hydrates with the formula Cu(NO₃)₂ₓH₂O.

All these hydrates decompose to form copper(II) oxide. 
1 mole of Cu(NO₃)₂ₓH₂O forms 1 mole of CuO.

What is meant by 1 mole of a substance?

(iii) 7.26 g of a hydrate, Cu(NO₃)₂ₓH₂O, formed 2.4 g copper(II) oxide.

number of moles of CuO formed = ……………

number of moles of Cu(NO₃)₂ₓH₂O in 7.26 g = ……………

mass of 1 mole of Cu(NO₃)₂ₓH₂O = …………… g
mass of 1 mole of Cu(NO₃)₂ is 188g

the value of x in this hydrate = ......................... [4]

Topic Chem 4 Q# 36/ IGCSE Chemistry/2015/s/Paper 32/Q3
(b) In the lattice of calcium nitride, the ratio of calcium ions to nitride ions is 3:2.
(ii) In terms of ionic charges, explain why the ratio of ions is 3:2.

................................................................................................................................. [2]

Topic Chem 4 Q# 37/ IGCSE Chemistry/2015/m/Paper 32/Q7
7. Ethanol is manufactured from glucose, C₆H₁₂O₆, by fermentation according to the following equation:

C₆H₁₂O₆ → 2C₂H₅OH + 2CO₂

(b) In an experiment, 30.0 g of glucose was fermented.
(i) Calculate the number of moles of glucose in 30.0 g.

....................... mol [2]

(ii) Calculate the maximum mass of ethanol that could be obtained from 30.0 g of glucose.

....................... g [2]

(iii) Calculate the volume of carbon dioxide at room temperature and pressure that can be obtained from 30.0 g of glucose.

....................... dm³ [1]

Topic Chem 4 Q# 38/ IGCSE Chemistry/2014/w/Paper 33/Q8

CoCO₃(s) + 2HCl(aq) → CoCl₂(aq) + CO₂(g) + H₂O(l)

50 cm³ of dilute hydrochloric acid, concentration 2.2 mol/dm³, was heated and cobalt(II)
(c) 6.31 g of cobalt(II) chloride-6-water crystals were obtained. Calculate the percentage yield to 1 decimal place.

number of moles of HCl in 50 cm³ of acid, concentration 2.2 mol/dm³ = ..............

maximum number of moles of CoCl₂·6H₂O which could be formed = ..............

mass of 1 mole of CoCl₂·6H₂O = 230 g

maximum yield of CoCl₂·6H₂O = .............. g

percentage yield = .............. %

Topic Chem 4 Q# 39/ iGCSE Chemistry/2014/w/Paper 32/Q6

(iii) A mineral of the type FeSO₄·xH₂O contains 37.2% of water. Complete the calculation to determine x.

mass of one mole of H₂O = 18 g

mass of water in 100 g of FeSO₄·xH₂O = 37.2 g

number of moles of H₂O in 100 g of FeSO₄·xH₂O = ..............

mass of FeSO₄ in 100 g of FeSO₄·xH₂O = .............. g

mass of one mole of FeSO₄ = 152 g

number of moles of FeSO₄ in 100 g of FeSO₄·xH₂O = ..............

x = ..............

Topic Chem 4 Q# 40/ iGCSE Chemistry/2014/s/Paper 32/Q7

7 The soluble salt hydrated lithium sulfate is made by titration from the soluble base lithium hydroxide.

(a) The sulfuric acid is added slowly from the burette until the indicator just changes colour. The volume of sulfuric acid needed to just neutralise the lithium hydroxide is noted.
(b) Using 25.0 cm$^3$ of aqueous lithium hydroxide, concentration 2.48 mol/dm$^3$, 2.20 g of hydrated lithium sulfate was obtained. Calculate the percentage yield, giving your answer to one decimal place.

\[
\begin{align*}
2\text{LiOH} + \text{H}_2\text{SO}_4 & \rightarrow \text{Li}_2\text{SO}_4 + 2\text{H}_2\text{O} \\
\text{Li}_2\text{SO}_4 + \text{H}_2\text{O} & \rightarrow \text{Li}_2\text{SO}_4\cdot\text{H}_2\text{O}
\end{align*}
\]

Number of moles of LiOH used = ....................

Number of moles of Li$_2$SO$_4$·H$_2$O which could be formed = ....................

Mass of one mole of Li$_2$SO$_4$·H$_2$O = 128 g

Maximum yield of Li$_2$SO$_4$·H$_2$O = .................... g

Percentage yield = ....................\%  

[4]

(c) An experiment was carried out to show that the formula of the hydrated salt is Li$_2$SO$_4$·H$_2$O. A sample of the hydrated salt was weighed and its mass recorded. It was then heated and the anhydrous salt was weighed. This procedure was repeated until two consecutive masses were the same. This procedure is called ‘heating to constant mass’.

(i) What is the reason for heating to constant mass?

........................................................................................................................................ [1]

(ii) The mass of the hydrated salt is m$_1$ and the mass of the anhydrous salt is m$_2$. Explain how you could show that the hydrated salt has one mole of water of crystallisation per mole of the anhydrous salt.

........................................................................................................................................ [3]

Topic Chem 5  Q# 41/ iGCSE Chemistry/2015/w/Paper 33/Q3

3 Lithium bromide is an ionic compound. It can be electrolysed when it is molten or in aqueous solution. It cannot be electrolysed as a solid.

(b) The diagram shows the electrolysis of molten lithium bromide.
(i) Mark on the diagram the direction of the electron flow. [1]

(ii) Write an ionic equation for the reaction at the negative electrode (cathode).

................................................................................................................................. [1]

(iii) Write an ionic equation for the reaction at the positive electrode (anode).

................................................................................................................................. [2]

(c) When aqueous lithium bromide is electrolysed, a colourless gas is formed at the negative electrode and the solution becomes alkaline.

Explain these observations and include an equation in your explanation.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
............................................................................................................................................ [3]

Topic Chem 5 Q# 42/  iGCSE Chemistry/2015/w/Paper 32/Q3

3 Two of the main uses of zinc are for galvanising and for making alloys.

One of the main ores of zinc is zinc blende, ZnS. There are two stages in the extraction of zinc from this ore.

(a) **Stage 1**  Zinc oxide is made from zinc blende.

(c) The zinc produced by this process is impure. It can be purified by electrolysis using a method which is similar to the purification of copper. Under the conditions used in the process, zinc is the product at the negative electrode (cathode).

Complete the following description of this purification.

The electrolyte is aqueous ........................................................................................................... [1]

The negative electrode (cathode) is made of .............................................................................. [1]

The positive electrode (anode) is impure zinc.

The equation for the reaction at the cathode is ........................................................................ [1]

The equation for the reaction at the anode is ............................................................................ [1]

Explain why the concentration of the electrolyte does not change.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................... [2]
3 Calcium reacts with nitrogen to form the ionic compound calcium nitride, \( \text{Ca}_3\text{N}_2 \).

(a) Draw a diagram, based on the correct formula, which shows the charges on the ions and the arrangement of the electrons around the negative ion.

Use \( o \) to represent an electron from a calcium atom.
Use \( x \) to represent an electron from a nitrogen atom.


(b) In the lattice of calcium nitride, the ratio of calcium ions to nitride ions is 3:2.

(i) What is meant by the term lattice?


(b) Write the equation for the chemical reaction that takes place in a hydrogen fuel cell.

\[ \text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O} + \text{electricity} \]

(c) (i) At which electrode does oxidation occur? Explain your choice.

(ii) Write an ionic equation for the reaction at this electrode.
4. Zinc is an important metal. Its uses include making alloys and the construction of dry cells (batteries).

   (d) A dry cell (battery) has a central rod, usually made of graphite. This is the positive electrode which is surrounded by the electrolyte, typically a paste of ammonium chloride and manganese(IV) oxide, all of which are in a zinc container which is the negative electrode.

   ![Diagram of a dry cell]

   (i) Draw an arrow on the diagram to indicate the direction of electron flow.

   (ii) Suggest why the electrolyte is a paste.

   (iii) The following changes occur in a dry cell.

   For each change, decide if it is oxidation or reduction and give a reason for your choice.

   \[ \text{Zn to Zn}^{2+} \]

   \[ \text{manganese(IV) oxide to manganese(III) oxide} \]

7. Aluminium is obtained from purified alumina, Al₂O₃, by electrolysis.

   (b) Describe the extraction of aluminium from alumina. Include the electrolyte, the electrodes and the reactions at the electrodes.

   (c) Aluminium is resistant to corrosion. It is protected by an oxide layer on its surface. The thickness of this oxide layer can be increased by anodising.
(ii) Anodising is an electrolytic process. Dilute sulfuric acid is electrolysed with an aluminium object as the anode. The thickness of the oxide layer is increased. Complete the equations for the reactions at the aluminium anode.

\[ \text{......} \text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + \text{......e}^- \]
\[ \text{......Al + .......} \rightarrow \text{......Al}_2\text{O}_3 \]  

[4]

Topic Chem 5 Q# 47/ iGCSE Chemistry/2014/s/Paper 32/Q5

(b) Chlorine is made by the electrolysis of concentrated aqueous sodium chloride. Describe this electrolysis. Write ionic equations for the reactions at the electrodes and name the sodium compound formed.

[5]

Topic Chem 6 Q# 48/ iGCSE Chemistry/2014/w/Paper 33/Q5

(b) The ions present in aqueous sodium chloride are Na\(^+\)(aq), Cl\(^-\)(aq), H\(^+\)(aq) and OH\(^-\)(aq).

The electrolysis of concentrated aqueous sodium chloride forms three products. They are hydrogen, chlorine and sodium hydroxide.

(i) Explain how these three products are formed. Give ionic equations for the reactions at the electrodes.

[4]

(ii) If the solution of the electrolyte is stirred, chlorine reacts with sodium hydroxide to form sodium chlorate(I), sodium chloride and water. Write an equation for this reaction.

\[ \text{Cl}_2 + \text{...NaOH} \rightarrow \text{............} + \text{............} + \text{............} \]  

[2]
Topic  Chem 6 Q# 49/ iGCSE Chemistry/2014/w/Paper 33/Q4

4  A fuel cell produces electrical energy by the oxidation of a fuel by oxygen. The fuel is usually hydrogen but methane and methanol are two other fuels which may be used. A diagram of a hydrogen fuel cell is given below.

![Diagram of a hydrogen fuel cell](image)

(a) When the fuel is hydrogen, the only product is water. What additional product would be formed if methane was used? [1]

(b) Fuel cells are used to propel cars. Give two advantages of a fuel cell over a gasoline-fuelled engine. [2]

Topic  Chem 6 Q# 50/ iGCSE Chemistry/2014/w/Paper 32/Q2

(ii) How can sodium metal be obtained from sodium chloride? [2]

Topic  Chem 6 Q# 51/ iGCSE Chemistry/2014/s/Paper 33/Q5

(e) Ammonia is used to make nitrogen trifluoride, NF₃. Nitrogen trifluoride is essential to the electronics industry. It is made by the following reaction.

\[
\begin{align*}
\text{H} & \quad \text{N} & \quad \text{H} \\
\text{H} & \quad \text{F} & \quad \text{F} & \quad \text{F} \\
\text{F} & \quad \text{F} & \quad \text{F} & \quad \text{F} \\
\text{F} & \quad \text{F} & \quad \text{F} & \quad \text{H} \\
\text{H} & \quad \text{F} & \quad \text{F} & \quad \text{F} \\
\end{align*}
\]

Determine if the above reaction is exothermic or endothermic using the following bond energies and by completing the following table. The first line has been done as an example.

Bond energy is the amount of energy, in kJ/mole, needed to break or make one mole of the bond.

<table>
<thead>
<tr>
<th>bond</th>
<th>bond energy in kJ/mole</th>
</tr>
</thead>
<tbody>
<tr>
<td>N−H</td>
<td>390</td>
</tr>
<tr>
<td>F−F</td>
<td>155</td>
</tr>
<tr>
<td>N−F</td>
<td>280</td>
</tr>
<tr>
<td>H−F</td>
<td>565</td>
</tr>
<tr>
<td>bond</td>
<td>energy change / kJ</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------</td>
</tr>
<tr>
<td>N–H</td>
<td>$(3 \times 390) = 1170$</td>
</tr>
<tr>
<td>F–F</td>
<td></td>
</tr>
<tr>
<td>N–F</td>
<td></td>
</tr>
<tr>
<td>H–F</td>
<td></td>
</tr>
</tbody>
</table>

The half equations for this reaction are given below:

\[
\begin{align*}
\text{Li}^+ + e^- & \rightarrow \text{Li}/\text{Li}^+ \rightarrow \text{Li}^- \quad \text{e}^-; \\
2\text{Br}^- & \rightarrow \text{Br}_2 + 2\text{e}^-/2\text{Br}^- - 2\text{e}^- \rightarrow \text{Br}_2
\end{align*}
\]

Topic Chem 6 Q# 52/ iGCSE Chemistry/2014/s/Paper 33/Q1

1. Choose a gas from the following list to answer the questions below. Each gas may be used once, more than once or not at all.

\[
\begin{align*}
\text{ammonia} & \quad \text{carbon dioxide} & \quad \text{carbon monoxide} & \quad \text{fluorine} \\
\text{hydrogen} & \quad \text{krypton} & \quad \text{nitrogen} & \quad \text{propene} & \quad \text{sulfur dioxide}
\end{align*}
\]

(g) It burns to form water as the only product. ......................................................... [1]

Topic Chem 6 Q# 53/ iGCSE Chemistry/2014/s/Paper 32/Q2

2. (a) Natural gas, which is mainly methane, is a fossil fuel.

(i) What is meant by the term 'fuel'?

................................................................. [1]

(iii) Name a solid fuel which is not a fossil fuel.

................................................................. [1]

Topic Chem 7 Q# 54/ iGCSE Chemistry/2015/w/Paper 33/Q5

(b) Sulfurous acid forms salts called sulfites, which contain the ion $\text{SO}_3^{2-}$.

When barium nitrate solution is added to aqueous sulfurous acid, a white precipitate, A, forms.

Bromine water changes from brown to colourless when added to aqueous sulfurous acid.

Bromine oxidises sulfurous acid. When this solution is tested with acidified barium nitrate solution, a different white precipitate, B, is formed.

(iii) Write an ionic equation for the reduction of the bromine molecule.

................................................................. [1]

Topic Chem 7 Q# 55/ iGCSE Chemistry/2015/w/Paper 33/Q3 NOT WITH Q3 bii or biii

3. Lithium bromide is an ionic compound. It can be electrolysed when it is molten or in aqueous solution. It cannot be electrolysed as a solid.

The half equations for this reaction are given below:

\[
\begin{align*}
\text{Li}^+ + \text{e}^- & \rightarrow \text{Li}/\text{Li}^+ \rightarrow \text{Li}^- \quad \text{e}^-; \\
2\text{Br}^- & \rightarrow \text{Br}_2 + 2\text{e}^-/2\text{Br}^- - 2\text{e}^- \rightarrow \text{Br}_2
\end{align*}
\]
(iv) Which ion is oxidised? Explain your answer.

<table>
<thead>
<tr>
<th>element</th>
<th>Na</th>
<th>Mg</th>
<th>Al</th>
<th>Si</th>
<th>P</th>
<th>S</th>
<th>Cl</th>
<th>Ar</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of outer electrons</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>oxidation state</td>
<td>+1</td>
<td>+2</td>
<td>+3</td>
<td>+4/−4</td>
<td>−3</td>
<td>−2</td>
<td>−1</td>
<td>0</td>
</tr>
<tr>
<td>melting point/°C</td>
<td>98</td>
<td>650</td>
<td>660</td>
<td>1414</td>
<td>317</td>
<td>115</td>
<td>−101</td>
<td>−189</td>
</tr>
</tbody>
</table>

(a) Describe and explain the variation in oxidation state across the period.

Topic Chem 7 Q# 56/ IGCSE Chemistry/2015/w/Paper 32/Q6
6 The table below shows the elements in the third period of the Periodic Table, the number of electrons in their outer energy level, their oxidation state in their common compounds and their melting points.

(i) What is meant by the phrase *photochemical reaction*?

(c) Photosynthesis is an unusual endothermic reaction.

(i) Where does the energy for photosynthesis come from?

(ii) Give the word equation for photosynthesis.

Topic Chem 7 Q# 58/ IGCSE Chemistry/2015/s/Paper 33/Q6
3 Quicklime, which is calcium oxide, is made by heating limestone in a furnace.

$$\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$$

The reaction does not come to equilibrium.

(a) Suggest why the conversion to calcium oxide is complete.
7 **Alcohols can be made by fermentation or from petroleum.**

(a) Ethanol can be made by the fermentation of glucose.

\[ C_6H_{12}O_6(aq) \xrightarrow{\text{yeast}} 2C_2H_5OH(aq) + 2CO_2(g) \]  

Yeasts are living single-cell fungi which ferment glucose by anaerobic respiration. This reaction is catalysed by enzymes from the yeast.

(iii) What are enzymes?

.............................................................................................................................................................................. [1]

(iv) Suggest a method of measuring the rate of this reaction.

............................................................................................................................................................................................................... [1]

(b) The following observations were noted.

- When a small amount of yeast was added to the aqueous glucose the reaction started and the solution went slightly cloudy.
- The reaction rate increased and the solution became cloudier and warmer.
- After a while, the reaction rate decreased and eventually stopped, leaving a 14% solution of ethanol in water.

(i) Why did the reaction rate increase?

.............................................................................................................................................................................. [1]

(ii) Suggest an explanation for the increase in cloudiness of the solution.

.............................................................................................................................................................................. [1]

(iii) Give two reasons why the fermentation stopped.

............................................................................................................................................................................................................... [2]

**Topic** Chem 7 Q# 61/ IGCSE Chemistry/2015/s/Paper 32/Q6

(b) All nitrates decompose when heated. The extent to which a nitrate decomposes is determined by the metal in the salt.

(ii) Sodium nitrite is a reducing agent.

What would be observed if an excess of sodium nitrite solution was added to a solution of acidified potassium manganate(VII)?

............................................................................................................................................................................................................... [2]
Topic Chem 7 Q# 62/ IGCSE Chemistry/2015/s/Paper 32/Q3

(c) The reaction between calcium and nitrogen to form calcium nitride is a redox reaction.

In terms of electron transfer, explain why calcium is the reducing agent.

------------------------------------------------------------------------------------------

------------------------------------------------------------------------------------------ [3]

Topic Chem 7 Q# 63/ IGCSE Chemistry/2014/w/Paper 33/Q8

8 (a) Describe how cobalt chloride paper can be used to test for the presence of water.

------------------------------------------------------------------------------------------ [2]

Topic Chem 7 Q# 64/ IGCSE Chemistry/2014/w/Paper 33/Q5

5 (a) Sodium chlorate(I) decomposes to form sodium chloride and oxygen. The rate of this reaction is very slow at room temperature provided the sodium chlorate(I) is stored in a dark bottle to prevent exposure to light.

\[2\text{NaClO} \rightarrow 2\text{NaCl} + \text{O}_2\]

The rate of this decomposition can be studied using the following experiment.

Sodium chlorate(I) is placed in the flask and 0.2 g of copper(II) oxide is added. This catalyses the decomposition of the sodium chlorate(I) and the volume of oxygen collected is measured every minute. The results are plotted to give a graph of the type shown below.

![Graph showing volume of oxygen vs. time]
(i) Explain why the gradient (slope) of this graph decreases with time.

........................................................................................................................................ [2]

(ii) Cobalt(II) oxide is a more efficient catalyst for this reaction than copper(II) oxide. Sketch, on the grid, the graph for the reaction catalysed by cobalt(II) oxide. All other conditions were kept constant. [2]

(iii) What can you deduce from the comment that sodium chlorate(I) has to be shielded from light?

........................................................................................................................................ [1]

(iv) Explain, in terms of collisions between particles, why the initial gradient would be steeper if the experiment was repeated at a higher temperature.

........................................................................................................................................ [3]

Topic: Chem 7 Q# 65/ iGCSE Chemistry/2014/w/Paper 33/Q2

2 Compound X is a colourless liquid at room temperature.

(a) A sample of pure X was slowly heated from −5.0°C, which is below its melting point, to 90°C, which is above its boiling point. Its temperature is measured every minute and the results are represented on the graph.

(i) Complete the equation for the equilibrium present in the region BC.

\[ \text{X(s)} \rightleftharpoons \text{.........} \] [1]
2. Compound X is a colourless liquid at room temperature.

(a) A sample of pure X was slowly heated from $-5.0^\circ\text{C}$, which is below its melting point, to $90^\circ\text{C}$, which is above its boiling point. Its temperature is measured every minute and the results are represented on the graph.

(i) Complete the equation for the equilibrium present in the region BC.

\[ X(s) \leftrightarrow \text{..................} \] [1]

6. Sulfuric acid is an important acid, both in the laboratory and in industry. Sulfuric acid is manufactured in the Contact Process. Originally, it was made by heating metal sulfates and by burning a mixture of sulfur and potassium nitrate.

(b) A group of naturally occurring minerals have the formula of the type FeSO$_4$.$x$H$_2$O where $x$ is 1, 4, 5, 6 or 7. The most common of these minerals is iron(II) sulfate-$y$-water.

(i) When this mineral is heated gently it dehydrates.

\[ \text{FeSO}_4.7\text{H}_2\text{O} \rightleftharpoons \text{FeSO}_4 + 7\text{H}_2\text{O} \]

green \hspace{1cm} pale yellow

Describe how you could show that this reaction is reversible.

[2]

(b) Starch hydrolyses to glucose in the presence of the enzyme, amylase. What is meant by the term enzyme?
(c) The effect of temperature on this reaction can be studied by the experiment shown below.
Starch and iodine form a blue-black colour.
Glucose and iodine do not form a blue-black colour.

![Teat pipette to add a few drops of iodine](image)

water at different temperatures
aqueous starch and amylase (enzyme)

The experiment is set up as in the diagram and the time measured for the mixture to change from blue-black to colourless. The experiment is repeated at different temperatures. Typical results of this experiment are given in the table below.

<table>
<thead>
<tr>
<th>experiment</th>
<th>temperature /°C</th>
<th>time for blue-black colour to disappear /min</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>70</td>
<td>remained blue-black</td>
</tr>
</tbody>
</table>

(i) Put the experiments in order of reaction rate – slowest first and fastest last.  .................................................................................................................................................................................. [2]

(ii) Explain why the reaction rates in experiments A and B are different. ........................................................................................................................................................................................................... [3]

(iii) Suggest why the colour remains blue-black in experiment C. ........................................................................................................................................................................................................... [1]
(ii) Freezing does not kill the microbes.
Suggest why freezing is still a very effective way of preserving food.

Topic Chem 7 Q# 70/ IGCSE Chemistry/2014/s/Paper 33/Q3
(c) Describe how the pea plant makes a sugar such as glucose.

Topic Chem 7 Q# 71/ IGCSE Chemistry/2014/s/Paper 33/Q2
2 Explain each of the following in terms of the kinetic particle theory.
(a) The rate of most reactions increases at higher temperatures.

Topic Chem 7 Q# 72/ IGCSE Chemistry/2014/s/Paper 32/Q5
5 Carbonyl chloride is made from carbon monoxide and chlorine.

\[ \text{CO}(g) + \text{Cl}_2(g) \rightleftharpoons \text{COCl}_2(g) \]

(a) Two methods of preparing carbon monoxide are from methane and oxygen, and from methane and steam.
(ii) The following reaction is used to make carbon monoxide and hydrogen.
The reaction is carried out at 1100 °C and normal pressure.

\[ \text{CH}_4(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}(g) + 3\text{H}_2(g) \]

The reaction is reversible and comes to equilibrium. Suggest why a high temperature is used.

(iii) What is the disadvantage of using a high pressure for the reaction given in (a)(ii)?
(d) A piece of magnesium was added to 100 cm$^3$ of an aqueous acid. The time taken for the metal to react completely was measured. This experiment was repeated using different aqueous acids. The same volume of acid was used in each experiment and the pieces of magnesium used were identical. In one experiment the reaction was carried out at a different temperature.

<table>
<thead>
<tr>
<th>experiment</th>
<th>acid</th>
<th>concentration in mol/dm$^3$</th>
<th>temperature / ℃</th>
<th>time / minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>propanoic</td>
<td>1.0</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>propanoic</td>
<td>1.0</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>propanoic</td>
<td>0.5</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>hydrochloric</td>
<td>1.0</td>
<td>20</td>
<td>1</td>
</tr>
</tbody>
</table>

Explain the following in terms of collision rate between reacting particles.

(i) Why is the rate in experiment C slower than the rate in experiment A?

(ii) Why is the rate in experiment B faster than the rate in experiment A?

(iii) Why is the rate in experiment D faster than the rate in experiment A?

The table below gives the electron distributions of atoms of different elements.

<table>
<thead>
<tr>
<th>element</th>
<th>electron distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 + 7</td>
</tr>
<tr>
<td>B</td>
<td>2 + 8 + 4</td>
</tr>
<tr>
<td>C</td>
<td>2 + 8 + 8 + 1</td>
</tr>
<tr>
<td>D</td>
<td>2 + 8 + 18 + 5</td>
</tr>
<tr>
<td>E</td>
<td>2 + 8 + 18 + 7</td>
</tr>
<tr>
<td>F</td>
<td>2 + 8 + 18 + 18 + 8</td>
</tr>
</tbody>
</table>

For each of the following, select an element or elements from the table that matches the description. Each element may be selected once, more than once or not at all.
(e) The only oxidation state of this element is 0.

Topic Chem 8  Q# 75/ iGCSE Chemistry/2015/w/Paper 33/Q7

7 Two salts can be made from potassium hydroxide and sulfuric acid. They are potassium sulfate, $K_2SO_4$, and the acid salt potassium hydrogen sulfate, $KHSO_4$. They are both made by titration.

(b) In the conical flask there is a neutral solution of potassium sulfate which still contains the indicator used in the titration.

(i) Describe how you could obtain a solution of potassium sulfate without the indicator.

(ii) Potassium hydrogen sulfate can be made by the following reaction.

$$KOH(aq) + H_2SO_4(aq) \rightarrow KHSO_4(aq) + H_2O(l)$$

Suggest how you could make a solution of potassium hydrogen sulfate without using an indicator.

(c) Describe a test which would distinguish between aqueous solutions of potassium sulfate and sulfuric acid.

test ..........................................................................................................................

result ..........................................................................................................................
5 Sulfuric acid is a strong acid. In aqueous solution, it ionises as shown below.

\[ \text{H}_2\text{SO}_4 \rightarrow 2\text{H}^+ + \text{SO}_4^{2-} \]

(a) (i) What is meant by the term *acid*?

........................................................................................................................................... [1]

(ii) Sulfurous acid, \( \text{H}_2\text{SO}_3 \), is a weak acid.

State the difference between a weak acid and a strong acid.

........................................................................................................................................... [2]

(b) Sulfurous acid forms salts called sulfites, which contain the ion \( \text{SO}_3^{2-} \).

When barium nitrate solution is added to aqueous sulfurous acid, a white precipitate, A, forms.

Bromine water changes from brown to colourless when added to aqueous sulfurous acid.

Bromine oxidises sulfurous acid. When this solution is tested with acidified barium nitrate solution, a different white precipitate, B, is formed.

(i) Identify the white precipitate, A.

........................................................................................................................................... [1]

(ii) Identify the white precipitate, B.

........................................................................................................................................... [1]

(iv) Name the product formed by the oxidation of sulfurous acid.

........................................................................................................................................... [1]

(c) Complete the following word equations.

(i) magnesium hydroxide + dilute sulfuric acid

........................................................................................................................................... [1]

(ii) zinc + dilute sulfuric acid

........................................................................................................................................... [1]

(iii) copper carbonate + dilute sulfuric acid

........................................................................................................................................... [1]
(d) Write equations for the reaction of dilute sulfuric acid with each of the following.

(i) ammonia

............................................................................................................................................. [2]

(ii) sodium hydroxide

............................................................................................................................................. [2]

(iii) iron

............................................................................................................................................. [2]

1. a) Describe a chemical test which shows the presence of water.

   test .............................................................................................................................................

   colour change if water is present ..............................................................................................

............................................................................................................................................. [3]

(g) Describe how you could show that magnesium oxide is a basic oxide and not an amphoteric oxide.

............................................................................................................................................. [2]

(b) The burning of fossil fuels is largely responsible for the formation of acid rain. Two of the acids in acid rain are sulfuric acid and nitric acid.

(iii) Nitric acid contains nitrate ions.

   Describe a test for nitrate ions.

............................................................................................................................................. [2]

(iv) Explain how you could determine which one of two samples of acid rain had the higher concentration of hydrogen ions.

............................................................................................................................................. [2]
This question is concerned with the following oxides:

- aluminium oxide
- carbon monoxide
- copper(II) oxide
- silicon(IV) oxide
- sodium oxide
- sulfur dioxide
- zinc oxide

Choose one oxide from the above list to match each of the following descriptions. An oxide may be used once, more than once or not at all.

(a) This oxide does not react with acid or alkali. ................................................................. [1]

(b) This oxide reacts with water to give a strong alkali solution. ........................................... [1]

(d) This oxide is amphoteric. .................................................................................................... [1]

(f) This oxide is soluble in water and it is acidic. ................................................................... [1]

Three common methods of preparing salts are shown below.

- method A adding an excess of an insoluble base or carbonate or metal to a dilute acid and removing excess by filtration
- method B using a burette and indicator
- method C mixing two solutions to obtain the salt by precipitation

For each of the following salt preparations, choose a method, A, B or C. Name any additional reagent which is needed and complete the equation.

(a) the soluble salt, nickel chloride, from the insoluble compound nickel carbonate

method .................................................................

reagent .................................................................

word equation ......................................................................................................................... [3]

(b) the insoluble salt, lead(II) bromide, from aqueous lead(II) nitrate

method .................................................................

reagent .................................................................

ionic equation ....... + ........ → PbBr₂ [3]
(c) the soluble salt, lithium sulfate, from the soluble base lithium hydroxide

method ................................................................................................................................. [4]
reagent .......................................................................................................................................

Equation ....................................................................................................................................

6 A student is told to produce the maximum amount of copper from a mixture of copper and copper(II) carbonate.

The student adds the mixture to an excess of dilute sulfuric acid in a beaker and stirs the mixture with a glass rod. The copper(II) carbonate reacts with the sulfuric acid, forming a solution of copper(II) sulfate but the copper does not react with the sulfuric acid.

The student then

- removes the unreacted copper from the mixture,
- converts the solution of copper(II) sulfate into copper by a series of reactions.

(a) Describe two things that the student would observe when the mixture is added to the dilute sulfuric acid.

.................................................................................................................................................. [2]

(c) The student then adds sodium hydroxide solution to the copper(II) sulfate solution to produce copper(II) hydroxide.

(i) Describe what the student would observe.

.................................................................................................................................................. [1]

(ii) Write an ionic equation for this reaction.

.................................................................................................................................................. [1]

Topic Chem 8 Q# 83/ IGCSE Chemistry/2015/m/Paper 32/Q3
3 Ammonia is manufactured by the Haber process. Nitrogen and hydrogen are passed over a catalyst at a temperature of 450°C and a pressure of 200 atmospheres.

The equation for the reaction is as follows:

\[ \text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 \]

The forward reaction is exothermic.

(h) Ammonia acts as a base when it reacts with sulfuric acid.

(i) What is a base?

.................................................................................................................................................. [1]

(ii) Write a balanced equation for the reaction between ammonia and sulfuric acid.

.................................................................................................................................................. [2]
Topic Chem 8 Q# 84/ IGCSE Chemistry/2015/m/Paper 32/Q1

1 For each of the following, give the name of an element from Period 3 (sodium to argon), which matches the description.

(c) an element that forms a basic oxide of the type XO

............................................................................................................................... [1]

(e) an element that forms an amphoteric oxide

............................................................................................................................... [1]

Topic Chem 8 Q# 85/ IGCSE Chemistry/2015/m/Paper 32/Q1

1 For each of the following, give the name of an element from Period 3 (sodium to argon), which matches the description.

Topic Chem 8 Q# 86/ IGCSE Chemistry/2014/w/Paper 33/Q8

(b) Complete the description of the preparation of crystals of the soluble salt, cobalt(II) chloride-5-water, CoCl₄·6H₂O, from the insoluble base, cobalt(II) carbonate.

\[
\text{CoCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CoCl}_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})
\]

50 cm³ of dilute hydrochloric acid, concentration 2.2 mol/dm³, was heated and cobalt(II) carbonate was added in small amounts until .................................................................

...........................................................................................................................................

...........................................................................................................................................

...........................................................................................................................................

...........................................................................................................................................

........................................................................................................................................... [4]

Topic Chem 8 Q# 87/ IGCSE Chemistry/2014/w/Paper 33/Q6

6 Rubidium and strontium are very reactive metals at the top of the reactivity series. Because their ions have different charges, their compounds behave differently when heated.

(b) Strontium carbonate is similar to calcium carbonate. It is insoluble in water and it decomposes when heated. Rubidium carbonate is soluble in water and does not decompose when heated.

(i) Describe a method to prepare a pure sample of the insoluble salt, strontium carbonate, by precipitation.

...........................................................................................................................................

...........................................................................................................................................

...........................................................................................................................................

...........................................................................................................................................

........................................................................................................................................... [4]
Topic Chem 8 Q# 88/ IGCSE Chemistry/2014/w/Paper 32/Q6

(c) When a mixture of sulfur and potassium nitrate is burned and the products are dissolved in water, sulfuric acid is formed.

(i) The sulfuric acid formed by this method is not pure. It contains another acid. Deduce the identity of this acid.

[1]

Topic Chem 8 Q# 89/ IGCSE Chemistry/2014/w/Paper 32/Q1

1 An important aspect of chemistry is purity and methods of purification.

- chromatography
- crystallisation
- diffusion
- dissolving
- evaporation
- filtration
- fractional distillation
- simple distillation

(ii) Describe how you would obtain a pure sample of copper(II) sulfate-5-water crystals from a mixture of copper(II) sulfate-5-water with copper(II) oxide using some of the techniques listed above.

[4]

Topic Chem 8 Q# 90/ IGCSE Chemistry/2014/s/Paper 32/Q7

7 The soluble salt hydrated lithium sulfate is made by titration from the soluble base lithium hydroxide.

(a) The sulfuric acid is added slowly from the burette until the indicator just changes colour. The volume of sulfuric acid needed to just neutralise the lithium hydroxide is noted.

Describe how you would continue the experiment to obtain pure dry crystals of hydrated lithium sulfate.
(c) Scandium oxide is insoluble in water. Describe how you could show that it is an amphoteric oxide.

---

**Topic Chem 9**  
**Q# 92/ iGCSE Chemistry/2015/w/Paper 33/Q6**

6 A reactivity series of metals is given below.

<table>
<thead>
<tr>
<th>metal name</th>
<th>symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium</td>
<td>Na</td>
</tr>
<tr>
<td>lithium</td>
<td>Li</td>
</tr>
<tr>
<td>magnesium</td>
<td>Mg</td>
</tr>
<tr>
<td>zinc</td>
<td>Zn</td>
</tr>
<tr>
<td>manganese</td>
<td>Mn</td>
</tr>
<tr>
<td>iron</td>
<td>Fe</td>
</tr>
<tr>
<td>copper</td>
<td>Cu</td>
</tr>
<tr>
<td>rhodium</td>
<td>Rh</td>
</tr>
</tbody>
</table>

(a) Which **two** metals will react most vigorously with cold water?

(f) Manganese is a typical transition metal.

Predict **three** physical and **two** chemical properties of this metal.

**physical properties**

**chemical properties**
2. Choose from the following list of gases. A gas may be chosen once, more than once or not at all.

- sulfur dioxide
- hydrogen
- methane
- carbon monoxide
- argon
- ethene
- butane

(d) It is used to provide an inert atmosphere for welding. ........................................... [1]

Topic Chem 9 Q# 94/ iGCSE Chemistry/2015/m/Paper 32/Q1

1. For each of the following, give the name of an element from Period 3 (sodium to argon), which matches the description.

(d) an element used as an inert atmosphere in lamps

......................................................................................................................... [1]

(f) an element that reacts vigorously with cold water to produce hydrogen

......................................................................................................................... [1]

Topic Chem 9 Q# 95/ iGCSE Chemistry/2014/w/Paper 33/Q3

(c) A mixture of a fullerene and potassium is an excellent conductor of electricity.

(iii) The mixture of fullerene and potassium has to be stored out of contact with air. There are substances in unpolluted air which will react with potassium. Name two potassium compounds which could be formed when potassium is exposed to air.

......................................................................................................................... [2]

Topic Chem 9 Q# 96/ iGCSE Chemistry/2014/w/Paper 33/Q1

1. For each of the following elements give one physical property and one chemical property.

(a) bromine (Br₂)

physical property ...........................................................................................................

chemical property ....................................................................................................... [2]

(c) manganese (Mn)

physical property ...........................................................................................................

chemical property ....................................................................................................... [2]

Topic Chem 9 Q# 97/ iGCSE Chemistry/2014/s/Paper 33/Q1

1. Choose a gas from the following list to answer the questions below. Each gas may be used once, more than once or not at all.

- ammonia
- carbon dioxide
- carbon monoxide
- fluorine
- hydrogen
- krypton
- nitrogen
- propene
- sulfur dioxide

(c) It is a noble gas. ........................................................................................................... [1]

(e) It is a very reactive non-metal. ................................................................................... [1]
6 Scandium, proton number 21, is not a typical transition element.

(a) Scandium is a low density metal which has only one oxidation state in its compounds. Scandium compounds are white solids which form colourless solutions. Titanium, the next metal in the period, is a far more typical transition element. How would the properties of titanium differ from those of scandium?

[3]

1 The table below gives the electron distributions of atoms of different elements.

<table>
<thead>
<tr>
<th>element</th>
<th>electron distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 + 7</td>
</tr>
<tr>
<td>B</td>
<td>2 + 8 + 4</td>
</tr>
<tr>
<td>C</td>
<td>2 + 8 + 8 + 1</td>
</tr>
<tr>
<td>D</td>
<td>2 + 8 + 18 + 5</td>
</tr>
<tr>
<td>E</td>
<td>2 + 8 + 18 + 7</td>
</tr>
<tr>
<td>F</td>
<td>2 + 8 + 18 + 18 + 8</td>
</tr>
</tbody>
</table>

For each of the following, select an element or elements from the table that matches the description. Each element may be selected once, more than once or not at all.

(a) These two elements are in the same group.

[1]

(c) This element reacts violently with cold water.

[1]

(f) This element is bromine.

[1]
6 A reactivity series of metals is given below.

<table>
<thead>
<tr>
<th>metal name</th>
<th>symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium</td>
<td>Na</td>
</tr>
<tr>
<td>lithium</td>
<td>Li</td>
</tr>
<tr>
<td>magnesium</td>
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</tr>
<tr>
<td>zinc</td>
<td>Zn</td>
</tr>
<tr>
<td>manganese</td>
<td>Mn</td>
</tr>
<tr>
<td>iron</td>
<td>Fe</td>
</tr>
<tr>
<td>copper</td>
<td>Cu</td>
</tr>
<tr>
<td>rhodium</td>
<td>Rh</td>
</tr>
</tbody>
</table>

(b) Which two metals will not react with dilute hydrochloric acid?  

........................................................................................................... [1]

(e) Describe a test-tube experiment which will show that manganese is more reactive than copper.

...........................................................................................................[3]

Topic Chem 10 Q# 101/ iGCSE Chemistry/2015/w/Paper 32/Q5

5 Iron is extracted from its ore, hematite, in a blast furnace.

Substances added to the furnace are:
- iron ore, hematite, containing impurities such as silica, SiO₂
- air
- coke, C
- limestone, CaCO₃

Substances formed in the blast furnace are:
- molten iron
- molten slag
- waste gases such as carbon dioxide

(a) State the two functions of the coke used in the blast furnace.

...........................................................................................................[2]

(b) Write an equation for the conversion of hematite, Fe₂O₃, to iron.

...........................................................................................................[2]
(c) Explain how the silica impurity is removed and separated from the molten iron.

........................................................................................................................................... [3]

........................................................................................................................................... [3]

(d) The molten iron from the furnace is impure.
It contains impurities which include the element carbon.

Explain how the carbon is removed. Include an equation in your answer.

........................................................................................................................................... [2]

........................................................................................................................................... [1]

........................................................................................................................................... [2]

Total: 10

3 Two of the main uses of zinc are for galvanising and for making alloys.

One of the main ores of zinc is zinc blende, ZnS. There are two stages in the extraction of zinc from
this ore.

(a) **Stage 1** Zinc oxide is made from zinc blende.

Describe how this is done and write a word equation for the reaction.

........................................................................................................................................... [2]

........................................................................................................................................... [1]
(e) In an experiment to investigate the rate of rusting of steel, three pieces of steel were used. One piece of steel was completely coated with copper, one piece completely coated with zinc and the third piece was left uncoated. All three pieces were left exposed to the atmosphere.

(ii) The coating on both of the other two pieces was scratched, exposing the steel.

exposed steel does not rust

thin layer of zinc

steel

The piece of steel coated with zinc still did not rust but the copper-coated piece of steel rusted very rapidly.

Explain these observations in terms of the formation of ions and the transfer of electrons

(topic)

Topic Chem 10 Q# 103/ iGCSE Chemistry/2015/w/Paper 32/Q3

(e) In an experiment to investigate the rate of rusting of steel, three pieces of steel were used. One piece of steel was completely coated with copper, one piece completely coated with zinc and the third piece was left uncoated. All three pieces were left exposed to the atmosphere.

(i) Explain why the uncoated piece started to rust.

(topic)

Topic Chem 10 Q# 104/ iGCSE Chemistry/2015/s/Paper 33/Q6

6 Chemical reactions are always accompanied by an energy change.

(a) Aluminium is extracted by the electrolysis of a molten mixture which contains aluminium oxide, \( \text{Al}_2\text{O}_3 \). This decomposes to form aluminium at the negative electrode and oxygen at the positive electrode.

(i) Write an ionic equation for the reaction at the negative electrode.

(ii) Complete the ionic equation for the reaction at the positive electrode.

\[ 2\text{O}^{2-} \rightarrow \ldots \ldots \]
(iii) Is the reaction exothermic or endothermic? Explain your answer. [1]

(b) The cell shown below can be used to determine the order of reactivity of metals.

(i) Is the reaction in the cell exothermic or endothermic? Explain your answer. [1]

(ii) Explain why the mass of the magnesium electrode decreases and the mass of the copper electrode increases. [2]

(iii) How could you use this cell to determine which is the more reactive metal, magnesium or manganese? [2]

Topic Chem 10 Q# 105/ iGCSE Chemistry/2015/s/Paper 33/Q5

5 The law of constant composition states that all pure samples of a compound contain the same elements in the same proportion by weight.

A typical experiment to test this law is to prepare the same compound by different methods and then show that the samples have the same composition.

Methods of making copper(II) oxide include:

- heating copper carbonate,
- heating copper hydroxide,
- heating copper nitrate,
- heating copper foil in air.

(a) Complete the following equations.

(i) $\text{CuCO}_3 \rightarrow \text{........} + \text{........}$ [1]
(ii) \( \text{Cu(OH)}_2 \rightarrow \text{.........} + \text{.........} \) \[1\]

(iii) \( 2\text{Cu(NO}_3\text{)}_2 \rightarrow \text{.........} + 4\text{NO}_2 + \text{.........} \) \[2\]

(b) Copper oxide can be reduced to copper by heating in hydrogen.

(i) What colour change would you observe during the reduction?

........................................................................................................... \[1\]

(ii) Explain why the copper must be allowed to cool in hydrogen before it is exposed to air.

........................................................................................................... \[2\]

(iii) Name another gas which can reduce copper(II) oxide to copper.

........................................................................................................... \[1\]

(iv) Name a solid which can reduce copper(II) oxide to copper.

........................................................................................................... \[1\]

Topic: Chem 10  
Q# 106/  
iGCSE Chemistry/2015/s/Paper 32/Q6

(b) All nitrates decompose when heated. The extent to which a nitrate decomposes is determined by the metal in the salt.

(i) Sodium nitrate decomposes to form sodium nitrite, \( \text{NaNO}_2 \).

Write the equation for decomposition of sodium nitrate.

........................................................................................................... \[2\]

(iii) Copper(II) nitrate decomposes to form copper(II) oxide, nitrogen dioxide and oxygen.

What is the relationship between the extent of decomposition and the reactivity of the metal in the nitrate?

........................................................................................................... \[1\]

(c) The equation for the decomposition of copper(II) nitrate is given below.

\[ 2\text{Cu(NO}_3\text{)}_2 \rightarrow 2\text{CuO} + 4\text{NO}_2 + \text{O}_2 \]

(i) Predict what you would observe when copper(II) nitrate is heated.

........................................................................................................... 

........................................................................................................... 

........................................................................................................... \[3\]
6 A student is told to produce the maximum amount of copper from a mixture of copper and copper(II) carbonate.

The student adds the mixture to an excess of dilute sulfuric acid in a beaker and stirs the mixture with a glass rod. The copper(II) carbonate reacts with the sulfuric acid, forming a solution of copper(II) sulfate but the copper does not react with the sulfuric acid.

The student then

- removes the unreacted copper from the mixture,
- converts the solution of copper(II) sulfate into copper by a series of reactions.

(d) After separating the copper(II) hydroxide from the mixture, the copper(II) hydroxide is heated strongly. The copper(II) hydroxide decomposes into copper(II) oxide and steam.

(i) Write an equation for the decomposition of copper(II) hydroxide. Include state symbols.  

(ii) Name a non-metallic element that can be used to convert copper(II) oxide into copper.  

---

5 Aluminium and iron are extracted from their ores by different methods.

Aluminium is extracted from its purified oxide ore by electrolysis.

(a) What is the name of the ore of aluminium which consists mainly of aluminium oxide?

(b) The electrodes are both made of the same substance.

Name this substance.

(c) Aluminium oxide is dissolved in molten cryolite before it is electrolysed.

Give two reasons why aluminium oxide dissolved in molten cryolite is electrolysed rather than molten aluminium oxide alone.
(d) Write the ionic equations for the reactions at the electrodes in this electrolysis.

anode (positive electrode) ...................................................................................................................... [2]

cathode (negative electrode) ................................................................................................................... [2]

(e) Iron is extracted from its oxide ore by reduction using carbon in a blast furnace.

(i) Place the elements aluminium, carbon and iron in order of reactivity with the least reactive element first.
......................................................................................................................................................... [1]

(ii) Use your answer to (e)(i) to explain why iron is extracted by reduction using carbon but aluminium is not.
......................................................................................................................................................... [1]

(f) What is the name of the ore of iron which consists mainly of iron(III) oxide?
......................................................................................................................................................... [1]

(g) Write balanced equations for the reactions occurring in the blast furnace which involve

(i) the complete combustion of coke (carbon).
......................................................................................................................................................... [1]

(ii) the production of carbon monoxide from carbon dioxide,
......................................................................................................................................................... [1]

(iii) the reduction of iron(III) oxide,
......................................................................................................................................................... [1]

(iv) the formation of slag.
......................................................................................................................................................... [1]
6 Rubidium and strontium are very reactive metals at the top of the reactivity series. Because their ions have different charges, their compounds behave differently when heated.
(ii) Complete the equation for the decomposition of strontium carbonate.

\[ \text{SrCO}_3 \rightarrow \text{ } \rightarrow \text{ } + \text{ } \rightarrow \]

[1]

(c) Metal nitrates decompose when heated.
(i) Rubidium nitrate decomposes as follows:

\[ 2\text{RbNO}_3 \rightarrow 2\text{RbNO}_2 + \text{O}_2 \]

What is the name of the compound RbNO₂?

............................................................................................................. [1]

(ii) The nitrates of most other metals decompose in a different way. Complete the equation for the decomposition of strontium nitrate.

\[ \text{ } \rightarrow \text{ } \rightarrow \text{ } + 4\text{NO}_2 + \text{ } \rightarrow \]

[2]

2 Compound X is a colourless liquid at room temperature.

(a) A sample of pure X was slowly heated from −5.0 °C, which is below its melting point, to 90 °C, which is above its boiling point. Its temperature is measured every minute and the results are represented on the graph.

(iv) What would be the difference in the region BC if an impure sample of X had been used?

............................................................................................................. [1]

1 For each of the following elements give one chemical property.
(b) carbon

[1]
(ii) The heat causes some of the potassium nitrate to decompose. Write the equation for the action of heat on potassium nitrate.

(a) Name an alloy which contains zinc. What is the other metal in this alloy?

name of alloy ................................................................................................................................. [2]
other metal in alloy ........................................................................................................................[2]

(b) The main ore of zinc is zinc blende, ZnS.

(i) The ore is heated in the presence of air to form zinc oxide and sulfur dioxide. Write the equation for this reaction.

.................................................................................................................................................. [2]

2 Aluminium is obtained by the reduction of aluminium ions to aluminium atoms.

(a) Write an ionic equation for the reduction of an aluminium ion to an aluminium atom.

.................................................................................................................................................. [2]

(b) The original method of extracting aluminium involved the reduction of aluminium chloride using the reactive metal sodium. Aluminium obtained by this method was very expensive due to the high cost of extracting sodium from sodium chloride.

(i) Complete the equation for this reduction.

\[ \text{AlCl}_3 + \text{...Na} \rightarrow \text{...} + \text{...} \] [2]

(c) In the modern method, aluminium is obtained by the electrolysis of aluminium oxide (alumina) dissolved in molten cryolite, Na$_3$AlF$_6$.

![Diagram of electrolysis process]

waste gases, O$_2$, CO$_2$, CO, F$_2$

carbon anode (+)

carbon cathode (−)
mixture of aluminium oxide and cryolite
molten aluminium
(i) The major ore of aluminium is impure aluminium oxide. What is the name of this ore?

......................................................................................................................................................................................... [1]

(ii) This ore is a mixture of aluminium oxide, which is amphoteric, and iron(III) oxide which is basic. Explain how these two oxides can be separated by the addition of aqueous sodium hydroxide.

........................................................................................................................................................................................................................................................................................................................................................................ [2]

(iii) Give two reasons why the electrolyte contains cryolite.

........................................................................................................................................................................................................................................................................................................................................................................ [2]

(iv) The mixture of gases evolved at the positive electrode includes:

- carbon dioxide
- carbon monoxide
- fluorine
- oxygen

Explain the presence of these gases in the gaseous mixture formed at the positive electrode. Include at least one equation in your explanation.

........................................................................................................................................................................................................................................................................................................................................................................ [5]

(d) A major use of aluminium is the manufacture of pots and pans. One reason for this is its resistance to corrosion.

(i) Explain why aluminium, a reactive metal, is resistant to corrosion.

........................................................................................................................................................................................................................................................................................................................................................................ [1]

(ii) Suggest two other reasons why aluminium is suitable for making pots and pans.

........................................................................................................................................................................................................................................................................................................................................................................ [2]
7 Aluminium is obtained from purified alumina, Al₂O₃, by electrolysis.

(a) Alumina is obtained from the main ore of aluminium. 
State the name of this ore. ................................................................................................................. [1]

(c) Aluminium is resistant to corrosion. It is protected by an oxide layer on its surface. 
The thickness of this oxide layer can be increased by anodising.

(i) State a use of aluminium due to its resistance to corrosion. .............................................................. [1]

4 Iron from a blast furnace contains about 5% of the impurities – carbon, silicon, phosphorus and sulfur. Most of this impure iron is used to make steels, such as mild steel, and a very small percentage is used to make pure iron.

(a) Calcium oxide and oxygen are used to remove the impurities from the iron produced in the blast furnace.

(ii) Describe how these two chemicals remove the four impurities. Include at least one equation in your answer.
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................ [5]

(iii) Mild steel is an alloy of iron and carbon. 
Suggest why mild steel is harder than pure iron.
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................ [2]

(c) Describe how water is treated before it is supplied to homes and industry. 
............................................................................................................................................................ [2]

(d) State two industrial uses of water. 
............................................................................................................................................................ [2]
2 (a) Polluted air contains two oxides of carbon and two oxides of nitrogen. A major source of these pollutants is motor vehicles.

(i) Describe how carbon dioxide and carbon monoxide are formed in motor vehicle engines.

(ii) State one adverse effect of each of these gases.

(iii) Nitrogen monoxide, NO, is released by motor vehicle exhausts.

   Explain how nitrogen monoxide is formed in motor vehicle engines.

(iv) When nitrogen monoxide is released into the atmosphere, nitrogen dioxide, NO₂, is formed.

   Suggest an explanation why this happens.

(b) Predict the possible adverse effect on the environment when this non-metal oxide, NO₂, reacts with water and oxygen.

(c) How are the amounts of carbon monoxide and nitrogen monoxide emitted by modern motor vehicles reduced? Include an equation in your answer.
Q# 119/ iGCSE Chemistry/2015/s/Paper 33/Q4

(b) The burning of fossil fuels is largely responsible for the formation of acid rain. Two of the acids in acid rain are sulfuric acid and nitric acid.

(i) Explain how the combustion of coal can form sulfuric acid.

......................................................................................................................................................... [3]

.........................................................................................................................................................

(ii) High temperatures generated by the combustion of fossil fuels can lead to the formation of nitric acid. Explain.

......................................................................................................................................................... [3]

Q# 120/ iGCSE Chemistry/2015/s/Paper 32/Q7

7 Alcohols can be made by fermentation or from petroleum.

(a) Ethanol can be made by the fermentation of glucose:

$$C_6H_{12}O_6(aq) \xrightarrow{\text{yeast}} 2C_2H_5OH(aq) + 2CO_2(g)$$ exothermic reaction

Yeast are living single-cell fungi which ferment glucose by anaerobic respiration. This reaction is catalysed by enzymes from the yeast.

(i) What is meant by the term respiration?

......................................................................................................................................................... [3]

.........................................................................................................................................................

(ii) Anaerobic means in the absence of oxygen.

Name the products formed from respiration in the presence of oxygen.

......................................................................................................................................................... [1]

Q# 121/ iGCSE Chemistry/2015/s/Paper 32/Q6

6 The Alacama desert in Chile has deposits of the salt sodium nitrate. Very large amounts of this salt were exported to Europe for use as a fertiliser. After the introduction of the Haber process in 1913, this trade rapidly diminished.

(a) (i) Explain why the introduction of the Haber process reduced the demand for sodium nitrate.

......................................................................................................................................................... [2]
(III) Suggest why surface deposits of sodium nitrate only occur in areas with very low rainfall such as desert areas.

................................................................................................................................................. [1]

(III) The desert has smaller surface deposits of potassium nitrate.

Suggest why potassium nitrate is a better fertiliser than the sodium salt.

................................................................................................................................................. [1]

Topic  Chem 11  Q# 122/  iGCSE Chemistry/2015/s/Paper 32/Q4
4 Ammonia is made by the Haber process.

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \]

The forward reaction is exothermic.

Typical reaction conditions are:

- finely divided iron catalyst,
- temperature 450 °C,
- pressure 200 atmospheres.

(a) Explain why the catalyst is used as a very fine powder and larger pieces of iron are not used.

.................................................................................................................................................

................................................................................................................................................. [2]

(b) Using the above conditions, the equilibrium mixture contains about 15% ammonia.

State two changes to the reaction conditions which would increase the percentage of ammonia at equilibrium.

.................................................................................................................................................

................................................................................................................................................. [2]

(c) Suggest why the changes you have described in (b) are not used in practice.

.................................................................................................................................................

................................................................................................................................................. [2]
Ammonia is manufactured by the Haber process. Nitrogen and hydrogen are passed over a catalyst at a temperature of 450 °C and a pressure of 200 atmospheres.

The equation for the reaction is as follows.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

The forward reaction is exothermic.

(a) State one use of ammonia.

................................................................................................................................................ [1]

(b) What is the meaning of the symbol $\rightleftharpoons$?

................................................................................................................................................ [1]

(c) What are the sources of nitrogen and hydrogen used in the Haber process?

   nitrogen .............................................................................................................................................. [2]

   hydrogen ............................................................................................................................................ [2]

(d) Name the catalyst in the Haber process.

................................................................................................................................................ [1]

(e) (i) If a temperature higher than 450 °C was used in the Haber process, what would happen to the rate of the reaction? Give a reason for your answer.

................................................................................................................................................

................................................................................................................................................ [2]

(ii) If a temperature higher than 450 °C was used in the Haber process, what would happen to the yield of ammonia? Give a reason for your answer.

................................................................................................................................................

................................................................................................................................................ [2]

(f) (i) If a pressure higher than 200 atmospheres was used in the Haber process, what would happen to the yield of ammonia? Give a reason for your answer.

................................................................................................................................................

................................................................................................................................................ [2]
(ii) Explain why the rate of reaction would be faster if the pressure was greater than 200 atmospheres.

.............................................................................................................................................. [1]

(iii) Suggest one reason why a pressure higher than 200 atmospheres is not used in the Haber process.

.............................................................................................................................................. [1]

Topic Chem 11 Q# 124/ iGCSE Chemistry/2015/m/Paper 32/Q1

1 For each of the following, give the name of an element from Period 3 (sodium to argon), which matches the description.
   (b) an element that is added to water to kill bacteria

.............................................................................................................................................. [1]

Topic Chem 11 Q# 125/ iGCSE Chemistry/2014/s/Paper 33/Q5

5 Ammonia is made by the Haber process.

\[ \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) \]

The forward reaction is exothermic.
The conditions in the reaction chamber are:

- a pressure of 200 atmospheres,
- a catalyst of finely divided iron,
- a temperature of 400 to 450°C.

(a) What are the two advantages of using a high pressure? Give a reason for both.

advantage 1 ........................................................................................................................................... reason .......................................................................................................................................................... ...........................................................................................................................................................

advantage 2 ........................................................................................................................................... reason .......................................................................................................................................................... ...........................................................................................................................................................

.............................................................................................................................................. [4]

(b) A higher temperature would give a faster reaction rate.

Why is a higher temperature not used?

.............................................................................................................................................. [3]
(c) (i) Why is the iron catalyst used as a fine powder?

(ii) Give two reasons why a catalyst is used.

Topic Chem 11 Q# 126/ iGCSE Chemistry/2014/s/Paper 33/Q4
4 Iron from a blast furnace contains about 5% of the impurities – carbon, silicon, phosphorus and sulfur. Most of this impure iron is used to make steels, such as mild steel, and a very small percentage is used to make pure iron.

(a) Calcium oxide and oxygen are used to remove the impurities from the iron produced in the blast furnace.

(i) State how these chemicals are manufactured.

Oxygen

Topic Chem 11 Q# 127/ iGCSE Chemistry/2014/s/Paper 33/Q1
1 Choose a gas from the following list to answer the questions below. Each gas may be used once, more than once or not at all.

ammonia carbon dioxide carbon monoxide fluorine
hydrogen krypton nitrogen propene sulfur dioxide

(a) It is a product of respiration.

Topic Chem 11 Q# 128/ iGCSE Chemistry/2014/s/Paper 33/Q1
1 Choose a gas from the following list to answer the questions below. Each gas may be used once, more than once or not at all.

ammonia carbon dioxide carbon monoxide fluorine
hydrogen krypton nitrogen propene sulfur dioxide

(d) It is the main component of air.

Topic Chem 11 Q# 129/ iGCSE Chemistry/2014/s/Paper 32/Q5
5 Carbonyl chloride is made from carbon monoxide and chlorine.

\[ CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g) \]

(a) Two methods of preparing carbon monoxide are from methane and oxygen, and from methane and steam.

(i) The reaction between methane and oxygen can also form carbon dioxide. How can carbon monoxide be made instead of carbon dioxide?
3 Plant growth is improved by the availability of essential elements, such as nitrogen, and by the soil having a suitable pH.

(a) Nitrogen-based fertilisers are made from ammonia. Ammonia is manufactured by the Haber process.

(i) Describe the Haber process giving reaction conditions and a balanced equation. (Do not discuss reaction rate and yield.)

........................................................................................................................................ [5]

(ii) Fertilisers contain nitrogen. Name the other two elements essential for plant growth commonly found in fertilisers.

........................................................................................................................................... [2]

(b) Crops do not grow well if the soil is too acidic.

(i) One cause of acidity in soil is acid rain. Explain how acid rain is formed.

........................................................................................................................................ [3]

2 (a) Natural gas, which is mainly methane, is a fossil fuel.

(ii) What are the two main disadvantages in the widespread use of fossil fuels?

........................................................................................................................................... [2]

Topic   Chem 12   Q# 132/ iGCSE Chemistry/2015/w/Paper 33/Q2
2  Choose from the following list of gases. A gas may be chosen once, more than once or not at all.

sulfur dioxide       hydrogen       methane       carbon monoxide

argon       ethene       butane

(a) It is used to bleach wood pulp. ........................................................................................ [1]
2 This question is concerned with the following oxides.

aluminium oxide
carbon monoxide
copper(II) oxide
silicon(IV) oxide
sodium oxide
sulfur dioxide
zinc oxide

Choose one oxide from the above list to match each of the following descriptions. An oxide may be used once, more than once or not at all.

(c) This oxide is used as a bleach. ................................................................. [1]

6 Sulfuric acid is an important acid, both in the laboratory and in industry. Sulfuric acid is manufactured in the Contact Process. Originally, it was made by heating metal sulfates and by burning a mixture of sulfur and potassium nitrate.

(a) Give a major use of sulfuric acid.

................................................................................................................................. [1]

(ii) When the iron(II) sulfate is heated strongly, further decomposition occurs.

$$2\text{FeSO}_4(s) \rightarrow \text{Fe}_2\text{O}_3(s) + \text{SO}_2(g) + \text{SO}_3(g)$$

The gases formed in this reaction react with water and oxygen to form sulfuric acid. Explain how the sulfuric acid is formed.

................................................................................................................................. [2]

7 Give a major use of sulfur dioxide.

................................................................................................................................. [1]

8 Choose a gas from the following list to answer the questions below. Each gas may be used once, more than once or not at all.

ammonia carbon dioxide carbon monoxide fluorine
hydrogen krypton nitrogen propene sulfur dioxide

(f) It is used to kill micro-organisms in fruit juice. ................................................................. [1]

3 Quicklime, which is calcium oxide, is made by heating limestone in a furnace.

$$\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$$

The reaction does not come to equilibrium.
(b) Calcium hydroxide, slaked lime, is made from calcium oxide.

Write an equation for this reaction.

................................................................................................................ [2]

(c) Calculate the maximum mass of calcium oxide which could be made from 12.5 tonnes of calcium carbonate. 1 tonne = $1 \times 10^6$ g.

................................................................................................................ [2]

(d) Limestone is used in agriculture to reduce the acidity of soil and for the desulphurisation of flue gases in power stations.

(i) Most crops thrive in soils whose pH is close to 7. Calcium carbonate, which is insoluble in water, and calcium oxide, which is slightly soluble in water, are both used to reduce the acidity of soils.

Suggest two advantages of using calcium carbonate for this purpose.

1. .................................................................................................................. [2]

2. .................................................................................................................. [2]

(ii) Explain the chemistry of desulphurisation of flue gases.

.................................................................................................................. [3]

(iii) Give one other use of calcium carbonate.

.................................................................................................................. [1]

Topic | Chem 13 | Q# 138/ | iGCSE Chemistry/2014/s/Paper 33/Q4
4 Iron from a blast furnace contains about 5% of the impurities – carbon, silicon, phosphorus and sulfur. Most of this impure iron is used to make steels, such as mild steel, and a very small percentage is used to make pure iron.

(a) Calcium oxide and oxygen are used to remove the impurities from the iron produced in the blast furnace.

(i) State how these chemicals are manufactured.

calcium oxide ........................................................................................................ [1]
3. Plant growth is improved by the availability of essential elements, such as nitrogen, and by the soil having a suitable pH.
   
   (b) Crops do not grow well if the soil is too acidic.

   (ii) Name two bases which are used to increase the pH of acidic soils.

   [2]

Topic Chem 14  Q# 140/  iGCSE Chemistry/2015/w/Paper 33/Q4

4. Two homologous series of hydrocarbons are the alkanes and the alkenes.

   (a) (i) One general characteristic of a homologous series is that the physical properties vary in a predictable way.

   State three other general characteristics of a homologous series.

   [3]

   (ii) How can the molecular formula of a hydrocarbon show whether it is an alkane or an alkene?

   [2]

   (iii) How do alkanes and alkenes differ in their molecular structures?

   [2]

   (b) Cracking is the thermal decomposition of alkanes into smaller hydrocarbons and possibly hydrogen.

   (i) State two conditions required for the cracking of an alkane.

   [2]

   (ii) One type of cracking produces an alkane and an alkene.

   Complete an equation for the cracking of heptane into an alkane and an alkene.

   \[ C_7H_{16} \rightarrow \ldots \ldots \ldots + \ldots \ldots \ldots \]  [1]

   (iii) Complete an equation for the cracking of heptane into hydrogen and two other products.

   \[ C_7H_{16} \rightarrow \ldots \ldots \ldots + \ldots \ldots \ldots + H_2 \]  [1]

   (iv) Suggest one reason why cracking is important.
2 Choose from the following list of gases. A gas may be chosen once, more than once or not at all.

sulfur dioxide hydrogen methane carbon monoxide
argon ethene butane

(c) It can polymerise. ................................................................. [1]

(f) It is produced by the decay of vegetation in the absence of oxygen. .................. [1]

4 (a) Propane reacts with chlorine to form a mixture of chloropropanes. This is a photochemical reaction.

(ii) The products of this reaction include two isomers, one of which has the following structural formula.

\[ \begin{array}{cccc}
H & H & H & H \\
H & C & C & C & Cl \\
H & H & H & H \\
\end{array} \]

Draw the structural formula of the other isomer.

(iii) Explain why these two different compounds are isomers.

.................................................................................................................................................... [2]

(c) (i) Chloropropene can be hydrolysed to propanol, \( \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \), by sodium hydroxide.

Write the equation for this reaction.

.................................................................................................................................................... [2]

(ii) Propanol can be dehydrated. It loses a water molecule to form a hydrocarbon.

Give the name and structural formula of this hydrocarbon.

name ..............................................................

structural formula .................................................... [2]
(iii) Propanol is oxidised to a carboxylic acid by acidified potassium manganate(VII).

Deduce the name of this acid.

................................................................................................................. [1]

Topic Chem 14 Q# 143/ iGCSE Chemistry/2015/s/Paper 33/Q7
7 (a) Alkanes and alkenes are both hydrocarbons.

(i) How does the structure of alkenes differ from the structure of alkanes?
......................................................................................................................... [1]

(ii) Is the straight-chain hydrocarbon C_{22}H_{44} an alkane or an alkene? Explain your choice.
......................................................................................................................... [2]

(iii) Describe how you could distinguish between pentane and pentene.

    test ..................................................................................................................

    result with pentane .......................................................................................

    result with pentene .......................................................................................

......................................................................................................................... [3]

(b) Alkenes polymerise to form poly(alkenes).

(i) The alkene 1,1-dichloroethene has the structural formula given below.

       Cl  H
       C==C
       Cl  H

Draw the structural formula of the polymer formed by the polymerisation of 1,1-dichloroethene.

......................................................................................................................... [3]
(ii) The structural formula of a different polymer is given below.

\[ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\
\text{C} \quad \text{C} \quad \text{C} \quad \text{C} \\
\text{CH}_3 \quad \text{CH}_3 \quad \text{CH}_3 \quad \text{CH}_3 \]

Deduce the structural formula of the monomer used to form this polymer.

[2]

(iii) There are two types of polymerisation - addition and condensation. Explain the difference between them.

..............................................................................................................................................
..............................................................................................................................................
.............................................................................................................................................. [2]

(iv) There are two types of condensation polymer. Give the name of one type of condensation polymer.

.............................................................................................................................................. [1]

[Total: 14]

Topic: Chem 14 Q# 144/ iGCSE Chemistry/2015/s/Paper 33/Q6

(c) The combustion of propane, \( \text{C}_3\text{H}_8 \), is exothermic.

Give an equation for the complete combustion of propane.

.............................................................................................................................................. [2]

Topic: Chem 14 Q# 145/ iGCSE Chemistry/2015/s/Paper 33/Q4

4 (a) (i) Coal is a solid fossil fuel. Name another fossil fuel.

.............................................................................................................................................. [1]

(ii) Explain what is meant by the term fossil fuel.

.............................................................................................................................................. [2]
(c) One use of ethanol is in alcoholic drinks.

Give two other uses of ethanol. ........................................................................................................... [2]

(d) Alcohols can be made from petroleum by the following sequence of reactions.

$$\text{alkanes from petroleum } \rightarrow \text{ alkene } \rightarrow \text{ alcohol}$$

Describe the manufacture of ethanol from hexane, $C_6H_{14}$. Include in your description an equation and type of reaction for each step.

..................................................................................................................................................... [5]

Topic  Chem 14  Q# 147/  iGCSE Chemistry/2015/m/Paper 32/Q7
7  Ethanol is manufactured from glucose, $C_6H_{12}O_6$, by fermentation according to the following equation.

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

(a) State the conditions required for this reaction.
..................................................................................................................................................... [2]

(c) Ethanol can also be manufactured from ethene.

(i) Name the raw material which is the source of ethene.
..................................................................................................................................................... [1]

(ii) Write a balanced equation for the manufacture of ethanol from ethene.
..................................................................................................................................................... [1]

Topic  Chem 14  Q# 148/  iGCSE Chemistry/2015/m/Paper 32/Q4
4  (a) A compound $X$ contains 82.76% of carbon by mass and 17.24% of hydrogen by mass.

(i) Calculate the empirical formula of compound $X$. [2]
(ii) Compound X has a relative molecular mass of 58.

Deduce the molecular formula of compound X.

[2]

(b) Alkenes are unsaturated hydrocarbons.

(i) State the general formula of alkenes.

[1]

(ii) State the empirical formula of alkenes.

[1]

(c) What is meant by the term unsaturated hydrocarbon?

unsaturated .................................................................

.................................................................

hydrocarbon .................................................................

.................................................................

[2]

(d) Describe a test that would distinguish between saturated and unsaturated hydrocarbons.

reagent ........................................................................

observation (saturated hydrocarbon) ..............................

observation (unsaturated hydrocarbon) ............................

[3]

(e) Addition polymers can be made from alkenes. The diagram shows part of an addition polymer.

\[
\begin{array}{c}
\text{C}_2\text{H}_5 \quad \text{H} \quad \text{C}_2\text{H}_5 \quad \text{H} \\
\text{H} \quad \text{C} \quad \text{C} \quad \text{C} \\
\text{C} \quad \text{C} \quad \text{C} \quad \text{H} \\
\text{H} \quad \text{H} \quad \text{H} \quad \text{H}
\end{array}
\]

(i) Draw a circle on the diagram to show one repeat unit in this polymer. [1]
(ii) Give the structure and the name of the monomer used to make this polymer.

structure

name ................................................................................................................................. [2]

(iii) Give the structure of an isomer of the alkene in (e)(ii).

4  (a) A compound X contains 82.76% of carbon by mass and 17.24% of hydrogen by mass.

(i) Calculate the empirical formula of compound X.

(ii) Compound X has a relative molecular mass of 58.
    Deduce the molecular formula of compound X.

(b) Alkenes are unsaturated hydrocarbons.

(i) State the general formula of alkenes.

........................................................................................................................................... [1]

(ii) State the empirical formula of alkenes.

........................................................................................................................................... [1]
(c) What is meant by the term *unsaturated hydrocarbon*?

unsaturated ...................................................................................................................................................................

...........................................................................................................................................................................

hydrocarbon ...................................................................................................................................................................

........................................................................................................................................................................... [2]

(d) Describe a test that would distinguish between saturated and unsaturated hydrocarbons.

reagent ........................................................................................................................................................................

observation (saturated hydrocarbon) ............................................................................................................................

observation (unsaturated hydrocarbon) ......................................................................................................................... [3]

(e) Addition polymers can be made from alkenes. The diagram shows part of an addition polymer.

\[
\begin{align*}
\text{C}_2\text{H}_5 \quad &\text{H} \\
\text{C} &\text{C} \\
\text{H} &\text{C}_2\text{H}_5 \quad \text{H}
\end{align*}
\]

(i) Draw a circle on the diagram to show one repeat unit in this polymer. [1]

(ii) Give the structure and the name of the monomer used to make this polymer.

structure ........................................................................................................................................................................

........................................................................................................................................................................... [2]

(iii) Give the structure of an isomer of the alkene in (e)(ii).
Butane is oxidised to a mixture of carboxylic acids by oxygen in the presence of a catalyst. The acids formed are methanoic acid, ethanoic acid and propanoic acid – the first three members of the carboxylic acid homologous series.

(a) (i) Give the name and structural formula of the fourth member of this series.

name ................................................................................................................ [3]

structural formula showing all the atoms and bonds

(II) State three characteristics of a homologous series.

.................................................................................................................. [3]

.................................................................................................................. [3]

(b) Carboxylic acids react with alcohols to form esters. Ethanol reacts with ethanoic acid to form the ester ethyl ethanoate, CH₃COOCH₂CH₃.

(i) Give the name and formula of the ester which is formed from methanol and propanoic acid.

name ................................................................................................................ [2]

formula ........................................................................................................... [2]

(ii) What is the name of the ester which has the formula CH₃COOCH₃?

.................................................................................................................. [1]

(c) (i) Complete the equation for the oxidation of butane to propanoic acid.

\[ 3C₂H₆ + \text{O}_2 \rightarrow 4C₂H₄\text{COOH} + \text{H}_₂\text{O} \] [1]

(ii) Name another compound which can be oxidised to propanoic acid.

.................................................................................................................. [1]
5 (a) Glucose, sucrose and starch are all carbohydrates. Their formulae are:

- glucose, $C_6H_{12}O_6$,
- sucrose, $C_{12}H_{22}O_{11}$,
- starch, $(C_6H_{10}O_5)_n$.

(i) Identify **two** common features in the formulae of these carbohydrates.

(ii) Draw the structure of a complex carbohydrate, such as starch. The formula of glucose, can be represented by

\[
\text{HO} \quad \boxed{\text{C}} \quad \text{OH}
\]

Include **three** glucose units in the structure.

---

3 (a) A hydrocarbon has the following structural formula.

(i) State the molecular formula and the empirical formula of this hydrocarbon.

- molecular formula
- empirical formula

(ii) Draw the structural formula of an isomer of the above hydrocarbon.
(iii) Explain why these two hydrocarbons are isomers.

................................................................................................................................................. [2]

(iv) Are these two hydrocarbons members of the same homologous series?
Give a reason for your choice.

................................................................................................................................................. [1]

(b) Alkenes can be made from alkanes by cracking.

(i) Explain the term cracking.

................................................................................................................................................. [2]

(ii) One mole of an alkane, when cracked, produced one mole of hexane, C₆H₁₄, and two moles of ethene.
What is the molecular formula of the original alkane?

................................................................................................................................................. [1]

(c) Alkenes are used in polymerisation reactions and addition reactions.

(i) Draw the structural formula of the product formed by the addition polymerisation of but-2-ene. Its formula is given below.

```
H
C=C
H
H₂C    CH₃
```

................................................................................................................................................. [3]

(ii) Give the name and structural formula of the addition product formed from ethene and bromine.

name .................................................................................................................................................. [2]

structural formula .................................................................................................................................
The alkanes are a family of saturated hydrocarbons. Their reactions include combustion, cracking and substitution.

(a) (i) What is meant by the term *hydrocarbon*?

(ii) What is meant by the term *saturated*?

(b) (i) What is the general formula for the homologous series of alkanes?

(ii) Calculate the mass of one mole of an alkane with 14 carbon atoms.

(c) The complete combustion of hydrocarbons produces carbon dioxide and water only.

(i) Write the equation for the complete combustion of nonane, \( C_{9}H_{20} \).

(ii) 20 cm\(^3\) of a gaseous hydrocarbon was mixed with an excess of oxygen, 200 cm\(^3\). The mixture was ignited. After cooling, 40 cm\(^3\) of oxygen and 100 cm\(^3\) of carbon dioxide remained. Deduce the formula of the hydrocarbon and the equation for its combustion. All volumes were measured at r.t.p..

(d) Cracking is used to obtain short-chain alkanes, alkenes and hydrogen from long-chain alkanes.

(i) Give a use for each of the three products listed above.

short-chain alkanes .................................................................

alkenes .................................................................

hydrogen ................................................................. [3]

(ii) Write an equation for the cracking of decane, \( C_{10}H_{22} \), which produces two different alkenes and hydrogen as the only products.

................................................................. [1]
(e) Chlorine reacts with propane in a substitution reaction to form 1-chloropropane.

\[ \text{CH}_3\text{--CH}_2\text{--CH}_3 + \text{Cl}_2 \rightarrow \text{CH}_3\text{--CH}_2\text{--CH}_2\text{--Cl} + \text{HCl} \]

(i) What is the essential condition for the above reaction?

.................................................................................................................................................. [1]

(ii) There is more than one possible substitution reaction between chlorine and propane. Suggest the structural formula of a different product.

.................................................................................................................................................. [1]

(b) Pea seeds grow in pods on pea plants.

Freshly picked pea seeds contain a sugar. The sugar can form a polymer. Give the structural formula of the polymer and name the other product of this polymerisation reaction.

You may represent the sugar by the formula:

\[ \text{HO--} \square \text{--OH} \]

structural formula of the polymer

other product ........................................................................................................................................ [3]

Topic Chem 14 Q# 155/ iGCSE Chemistry/2014/s/Paper 33/Q1

1 Choose a gas from the following list to answer the questions below. Each gas may be used once, more than once or not at all.

ammonia carbon dioxide carbon monoxide fluorine hydrogen krypton nitrogen propene sulfur dioxide

(b) It polymerises to form a poly(alkene). .................................................................................. [1]
4 Propanoic acid is a carboxylic acid. Its formula is \( \text{CH}_3\text{CH}_2\text{COOH} \).

(a) Propanoic acid is the third member of the homologous series of carboxylic acids.

(i) Give the name and structural formula of the fourth member of this series.

name ........................................................................................................................................

formula ................................................................................................................................. [2]

(ii) Members of a homologous series have very similar chemical properties. State three other characteristics of a homologous series.

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................ [3]

(b) Carboxylic acids can be made by the oxidation of alcohols.

(i) Draw the structural formula of the alcohol which can be oxidised to propanoic acid. Show all atoms and bonds.

........................................................................................................................................ [1]

(ii) Name a reagent, other than oxygen, which can oxidise alcohols to carboxylic acids.

........................................................................................................................................ [2]

(c) Complete the following equations for some of the reactions of propanoic acid. The salts of this acid are called propanoates.

(i) \[ \text{zinc} + \text{propanoic acid} \rightarrow \text{ } + \text{hydrogen} \] [1]

(ii) \[ \text{calcium} + \text{propanoic} \rightarrow \text{oxide} + \text{acid} \] [1]

(iii) \[ \text{LiOH} + \text{CH}_3\text{CH}_2\text{COOH} \rightarrow \text{ } + \text{ } \] [1]
(b) Fossil fuels are formed by the anaerobic decomposition of organic matter. Anaerobic means in the absence of oxygen.

(i) The organic matter contains hydrogen and carbon. Suggest the products that would be formed if the decomposition occurred in the presence of oxygen. 

Mark Scheme for Section 1

<table>
<thead>
<tr>
<th>Topic Chem 1 Q# 1/ iGCSE Chemistry/2015/s/Paper 32/Q2</th>
<th>Topic Chem 1 Q# 2/ iGCSE Chemistry/2014/w/Paper 33/Q2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(c) A melting point / -7°C is below room temperature / 25°C / RTP or; boiling point / 59°C is above room temperature / 25°C / RTP or;</td>
<td>3 How melting point / boiling point / conductivity 25°C / room temperature / RTP is in between -7°C and 59°C OR 25°C / room temperature / RTP is between mp and bpt would both score the 2 evidence marks</td>
</tr>
<tr>
<td>(ii) melting point/freezing point (of X)</td>
<td></td>
</tr>
<tr>
<td>(iii) gas/gaseous or vapour</td>
<td>[1]</td>
</tr>
</tbody>
</table>

Topic Chem 1 Q# 3/ iGCSE Chemistry/2014/w/Paper 33/Q2

(b) (i) 14.3

(ii) 85.7 \div 12 and 14.3 \div 1 or 7.14 and 14.3 ratio 1:2

CH₂

Note: Award all 3 marks for correct answer accept: alternative working e.g.
85.7 \times 84 \div 100 and 14.3 \times 84 \div 100 or 71.986/72 and 12/12.012

6.12 or ratio 1:2

CH₂

(iii) C₆H₁₂

[1]

Topic Chem 1 Q# 4/ iGCSE Chemistry/2014/s/Paper 33/Q2

(b) particles move in all directions / randomly in both liquids and gases (1)

no bonds / very weak forces between particles in gases (1)
molecules can move apart / separate (to fill entire volume) (1)

OR

bonds / forces / IMF between particles in liquids (1)
molecules cannot move apart / separate (so fixed volume in liquids) (1)

[3]

MS Topic Chem 2 Q# 5/ iGCSE Chemistry/2015/w/Paper 33/Q1

(b) boils at 100°C / boiling point 100°C / freezes at 0°C / freezing point 0°C / melts at 0°C / melting point 0°C 1

Topic Chem 2 Q# 6/ iGCSE Chemistry/2015/m/Paper 32/Q6

(b) filter / centrifuge / decant

wash with (distilled) water

(dry with) filter paper / tissues / warm windowsill / in sun / oven / fan / heat

[1]

Topic Chem 2 Q# 7/ iGCSE Chemistry/2014/w/Paper 32/Q1

1 (a) foodstuffs or drugs
(b) (i) simple distillation
  fractional distillation or diffusion
  fractional distillation
  filtration or evaporation
  chromatography

Topic Chem 2 Q# 8/ iGCSE Chemistry/2014/s/Paper 33/Q5

(d) lower the temperature (1)
  only ammonia will liquefy (1)
  OR
  add water (1)
  only ammonia will dissolve (1)
  OR
  increase pressure (1)
  only ammonia will liquefy (1)

MS Topic Chem 3 Q# 9/ iGCSE Chemistry/2015/w/Paper 33/Q6

| 6(c) | Mg$^{2+}$ | 1 |

Topic Chem 3 Q# 10/ iGCSE Chemistry/2015/w/Paper 33/Q3

| 3(a)(i) | vibrate (about fixed position)/vibration; | 1 |
| 3(a)(ii) | electrostatic force of attraction;
  (between) positive ions and negative ions/oppositely charged ions/unlike charged ions/cations and anions; | 1 |
| 3(a)(iii) | regular/repeated/pattern/framework/ordered/alternating/organised arrangement of;
  positive and negative ions/oppositely charged ions/cations and anions/unlike charged ions; | 1 |

Topic Chem 3 Q# 11/ iGCSE Chemistry/2015/w/Paper 32/Q6

| 6(b) | M1 positive ions/cations/metallic ions;
  the (correct) particles named in M1 are arranged in a lattice/rows/layers;
  sea of electrons/delocalised electrons; | 3 |
| 6(c) | they have mobile electrons; | 1 |
| 6(d) | chlorine; | 1 |
| 6(e) | strong covalent bonds:
  in a giant lattice/macromolecule/giant (structure); | 2 |
| 6(f) | any two from:
  - sodium chloride is ionic and PCl$_3$ is covalent;
  - ionic bonds are strong and intermolecular forces are weak;
  - PCl$_3$ reacts with water and NaCl does not; | 2 |
| 6(h) | magnesium with 8 or 0 outer shell electrons;
  oxygen with 8 outer shell electrons and 2 indicated differently from the other 6 and these 2 electrons must match the Mg electrons if these have been shown;
  correct charges; | 3 |

Topic Chem 3 Q# 12/ iGCSE Chemistry/2015/w/Paper 32/Q1

| 1(a)(i) | NaF$^-$; | 1 |
| 1(a)(ii) | P$_2$S$_4$; | 1 |
| 1(b)(i) | Se$^{2-}$; | 1 |
| 1(b)(ii) | Ga$^{3+}$; | 1 |

Topic Chem 3 Q# 13/ iGCSE Chemistry/2015/s/Paper 33/Q2

| 2(e) | silicon(V) oxide; | 1 |
  A silicon (d)oxide or SiO$_2$

Topic Chem 3 Q# 14/ iGCSE Chemistry/2015/s/Paper 33/Q1

| 1(a)(i) | AF$_3$; | 1 |
| 1(a)(ii) | As$_2$O$_3$; | 1 |
| 1(b)(i) | SBr$_2$; | 1 |
| 1(b)(ii) | P$^+$; | 1 |
| 1(b)(iii) | Ba$^{2+}$; | 1 |
| 1(b)(iv) | Fr$^+$; | 1 |
1(c) M1: 2 double bonds, one between O and the C atom;  
M2: each O has 6 outer electrons;  
M3: each C has 6 outer electrons;  
3  
R wrong symbols for O for M2  
R wrong symbols for C for M3  
I missing symbols  
A any combination of x and e  

Topic Chem 3 Q# 15/ iGCSE Chemistry/2015/s/Paper 32/Q2

2(a) E: high melting point/ mp/mp OR high boiling point/ bp/bp;  
poor/non conductor (when liquid and/or solid);  
3  
I mp/bp above room temp  

2(b) B: (good) conductor when solid (and liquid);  
2  
A (good) conductor in any state/ both states  
I high melting point/ boiling point  
R low melting point/ boiling point  

2(d) C: high melting point/ mp/mp OR high boiling point/ bp/bp;  
BOTH poor/non conductor when solid and good conductor when liquid OR melted/only conduct when liquid;  
A melting point and boiling point both above room temp/ 25°C/ RTP  
I conducts when aqueous or in solution  
3  
I conducts in liquid due to free electrons  

Topic Chem 3 Q# 16/ iGCSE Chemistry/2015/s/Paper 32/Q1

<table>
<thead>
<tr>
<th>1</th>
<th>8</th>
</tr>
</thead>
</table>
| Li⁺ | 26p 26e 30n All three for 1 mark;  
²⁶Li numbers and symbol; charge +;  
³¹P 28e 30n All three for 2 marks, any two for 1 mark;  
³¹P²⁺ numbers and symbol; charge ²⁻;  |  

Topic Chem 3 Q# 17/ iGCSE Chemistry/2015/m/Paper 32/Q3  
(g) 3 bond pairs between N & H  
Lone pair on N  
[1]  

Topic Chem 3 Q# 18/ iGCSE Chemistry/2015/m/Paper 32/Q2  
2 (a) Atoms of the same element/ atoms with same proton number/ atoms with same atomic number  
[1]  
different neutron number/ nucleon number/ mass number  
[1]

(b)  

<table>
<thead>
<tr>
<th>particle</th>
<th>number of protons</th>
<th>number of electrons</th>
<th>number of neutrons</th>
<th>nucleon number</th>
<th>symbol or formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td>23 (1)</td>
<td>Na(1)⁺ (1)</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>10(1)</td>
<td></td>
<td>16(1)</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>13 (1)</td>
<td></td>
<td>15 (1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Total: 9]

Topic Chem 3 Q# 19/ iGCSE Chemistry/2015/m/Paper 32/Q1

1 (a) chlorine/ argon  
[1]

Topic Chem 3 Q# 20/ iGCSE Chemistry/2014/w/Paper 33/Q6  
6 (a) Rb loses 1 electron/ 1 electron in outer shell/ 1 valency or valence electron  
[1]  
Sr loses 2 electrons/ 2 electrons in outer shell/ 2 valency or valence electrons  
[1]
Topic Chem 3 Q#21/ iGCSE Chemistry/2014/w/Paper 33/Q3

3 (a) (i) 3 [1]
(ii) 70 [1]
(b) Add octane (or other liquid hydrocarbon) (to soot)
(allow to) evaporate or heat or warm or leave in sun (to get crystals of fullerene) [1]
(c) (i) graphite [1]
(ii) delocalised electrons/free electrons/sea of electrons
COND (on electrons) move/mobile/electrons flow [1]

Topic Chem 3 Q#22/ iGCSE Chemistry/2014/w/Paper 33/Q1

(b) Graphite
Physical: (good) conductor (of electricity) or soft or lubricant or high melting point/high boiling point or grey black or black solid or slippery or greasy (to touch) or brittle/breaks when subjected to stress or insoluble in water [1]

Topic Chem 3 Q#23/ iGCSE Chemistry/2014/s/Paper 33/Q4

4 (a) (i) heat limestone/calcium carbonate (1)
(b) (i) lattice/rows/regular arrangement of cations/positive ions/Fe^{2+} (1)
mobile/free/delocalised/sea of electrons (1)
(ii) the rows of ions/ions can move past each other (1)
without the metal breaking/bonds are not directional/not rigid (1) [2]

Topic Chem 3 Q#24/ iGCSE Chemistry/2014/s/Paper 32/Q6

(b) ScF$_3$ (1)
correct charges on both ions (1)
8 electrons around (each) fluoride (1) [3]

Topic Chem 3 Q#25/ iGCSE Chemistry/2014/s/Paper 32/Q5

5 (c) each chlorine 1 bond pair and 3 non-bond pair (1)
oxygen atom 2 non-bond pairs and 2 bond pairs as double bond (1)
carbon atom 4 bond pairs including 2 bond pairs as double bond (1) [3]

Topic Chem 3 Q#26/ iGCSE Chemistry/2014/s/Paper 32/Q1

(b) D (1) [1]
(d) B (1) [1]
(f) E (1) [1]

MS Topic Chem 4 Q#27/ iGCSE Chemistry/2015/w/Paper 33/Q7

| 7(a) | makes of KOH used (\(= \frac{0.025 \times 2.53}{0.06325/0.063}\): number of moles of H$_2$SO$_4$ needed to neutralise the KOH = 0.031625/0.032; concentration of dilute sulfuric acid = 1.121/1.1 (mol/dm$^3$); | 3 |
| 7(c) | \(\text{Fe}_2\text{(SO}_4\text{)}_3\): |

Topic Chem 4 Q#28/ iGCSE Chemistry/2015/w/Paper 33/Q6

| 8(c) | Fe$_2$(SO$_4$)$_3$; |

Topic Chem 4 Q#29/ iGCSE Chemistry/2015/w/Paper 33/Q4

| 4(c)(i) | 150 (cm$^3$); |
| 4(c)(ii) | 100 (cm$^3$); |
Topic Chem 4 Q# 30/ iGCSE Chemistry/2015/w/Paper 33/Q2

2(b) hydrogen/H₂

2(e) carbon monoxide/CO;

Topic Chem 4 Q# 31/ iGCSE Chemistry/2015/w/Paper 32/Q4

4(b) M₁ bonds breaking = (8 × 412) + (2 × 348) + 242 = 4234;
M₂ bonds breaking = (7 × 412) + (2 × 349) + 336 + 431 + 4340;
M₃ 4234 – 4349 = -115 and exothermic;

Topic Chem 4 Q# 32/ iGCSE Chemistry/2015/w/Paper 32/Q4

4(d)(i) 88;
4(d)(ii) 60;
4(d)(iii) moles of CH₃CH₂CH₂OH = 0.1;
moles of HCOOH = 0.087 (0.08) and limiting reagent is methanoic acid;
4(d)(iv) 88 × (mol of limiting reagent) = (4(d)(iii));
ex: 88 × 0.087 = 7.65g;

Topic Chem 4 Q# 33/ iGCSE Chemistry/2015/w/Paper 32/Q1

1(c)(ii) Cr₂(SO₄)₃;

1(c)(iii) Ba(OH)₂;

Topic Chem 4 Q# 34/ iGCSE Chemistry/2015/s/Paper 33/Q5

5(c)(i) 79.282685;
79.6205653;
84.7161572;

5(c)(ii) the last one OR Cu and O₂ OR the one from copper;
not all the copper oxidised OR the outside of the pieces of copper oxidised
but the inside did not OR (still) contains copper (metal);

Topic Chem 4 Q# 35/ iGCSE Chemistry/2015/s/Paper 32/Q6

6(c)(i) Avogadro(s) number/constant/6.02 x 10²³, COND particles;
OR
the number of particles which is equal to the number of atoms in 12g of
carbon 12; COND atoms;
OR
the mass in grams which contains Avogadro(s) Number; COND particles;
OR
the amount of substance which has a mass equal to its relative formula
mass/RFM relative atomic mass/Ar/relative molecular mass/Mr/molar
mass; COND grams;
OR
the amount of substance which has a volume equal to 24 dm³; COND of
a gas at RTP;

A any values from 6.023 x 10²³
A atoms/molecules/electrons
A one mark for reference to C12;
A equivalent statement for any element or compound, e.g. 32 grams of oxygen(1) COND
molecules/O(1) e.g. 16 grams of oxygen(1) COND atoms/O(1);
A different volumes under different conditions e.g.22.4 dm³ at STP or volumes in different
units e.g. 24000 cm³ at RTP

Topic Chem 4 Q# 36/ iGCSE Chemistry/2015/s/Paper 32/Q3

3(b)(i) M₁ (so that ionic) charges balance or cancel, charge = 0/no charge/number of
positive = number of negative charges/charge is neutral or neutralised;
M₂
3(−) × 2 = 2(+) × 3;

A 6(+) = 6(−)

I statements about electron transfer/valency/or state unless valency is referring to ionic
charges e.g. valencies 3+ and 2– can get credit if used properly;
Ratio of ions is 3:2 therefore ratio of charges is
2:3 scores 2

Topic Chem 4 Q# 37/ iGCSE Chemistry/2015/m/Paper 32/Q7

(b) (i) Mr = 180 (1) (30/180) = 0.167 (1)

(ii) 2 × 0.167 or 2 × 46 or 0.333 or 92

(2 × 0.167 × 46) = 15.3(33) (g)

(iii) 2 × 0.167 × 24 = 8 (dm³)
**Topic Chem 4 Q# 38** iGCSE Chemistry/2014/w/Paper 33/Q8

(c) number of moles of HCl in 50 cm$^3$ of acid, concentration 2.2 mol/dm$^3$ = 0.11

maximum number of moles of CoCl$_2$.6H$_2$O which could be formed = 0.055

mass of 1 mole of CoCl$_2$.6H$_2$O = 238 g

maximum yield of CoCl$_2$.6H$_2$O = 13.09 g

percentage yield = 48.2% or ecf mass of CoCl$_2$.6H$_2$O above/13.09 $\times$ 100% to 1 dp

**Topic Chem 4 Q# 39** iGCSE Chemistry/2014/w/Paper 32/Q6

(iii) M$_1$ = 2.07 Allow 2.1 or 2.0666...7

\[ M_2 = 62.8 \text{ g} \]

\[ M_3 = \frac{M_2}{152} = 0.41(3) \]

\[ M_4 = \left( \frac{M_1}{M_3} \right) \text{ rounded to the nearest whole number} \times 5 \]

**Topic Chem 4 Q# 40** iGCSE Chemistry/2014/s/Paper 32/Q7

(b) 0.062 (1)

0.031 (1)

3.97 g (1)

55.4% (1)

(c) (i) (to prove) all water driven off or evaporated or boiled / no water remains / to make salt anhydrous (1)

(ii) \( m_1 - m_2 \) = mass of water (1)

(calculate) moles of water AND moles of hydrated or anhydrous salt (1)

1:1 ratio / should be equal (1)

**MS Topic Chem 5 Q# 41** iGCSE Chemistry/2015/w/Paper 33/Q3

<table>
<thead>
<tr>
<th>3(b)(i)</th>
<th>correct direction (going towards negative electrode);</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3(b)(ii)</th>
<th>( \text{Li}^+ + e^- \rightarrow \text{Li}^+ / \text{Li}^- \rightarrow \text{Li}^- + e^-; )</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>3(b)(iii)</th>
<th>( 2\text{Br}_2 \rightarrow 2\text{Br}_2 + 2e^- / 2\text{Br}^- + 2\text{e}^- \rightarrow \text{Br}_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>formuлаs;</td>
<td>balancing;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3(b)(iv)</th>
<th>( \text{Br}_2 / \text{bromide (ion)}; ) electronic lost/donated electrons / increased oxidation state / increased oxidation number / oxidation numbers changed from −1 to 0 / increased valency;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>3(c)</th>
<th>( \text{M}_1 ) (gas) hydrogen (given off at cathode)/H$_2$; ( \text{M}_2 ) hydroxide ions/lithium hydroxide/OH$^-$/LiOH are alkali(ne); ( \text{M}_3 2\text{LiBr} + 2\text{H}_2\text{O} \rightarrow 2\text{LiOH} + \text{H}_2 + \text{Br}_2; ) or ( 2\text{H}^+ + 2e^- \rightarrow \text{H}_2 / 2\text{H}^+ \rightarrow \text{H}_2 - 2e^-; ) or ( 2\text{Br}^- \rightarrow \text{Br}_2 + 2e^- / 2\text{Br}^- - 2e^- \rightarrow \text{Br}_2; ) or ( 2\text{H}^+ + 2\text{Br}^- \rightarrow \text{H}_2 + \text{Br}_2; )</th>
</tr>
</thead>
</table>

| Topic Chem 5 Q# 42** iGCSE Chemistry/2015/w/Paper 32/Q3

3(c) zinc sulfate; pure zinc; \( \text{Zn}^{2+} + 2e^- \rightarrow \text{Zn}; \) \( \text{Zn} \rightarrow \text{Zn}^{2+} + 2e^-; \) zinc ions are removed (from solution) and replaced (into solution); at the same rate / speed;
Topic Chem 5 Q# 43/ iGCSE Chemistry/2015/s/Paper 32/Q3

3(a) M1 both correct charges of ions (calcium 2+ and nitrogen 3-);
M2 8 electrons around nitrogen (can be 3 dots and 5 crosses or 5 crosses and 3 dots or all dots or all crosses, but reject any other combinations of dots and crosses);
M3 Two electrons on the inner shell on any nitride ions/nitrogen atoms allow 2x or 2e on ox;

3(b)(i) regular/repeated/pattern/framework/periodic/ordered/alternating/organised;
(of) particles/atoms/molecules/ions/cations/anions;

3(b)(ii) Layer(s)

3 General guidance:
Electron configuration/symbol of calcium ion/formulae/stoichiometry/Covalent can score only M3

A if electron configuration of nitride is given as 2,8 or N is given as 2,5
Lany missing inner shells as long as one is present

Topic Chem 5 Q# 44/ iGCSE Chemistry/2014/w/Paper 33/Q4

(b) \( 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \)

(c) (i) anode/negative electrode and electrons lost (by hydrogen/H/H\textsubscript{2})/electrons move from this electrode

(ii) \( \text{H}_2 \rightarrow 2\text{H}^+ + 2e^- / \text{H}_2 - 2e^- \rightarrow 2\text{H}^+ / \text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2e^- / \text{H}_2 + 2\text{OH}^- - 2e^- \rightarrow 2\text{H}_2\text{O} \)
Species (1) Balancing (1)

Topic Chem 5 Q# 45/ iGCSE Chemistry/2014/w/Paper 32/Q4

(d) (i) from zinc to carbon (clockwise direction on or near the wire)

(ii) to allow ions to flow

(iii) oxidation and loss of electron(s) or increase in oxidation number/state

(reduction and decrease in oxidation number/state or gain of electron(s)

Topic Chem 5 Q# 46/ iGCSE Chemistry/2014/s/Paper 33/Q7

7 (a) bauxite (1)

(ii) \( 4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4e^- \)

\( 4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3 \)

Topic Chem 5 Q# 47/ iGCSE Chemistry/2014/s/Paper 32/Q5

5 (b) hydrogen and chlorine/\(\text{H}_2\) and \(\text{Cl}_2\)

sodium hydroxide/NaOH/Na\(^+\)OH\(^-\) (1)

\( 2\text{H}^+ + 2e^- \rightarrow \text{H}_2/2\text{H}^+ \rightarrow \text{H}_2 - 2e^- \) (1)

\( 2\text{Cl}^- \rightarrow \text{Cl}_2 + 2e^-/2\text{Cl}^- - 2e^- \rightarrow \text{Cl}_2 \) (1)

Hydrogen/\(\text{H}_2\)/\(\text{H}/\text{H}^+\) at cathode and chlorine/chloride/\(\text{Cl}_2\)/\(\text{Cl}^-\)/\(\text{Cl}^+\) at anode (1) [5]
MS Topic Chem 6 Q# 48/ iGCSE Chemistry/2014/w/Paper 33/Q5

(b) (i) \[ 2CI^- \rightarrow CI_2 + 2e^(-) / 2CI^- - 2e^(-) \rightarrow CI_2 \] [1]

\[ 2H^+ + 2e^(-) \rightarrow H_2 / 2H^+ \rightarrow H_2 - 2e^(-) \] [1]

hydrogen formed at cathode/– and chlorine at anode/+ [1]

**Na**^+ and **OH**^− or sodium ions and hydroxide ions left in solution/form/become sodium hydroxide [1]

(ii) \[ CI_2 + 2NaOH \rightarrow NaClO/NaOCl + NaCl + H_2O \] [2]

Species (1) Balancing (1)

Topic Chem 6 Q# 49/ iGCSE Chemistry/2014/w/Paper 33/Q4

4 (a) carbon dioxide/CO₂ [1]

(d) Any two from:

**CELL:**
- lightweight
- quieter
- fewer working parts/less maintenance
- more efficient or less energy wasted or more energy produced

**SUSTAINABILITY:**
- conserves a limited resource/petroleum/fossil fuels
- unlimited supplies of renewable resource (of hydrogen from water)

**POLLUTION:**
- No or less greenhouse effect
- No or less acid rain
- No or less toxic gases
- No or less smog

**POLLUTANTS:**
- No or less C/soot
- No or less CO₂
- No or less CO
- No or less SO₂
- No or less oxides of nitrogen/NO/NO₂/N₂O₄/NO₃
- No or less (unburnt) hydrocarbons
- No or less low level ozone

H₂O is the **only** product [2]

[Total: 7]

Topic Chem 6 Q# 50/ iGCSE Chemistry/2014/w/Paper 32/Q2

(ii) M1 electrolysis [1]

M2 molten sodium chloride [1]

or

M1 Add named more reactive metal (e.g. K)
M2 Molten sodium chloride

Topic Chem 6 Q# 51/ iGCSE Chemistry/2014/s/Paper 33/Q5

(e) second line \[ +3 \times 155 = + 465 \]
third line \[ -3 \times 280 = (-) 840 \]
fourth line \[ -3 \times 565 = (-) 1695 \]
all three correct (2)
two correct (1)

1170 + 465 = 1635
840 + 1695 = 2535
both numerically correct (1)
exothermic reaction with some reasoning (1)
### Topic Chem 6 Q# 52/ iGCSE Chemistry/2014/s/Paper 33/Q1

**(g)** hydrogen (1)  

### Topic Chem 6 Q# 53/ iGCSE Chemistry/2014/s/Paper 32/Q2

2. (a) (i) substance/material/compound/element/mixture (burnt) to **produce/release energy** or **heat** (1)  

(iii) **wood/charcoal/animal dung/biomass/Uranium/U/plutonium/Pu** (1)  

### MS Topic Chem 7 Q# 54/ iGCSE Chemistry/2015/w/Paper 33/Q5

| 5(b)(iii) | Br₂ + 2e⁻ → 2Br⁻/Br₂ → 2Br⁻ – 2e⁻ | 1 |

### Topic Chem 7 Q# 55/ iGCSE Chemistry/2015/w/Paper 33/Q3

3(b)(iv) Br⁻/bromide (ion); electron lost/donated electrons; increased oxidation state/increased oxidation number/oxidation numbers changed from –1 to 0/increased valency;  

### Topic Chem 7 Q# 56/ iGCSE Chemistry/2015/w/Paper 32/Q6

6(a) the number of e⁻ gained or lost = numerical value of oxidation state;  
   - any two:  
     - Na to Al (Si) lose e⁻;  
     - (Si) P to Cl(gain e⁻);  
     - Si gains and loses e⁻/A neither gains nor loses e⁻;  

### Topic Chem 7 Q# 57/ iGCSE Chemistry/2015/w/Paper 32/Q4

4(a)(i) a reaction whose rate is influenced by light/reaction which occurs in presence of light;  

### Topic Chem 7 Q# 58/ iGCSE Chemistry/2015/s/Paper 33/Q6

| 6(d)(i) | (light from the sun/sunlight) | 1 | A. UV |

| 6(d)(ii) | carbon dioxide + water → glucose + oxygen; | 1 | A starch/sugar/(named)carbohydrate 1 energy or light on LHS |

### Topic Chem 7 Q# 59/ iGCSE Chemistry/2015/s/Paper 33/Q3

3(a) carbon dioxide escapes/leaves/lost/released OR not a closed system;  
   - A gas escapes/leaves/lost/released  

### Topic Chem 7 Q# 60/ iGCSE Chemistry/2015/s/Paper 32/Q7

| 7(a)(i) | living/organism or named example e.g. yeast/cells/plants/animals/part of animal or plant e.g. muscle/humans/micro-organisms; produces/releases or gain or obtain energy/exothermic/heat; from food/named foodstuff/carbohydrates/named carbohydrate/sugar/named sugar/glucose/nutrients; | 3 | A ‘we/us’ for ‘humans’  

| 7(a)(ii) | biological catalyst or protein catalyst; | 1 | R biocatalyst/living biological catalyst |

| 7(a)(iv) | answer must include both: measuring the time and measuring a relevant quantity; OR alternatively measuring the time taken for something to happen; alternatives to time are: units of time/apparatus to measure time/regular intervals/how long; examples of relevant quantities are: (increase in/decrease in) amount/mass/volume/bubbles of carbon dioxide/bubbles of gas OR (increase in/decrease in) mass of apparatus; | 1 |

| 7(b)(i) | temperature increase/heat increase/warmer/high temperature/exothermic/more yeast/yeast reproduces/yeast increases/yeast multiplies; | 1 | R yeast was added |

| 7(b)(ii) | more yeast/yeast reproduces/increases/multiplies; | 1 | R yeast was added |

| 7(b)(iii) | all glucose or reactant(s) reacted OR no glucose or reactant(s) left OR glucose or reactant(s) used up/finished/runs out/reacted completely/fully reacted; yeast (cells) dies OR enzymes denatured OR ethanol is toxic to yeast/ethanol kills yeast; | 2 | I glucose or reactants reacted/stopped reacting  

R enzyme dies/yeast denatures  
R yeast used up
Topic Chem 7 Q# 61/ iGCSE Chemistry/2015/s/Paper 32/Q6

6(b)(ii)  
(5 marks)

(colour changes) from pink/purple:
to colourless/decolourised;

2

1 clear/discoloured/effervescence
1 brown fumes/brown gas
NOTE: stays pink or purple gets first mark but
turns purple or pink is 0

Topic Chem 7 Q# 62/ iGCSE Chemistry/2015/s/Paper 32/Q3

3(c)  
(3 marks)

it (refers to Ca)/Calcium/Ca (atom) loses/gives/donates electrons/e/e⁻;

(there are) gained by nitrogen/N/N₂;
nitrogen/ N/N₂ is reduced so calcium/Ca is the reducing agent (these two statements could be split i.e. not in same sentence)
OR reducing agents are electron doners/give/lose electrons
OR calcium/Ca is oxidised (by electron loss) therefore calcium is the reducing agent (these two statements could be split i.e. not in same sentence);

A half-equation with electrons on right-hand side
R calcium ion/Ca²⁺
A half-equation with electrons on left-hand side
R nitride ion/ N³⁻
I numbers of electrons/charges on ions/oxidation state/valency if mentioned
R reference to oxygen/hydrogen if there is a suggestion that oxygen/hydrogen are involved in the reaction
R reference to oxygen/hydrogen if in general statement e.g. oxidation is gain of oxygen
Electrons/e/e⁻ move from calcium to nitrogen get marks 1 and 2
A calcium/Ca it is a reductant or calcium/Ca/
it reduces

3

Topic Chem 7 Q# 63/ iGCSE Chemistry/2014/w/Paper 33/Q8

8  

(a) (changes from) blue (1) to pink (1)

[2]

Topic Chem 7 Q# 64/ iGCSE Chemistry/2014/w/Paper 33/Q5

5  

(a) (i) rate decreases

concentration of sodium chlorate ((I))/reactant decreases

(ii) (initial) gradient greater/steeper (must start at origin)

same final volume of oxygen

(iii) (to prevent) photochemical reaction/(to prevent) reaction catalysed by

light/light breaks down or decomposes sodium chlorate((I))

(iv) particles have more energy/particles move faster/

more collisions

collisions more frequent or more often/greater chance of collision/collision

rate increases/more particles have energy to react/more collisions are

successful or effective

[1]  

[1]  

[1]  

[1]  

[1]  

[1]  

[1]  

[1]  

[1]  

[1]  

[1]  

[1]

Topic Chem 7 Q# 65/ iGCSE Chemistry/2014/w/Paper 33/Q2

2  

(a) (i) X(s) ↔ X(l)

[1]

Topic Chem 7 Q# 66/ iGCSE Chemistry/2014/w/Paper 33/Q2

2  

(a) (i) X(s) ↔ X(l)

[1]

Topic Chem 7 Q# 67/ iGCSE Chemistry/2014/w/Paper 32/Q6

(b) (i) add water to yellow solid or to (anhydrous) iron(II) sulfate or to FeSO₄ or to products

goes green

[1]

Topic Chem 7 Q# 68/ iGCSE Chemistry/2014/w/Paper 32/Q5

5  

(b) catalyst

[1]

5  

(c) (i) C A B

[2]

ABC = 1 ACB = 1 BCA = 1 CBA = 1 BAC = 0

Allow 70 for C, 40 for B and 20 for A
(ii) M1 Energy mark: at higher temperature particles/molecules more have more energy or move faster [1]

M2 Collision frequency mark: collide more frequently/often or more collisions per unit time or higher rate of collisions. Ignore: ‘more collisions’ [1]

M3 Collision energy mark: more molecules have enough energy to react or more collisions are above activation energy or successful [1]

(iii) C rate zero or enzymes denatured [1]

Topic Chem 7 Q# 69/ iGCSE Chemistry/2014/s/Paper 33/Q3
3 (a) (i) enzymes (1) [1]

(ii) reduces growth of microbes/rate of reproduction of microbes is lower/microbes are dormant (1) fewer (enzymes) to decay food (1) OR enzymes less efficient at lower temperatures (1) slower reaction rate (1) [2]

Topic Chem 7 Q# 70/ iGCSE Chemistry/2014/s/Paper 33/Q3
(c) any three from:
photosynthesis (1)
light/photochemical (1)
chlorophyll/chloroplasts (1)
carbon dioxide and water needed (1)
glucose and oxygen (1) [3]

Topic Chem 7 Q# 71/ iGCSE Chemistry/2014/s/Paper 33/Q2
2 (a) any three from:
particles have more energy (1)
move faster (1)
collide more frequently (1)
more particles have energy greater than $E_a$ guidance: more colliding molecules have enough energy to react is worth (2) [3]

Topic Chem 7 Q# 72/ iGCSE Chemistry/2014/s/Paper 32/Q5
(ii) any two from:
(forward) reaction is endothermic (1)
high temperature increases yield/favours forward reaction/shifting equilibrium to right (1)
faster reaction (rate) (1) [2]

(iii) any two from:
high pressure reduces yield or favours LHS (1)
because LHS has smaller volume or number of moles/number of molecules (of gas) OR A (1)
(high pressure plant is) expensive/dangerous/explosion/leaks [2]
Topic Chem 7 Q# 73/ iGCSE Chemistry/2014/s/Paper 32/Q4

(d) (i) concentration of acid in C is less/halved or concentration of A is more/doubled. (1)

less collisions or more collisions in A (than in C) (1)

(ii) (higher temperature in B particles/molecules/atoms) move faster/have more energy/more have E_a or (particles/molecules/atoms) in A move slower/have less energy/less have E_a (1)

more collisions or less collisions in A (than in B) (1)

(iii) If (D) has strong (acid) and A has weak acid/(D) stronger/(D) ionises more/(D) dissociates more or A is weaker/A ionises less/A dissociates less (1)

It (D) has higher concentration of hydrogen ions or A has a lower concentration of hydrogen ions (1)

more collisions (in D) or fewer collisions in A (1)

Topic Chem 7 Q# 74/ iGCSE Chemistry/2014/s/Paper 32/Q1

(e) F (1) [1]

MS Topic Chem 8 Q# 75/ iGCSE Chemistry/2015/w/Paper 33/Q7

7b(i)
repeat experiment using same volume/amount of (same) H_2SO_4
and same volume/amount of (same) KOH;
or (add activated) charcoal/carbon;
filter out the charcoal;
or mix volumes/amounts of H_2SO_4 and KOH in the ratio 1:2;
of the same concentration.

7b(ii)
make solution of potassium sulfate as above;
add same volume/amount of acid again;
or same volume/amount of KOH;
add double the volume/amount of H_2SO_4
25 cm^3 KOH + 56.4 cm^3 H_2SO_4 = [2]
or same volume/amount of H_2SO_4;
add half the volume/amount of KOH;
12.5 cm^3 KOH + 28.2 cm^3 H_2SO_4 = [2]
or mix equal volumes/amounts of H_2SO_4 and KOH;
of the same concentration;
mix solutions containing equal numbers moles of KOH and H_2SO_4 = [2]

7c
- test reactive metal/ name or formula of suitable metal, e.g. Mg/ Fe/ Zn;
- result bubbles or gas or hydrogen or H_2 evolved/dissolves;
- test: insoluble carbonate or name/formula of suitable insoluble carbonate, e.g. CaCO_3;
- result bubbles or gas or carbon dioxide or CO_2 evolved/dissolves provided that carbonate is insoluble;
- test: alkali or name/formula of suitable alkali, e.g. NaOH/KOH;
- result temperature change;
- test: alkali or name/formula of suitable alkali, e.g. NaOH/KOH and indicator;
- result colour change;
- test: insoluble base or name/formula of suitable insoluble base;
- result dissolves;
- test indicator, e.g. blue litmus;
- result colour change (colour need not be specified);
- test: measure pH/pH paper/pH paper/pH meter;
- result pH 0-3 or indicator red/orange or pH lower than pH of K_2SO_4,

Topic Chem 8 Q# 76/ iGCSE Chemistry/2015/w/Paper 33/Q5

5a(i) proton donor/H^+ donor/hydrogen ion donor; 1

5a(ii) strong acid completely or fully ionises/completely or fully dissociates/completely or fully splits into ions; weak acid partially or incompletely ionises or dissociates or splits into ions/does not ionise fully; 1
5(b)(i) barium sulphate/barium sulfate(IV)/BaSO₄.

5(b)(ii) barium sulfate/BaSO₄.

5(b)(iii) $\text{Br}_2 + 2e^- \rightarrow 2\text{Br}^-/\text{Br}_2 \rightarrow 2\text{Br}^- - 2e$.

5(b)(iv) sulfuric acid.

5(c)(i) $\text{MgSO}_4 + \text{H}_2\text{O} \rightarrow \text{MgSO}_4 \cdot \text{H}_2\text{O}.$

5(c)(ii) $\text{ZnSO}_4 + \text{H}_2.$

5(c)(iii) $\text{CuSO}_4 + \text{CO}_2 + \text{H}_2\text{O}.$

5(d)(i) $2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

rest of equation correct;

or

$\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$

$\text{H}_2\text{O}$ as the only product on the right hand side;

rest of equation correct;

or

$\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{H}_2\text{O}$

rest of equation correct;

or

$2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$

rest of equation correct;

or

$\text{H}_2\text{SO}_4 \rightarrow \text{HSO}_4^- + \text{H}_2\text{O}$

$\text{HSO}_4^-$; rest of equation correct;

5(d)(ii)

$\text{Fe} + \text{H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + \text{H}_2$:

rest of equation correct;

or

$\text{Fe} + 2\text{H}^+ \rightarrow \text{Fe}^{2+} + \text{H}_2$;

$\text{Fe}^{2+}$; rest of equation correct;

or

$2\text{Fe} + 4\text{H}_2\text{SO}_4 \rightarrow \text{Fe}_2\text{(SO}_4)_3 + 3\text{H}_2$;

$\text{Fe}_2\text{(SO}_4)_3$; rest of equation correct;

or

$2\text{Fe} + 6\text{H}^+ \rightarrow 2\text{Fe}^{3+} + 3\text{H}_2$;

$\text{Fe}^{3+}$; rest of equation correct;

Topic Chem 8 Q# 77/ iGCSE Chemistry/2015/w/Paper 33/Q1

1(a) cobalt chloride (paper)/anhydrous cobalt chloride/CoCl₂;

from blue;

to pink;

or

copper sulfate/anhydrous copper sulfate/CuSO₄;

from white;

to blue.

Topic Chem 8 Q# 78/ iGCSE Chemistry/2015/w/Paper 32/Q6

6(g) $\text{MgO}$ will react with $\text{H}_2\text{O}$ in water to form $\text{Mg(OH)}_2$.

if amphoteric, $\text{MgO}$ will react with $\text{H}_2\text{O}$ to form $\text{Mg(OH)}_2$ or $\text{MgO}$ will react with $\text{H}_2\text{O}$ to form $\text{Mg(OH)}_2$ or an alkali or base or basic oxide.

$\text{MgO}$ will not react with $\text{H}_2\text{O}$ to form $\text{Mg(OH)}_2$ or an alkali or base or basic oxide.

Topic Chem 8 Q# 79/ iGCSE Chemistry/2015/s/Paper 33/Q4

4(b)(iii) add sodium hydroxide (solution) and aluminium

(warm) and ammonia made.

A zinc or Devil’s dust

A description of smell of ammonia or test for ammonia.
Topic Chem 8 Q# 80/ iGCSE Chemistry/2015/s/Paper 33/Q2

| 2(a) | carbon monoxide;                | 1 A CO |
| 2(b) | sodium oxide;                   | 1 A Na₂O |
| 2(d) | zinc oxide OR aluminium oxide;  | 1 A ZnO or Al₂O₃ |
| 2(f) | sulfur dioxide;                 | 1 A SO₂ |

Topic Chem 8 Q# 81/ iGCSE Chemistry/2015/s/Paper 32/Q5

5(a) method A; hydrochloric acid/HCl / hydrogen chloride solution; nickel carbonate + hydrochloric acid → nickel chloride + water + carbon dioxide;hydrochloric acid / HCl can only score if written in the reagent space i.e. R hydrochloric acid/HCl in equation if reagent space is blank hydrogen chloride (therefore hydrogen chloride + HCl would get mark 2 BOD)INickel carbonate A fully correct balanced chemical equation i.e. NiCO₃ + 2HCl → NiCl₂ + CO₂ + H₂O for the third markRCombination of words and formulae in the same equation for the third mark I concentration of acid for marks 2 and 3

5(b) method C; any (aqueous/dilute/solution of soluble) bromide including potassium bromide / KBr, hydrogen bromide / HBr i.e. all bromides except silver, lead and mercury; Pb²⁺ + 2Br⁻ → PbBr₂;A correct formula of soluble bromide I need nitrate IA multiplicity

5(c) method B; sulfuric acid / hydrogen sulfate / H₂SO₄; 2LiOH + H₂SO₄ → Li₂SO₄ + 2H₂O; balancing;I concentration of acid for mark 2 I indicators / lithium hydroxide IA multiplicity

6 (a) Any two from:
- bubbles / effervescence / fizzing
- (some of the) solid / copper carbonate dissolves / disappears or some (brown) solid seen (undissolved)
- (colourless) solution or liquid turns blue

(c) (i) Blue precipitate / ppt [1]
(ii) Cu²⁺ + 2OH⁻ → Cu(OH)₂ [1]

(d) (i) Cu(OH)₂(s) → CuO(s) + H₂O(g)

Equation [1]

State symbols of correct chemical equation [1]

Topic Chem 8 Q# 83/ iGCSE Chemistry/2015/m/Paper 32/Q3

(h) (i) proton / H⁺ acceptor [1]
(ii) 2NH₃ + H₂SO₄ → (NH₄)₂SO₄ [2]

Formula of (NH₄)₂SO₄ (1)
The rest (1)

Topic Chem 8 Q# 84/ iGCSE Chemistry/2015/m/Paper 32/Q1

(c) magnesium [1]
(e) aluminium [1]
Topic Chem 8 Q# 85/ iGCSE Chemistry/2015/m/Paper 32/Q1

(b) no more (solid) dissolves or no more cobalt(II) carbonate dissolves or no more effervescence or bubbling or fizzing

filter/residue/centrifuge/decant

evaporate/heat/warm/boil/leave in sun AND until most of the water has gone/some water is left/until it is concentrated/saturation (point)/crystallisation point/crystals form on glass rod or microscope slide/crystals start to form

Leave/allow to cool/allow to crystallise/filter (off crystals)/wash (with distilled water)/dry crystals with filter paper/dry crystals in warm place or dry in oven or dry on windowsill

Topic Chem 8 Q# 86/ iGCSE Chemistry/2014/w/Paper 33/Q8

(b) (i) (mix solutions of) rubidium carbonate/Rb₂CO₃

strontium chloride/SrCl₂ or strontium nitrate/Sr(NO₃)₂ or strontium sulfate/SrSO₄ or strontium hydroxide/Sr(OH)₂

COND (on two correct reactants) filter or centrifuge or decant (the residue)

wash with water and dry/press between filter paper/put in (low) oven/put on a (sunny) windowsill/put in sun/heat

Topic Chem 8 Q# 87/ iGCSE Chemistry/2014/w/Paper 33/Q6

(c) (i) nitric acid or nitric(V) acid or HNO₃

Topic Chem 8 Q# 88/ iGCSE Chemistry/2014/w/Paper 32/Q6

6 (c) (i) nitric acid or nitric(V) acid or HNO₃

Topic Chem 8 Q# 89/ iGCSE Chemistry/2014/w/Paper 32/Q1

(ii) M1 dissolving
M2 filtration
M3 evaporation or heat (to crystallisation point)
M4 crystallisation or allow leave to cool
or
M3 crystallisation
M4 filtration

OR: Adding to H₂SO₄ method

M1 Add excess mixture to acid (or until no more dissolves)
M2 Filtration
or
M1 Add excess acid to mixture
M2 With heat

M3 evaporation or heat (to crystallisation point) Stop marking if heated to dryness.
M4 crystallisation or allow leave to cool
or
M3 crystallisation
M4 filtration

[Total: 10]
Topic Chem 8 Q# 90/ iGCSE Chemistry/2014/s/Paper 32/Q7

7 (a) repeat without indicator/repeat using same volumes of acid and alkali or use carbon/charcoal to remove indicator (1)

evaporate/heat/warm/boil/leave in sun (1)

until most of the water has gone/some water is left/saturation (point)/crystallisation point (1)

leave/allow to cool/allow to crystallise (1)

filter (off crystals)/wash(with distilled water)/dry crystals with filter paper/dry crystals in warm place/oven/windowsill (1) [5]

Topic Chem 8 Q# 91/ iGCSE Chemistry/2014/s/Paper 32/Q6

(c) name or formula of strong acid and alkali (1)

reacts with or neutralises both acid and base or alkali (then amphoteric) (1)

it dissolves/soluble in both(acid and alkali) or form solutions in both (1) [3]

MS Topic Chem 9 Q# 92/ iGCSE Chemistry/2015/w/Paper 33/Q6

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<tbody>
<tr>
<td>6(a) Na/sodium and Li/lithium;</td>
<td>1</td>
</tr>
<tr>
<td>6(f) physical properties</td>
<td>6</td>
</tr>
<tr>
<td>any three from:</td>
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</tr>
<tr>
<td>hard; strong; high density; malleable; ductile; sonorous; shiny; high melting point/high boiling point; (good) conductor (of heat/electricity); forms coloured compounds/coloured ions/coloured sats:</td>
<td></td>
</tr>
<tr>
<td>chemical properties</td>
<td></td>
</tr>
<tr>
<td>any two:</td>
<td></td>
</tr>
<tr>
<td>catalytic behaviour; more than one or different or variable oxidation state or oxidation number or valency/variable charges/many differently charged ions; forms complex (ions); forms coloured compounds/coloured ions/coloured sats; amphoteric oxide/amphoteric/basic oxide/alkaline oxides/acidic oxide; (other metallic reactions) with acids/water/steam; reducing agent/electron donor/ reacts with non-metal to form ionic compound/forms positive ions;</td>
<td></td>
</tr>
</tbody>
</table>

Topic Chem 9 Q# 93/ iGCSE Chemistry/2015/w/Paper 33/Q2

2(d) argon/Ar;  | 1 |

Topic Chem 9 Q# 94/ iGCSE Chemistry/2015/m/Paper 32/Q1

(d) argon  | [1] |

(f) sodium  | [1] |

Topic Chem 9 Q# 95/ iGCSE Chemistry/2014/w/Paper 33/Q3

(iii) Any two from:
- potassium oxide
- potassium hydroxide
- potassium carbonate
- potassium hydrogen carbonate (bicarbonate)  | [2] |

Topic Chem 9 Q# 96/ iGCSE Chemistry/2014/w/Paper 33/Q1

1 (a) Bromine
Physical: reddish-brown liquid or brown liquid or volatile liquid/low boiling point liquid or poor/non-conductor (of electricity) or soluble in water or soluble in organic/non-polar solvents [1]

Chemical: Reacts with water or reacts with iodides (in solution) or displaces iodine or reacts with alkenes/named alkene/unsaturated hydrocarbons or reacts with alkane in UV/named alkane in UV or valency/oxidation state(--)1 or forms Br⁻ or gains or shares 1 electron or combines or reacts with metals/named metal or combines or reacts with non-metals/named non-metal or oxidising agent or bleaches litmus paper/indicator paper or corrosive or forms acidic oxides [1]
(c) **Manganese**

**Physical:** (good) conductor (of heat/electricity) or high melting point/high boiling point or forms coloured compounds/coloured ions or hard or strong or high density or malleable or ductile or sonorous or shiny

**Chemical:** Variable or different valency/oxidation state/oxidation number or catalytic activity or forms coloured compounds/coloured ions or forms complex ions/complexes or reacts with acids or reducing agent or reacts with non-metals

Topic Chem 9 **Q# 97/ iGCSE Chemistry/2014/s/Paper 33/Q1**

(c) krypton (1)

(e) fluorine (1)

Topic Chem 9 **Q# 98/ iGCSE Chemistry/2014/s/Paper 32/Q6**

6 (a) any three from:

(it would have) more than one or variable valency/oxidation state/oxidation number (1)

(metal/element/titanium/it has a) high density (1)

coloured compounds/ions/solutions (1)

form complex (ions) (1)

(element/compound act as) catalyst (1)

Topic Chem 9 **Q# 99/ iGCSE Chemistry/2014/s/Paper 32/Q1**

1 (a) A and E need both (1)

(c) C (1)

(f) E (1)

**MS Topic Chem 10 Q# 100/ iGCSE Chemistry/2015/w/Paper 33/Q6**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Cu (copper) and Rh (rhodium);</td>
</tr>
<tr>
<td>(d)</td>
<td>Fe₂(SO₄)₃;</td>
</tr>
<tr>
<td>(c)</td>
<td>Mg²⁺;</td>
</tr>
<tr>
<td>(e)</td>
<td>copper sulfate (solution): add manganese/Mn to solution; copper displaced or forms blue colour changes; or (a solution of) an iron salt or a zinc salt; add copper and manganese to each; only manganese reacts/displaces; or (a solution of) a manganese salt and a copper salt; add, e.g., iron/zinc; copper (displaced) and manganese not; or to a (dilute) acid/any named acid/water/steam; add Mn and Cu to both metals to the liquid; rate faster or shorter time or more bubbles or more hydrogen or more gas with Mn or with the more reactive metal/reaction only with Mn or with the more reactive metal; or copper oxide; add manganese and heat; evidence of reaction; or burn manganese and copper/both elements; in air/oxygen; Mn or more reactive metal burns brighter/only Mn or more reactive metal burns; evidence that manganese reacts faster; or add carbon; to both metal oxides and heat; evidence that reaction occurs with copper oxide more readily/least reactive metal oxide;</td>
</tr>
</tbody>
</table>
or both metal nitrates or carbonates; 
heat; 
evidence that manganese compound is most stable/most reactive compound is most stable; 
or (electrochemical) cell/use of voltmeter/electrolyte; 
copper and manganese (as electrodes); 
manganese is the negative terminal;

Topic Chem 10 Q# 101/ iGCSE Chemistry/2015/w/Paper 32/Q5

5(a) as a reducing agent 
source of heat/energy; 2
5(b) \( \text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2 \) species; balancing; 2
5(c) silice reacts with limestone or calcium oxide; to form a slag or calcium silicate or \( \text{CaSiO}_3 \); (liquid) slag floats (above molten iron); 3
5(d) blow or pass oxygen through (molten) iron; \( \text{C} + \text{O}_2 \rightarrow \text{CO}_2; \) carbon dioxide escapes or carbon dioxide is a gas; 3

Topic Chem 10 Q# 102/ iGCSE Chemistry/2015/w/Paper 32/Q3

3(a) zinc blend is burnt/roasted/heated in air; zinc sulfide + oxygen → zinc oxide + sulfur dioxide; 2
3(b) zinc oxide + carbon → zinc + carbon dioxide/monoxide; 1
3(d)(i) copper; 1
3(d)(ii) any two from: 
- hard(er)/less malleable; 
- strong(er); 
- (better) appearance; 
- (more) resistant to corrosion; 2
3(e)(i) steel (or iron) is exposed to oxygen and water; 1
3(e)(ii) steel (or iron) is exposed to oxygen and water; 4

Topic Chem 10 Q# 103/ iGCSE Chemistry/2015/w/Paper 32/Q3

3(e)(i) steel (or iron) is exposed to oxygen and water; 1

Topic Chem 10 Q# 104/ iGCSE Chemistry/2015/s/Paper 33/Q6

6(a)(i) \( \text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al} \) formula of \( \text{Al}^{3+} \) ion; rest correct; 2
6(a)(ii) \( 2\text{CO}_2 \rightarrow \text{O}_3 + 4\text{e}^- \) species; balancing; 2
6(a)(iii) endothermic AND (electrical) energy supplied; 1
6(b)(i) exothermic AND (electrical) energy release; 1
6(b)(ii) magnesium forms ions (in solution) OR magnesium loses electrons OR magnesium is oxidised; copper is deposited (on the electrode) OR copper ions become copper atoms OR copper ions gain electrons OR copper ions are reduced; 2
6(b)(iii) \( \text{M1} \) set up a magnesium/manganese cell; \( \text{M2} \) the negative electrode (is the more reactive) OR the electrode that loses mass (is more reactive); OR 
\( \text{M1} \) replace magnesium with manganese; \( \text{M2} \) if voltage less (positive) manganese is less reactive OR if voltage is more (positive) manganese is more reactive; 2

Topic Chem 10 Q# 105/ iGCSE Chemistry/2015/s/Paper 33/Q5

5(a) \( (\text{Cu}_2\text{CO}_3 \rightarrow \text{CuO} + \text{CO}_2; \) \( (\text{Cu} \text{(OH})_2 \rightarrow \text{CuO} + \text{H}_2\text{O}; \) \( (2\text{Cu}(\text{NO})_2 \rightarrow 2\text{CuO} + (4\text{NO}) + \text{O}_2 \) species; balancing; 4

A multiples I state symbols
5(b)(i) (black to pink/brown/orange; 1
5(b)(ii) (hot) copper reacts/ is oxidised; 2
with oxygen/air; 2
5(b)(ii) carbon monoxide/ammonia/methane; 1
5(b)(v) carbon/graphite or any metal more reactive than copper; 1

Topic Chem 10 Q# 106/ iGCSE Chemistry/2015/s/Paper 32/Q6

6(b)(i) \[2\text{NaNO}_3 \rightarrow 2\text{NaNO}_2 + \text{O}_2\] species; balancing;
2
6(b)(ii) the more reactive the metal the lower rate of decomposition/more difficult the decomposition/more stable the nitrate/more energy needed to decompose/decomposes at higher temperature or;
1
6(c)(i) (changes from) blue solid/blue crystals; 3
black solid formed.
brown gas/brown vapour/(pungent) smell;

6(b)(ii) A less (extent the) decomposition
A reactive metals produce nitrates difficult to decompose or i.e. comparative not essential
A the more reactive the metal the less if decomposes is acceptable because we can assume that it refers to the nitrate BCD
A inverse relationship with further qualification
A group 1/effective metals produce nitrite (and oxygen) and less reactive metals produce oxide (+ NO₂ + O₂) (both required for mark)
R less products (unqualified)
R less products/metals decompose

Topic Chem 10 Q# 107/ iGCSE Chemistry/2015/m/Paper 32/Q6

(d) (i) \(\text{Cu(OH)}_2(s) \rightarrow \text{CuO} (s) + \text{H}_2\text{O} (g)\)

Equation [1]

State symbols of correct chemical equation [1]

(iii) carbon/hydrogen [1]

Topic Chem 10 Q# 108/ iGCSE Chemistry/2015/m/Paper 32/Q5

5 (a) Bauxite [1]

(b) carbon/graphite [1]

(c) improves conductivity/better conductor [1]

Lower (operating) temperature/save energy/saves electricity/saves heat [1]

(d) anode: \(2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^- / 2\text{O}^{2-} - 4\text{e}^- \rightarrow \text{O}_2\) [1]
cathode: \(\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al} / \text{Al}^{3+} \rightarrow \text{Al} - 3\text{e}^-\) [1]

(e) (i) Iron carbon aluminium/Fe, C, Al [1]

(ii) Aluminium oxide is not reduced by carbon but iron(III) oxide is [1]

(f) haematite/hematite [1]
(g) Allow: multiples in (i) to (iv)

(i) \[ \text{C} + \text{O}_2 \rightarrow \text{CO}_2 \]  

(ii) \[ \text{CO}_2 + \text{C} \rightarrow 2\text{CO} \]  

(iii) \[ \text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2 / \text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO} / 2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2 \]  

(iv) \[ \text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3 / \text{CaCO}_3 + \text{SiO}_2 \rightarrow \text{CaSiO}_3 + \text{CO}_2 \]  

Topic Chem 10 Q#109/ iGCSE Chemistry/2014/w/Paper 33/Q6

(ii) \[ \text{SrCO}_3 \rightarrow \text{SrO} + \text{CO}_2 \]  

(c) (i) rubidium nitrate or nitrate(III)  

(ii) \[ 2\text{Sr(NO}_3)_2 \rightarrow 2\text{SrO} + 4\text{NO}_2 + \text{O}_2 \]  

Species (1) Balancing (1)  

Topic Chem 10 Q#110/ iGCSE Chemistry/2014/w/Paper 33/Q2

(iv) not horizontal or line slopes or line is lower  

Topic Chem 10 Q#111/ iGCSE Chemistry/2014/w/Paper 33/Q1

(b) Graphite

Chemical: reducing agent or reduces metal oxides/named metal oxide or reacts with burns in air/oxygen or forms an acidic oxide (CO\(_2\)) or valency/oxidation state of 2 or 4  

Topic Chem 10 Q#112/ iGCSE Chemistry/2014/w/Paper 32/Q6

(ii) \[ 2\text{KNO}_3 = 2\text{KNO}_2 + \text{O}_2 \]  

Species (1) 
Balance (1)  

Topic Chem 10 Q#113/ iGCSE Chemistry/2014/w/Paper 32/Q4

4  

(a) M1 brass  
M2 copper COND on M1  

2  

(a) \[ \text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al} \]  

species (1) balancing (1)  

(b) (i) \[ \text{AlCl}_3 + 3\text{Na} \rightarrow 3\text{NaCl} + \text{Al} \]  

species (1) balancing (1)  

(c) (i) bauxite  

(ii) M1 aluminium oxide / amphoteric oxide dissolves OR iron(III) oxide / basic oxide does not  

M2 Filter COND on M1  

(iii) Any two from:  
Lowers (working) temperature or lowers mpt (of mixture)  
increases conductivity  
reduces cost OR energy need
(d) (i) Has an impervious or non-porous or passive or unreactive or protective oxide layer [1]

(ii) Any two from:
- good conductor of heat
- high melting point
- Unreactive towards foods [2]

Topic Chem 10 Q# 115/ iGCSE Chemistry/2014/s/Paper 33/Q7

7 (a) bauxite (1) [1]

(c) (i) food containers/window frames/cooking foil/cars/bikes/drink cans (1) [1]

Topic Chem 10 Q# 116/ iGCSE Chemistry/2014/s/Paper 33/Q4

(ii) any two of the oxides, C, S, P and Si, mentioned (1)
- carbon dioxide and sulfur dioxide escape/are gases (1)
- phosphorus oxide or silicon(IV) oxide react with calcium oxide/ phosphorus oxide or silicon(IV) oxide are acidic and calcium oxide is basic (1)

must have correct equation for one of the above reactions (1) [5]

(iii) carbon particles/atoms different size (1)
- prevents movement of rows, etc. (1) [2]

MS Topic Chem 11 Q# 117/ iGCSE Chemistry/2015/w/Paper 33/Q1

<table>
<thead>
<tr>
<th>1(c)</th>
<th>any two from:</th>
</tr>
</thead>
<tbody>
<tr>
<td>filtration/sedimentation/sieving/screening //pass through) gravel (bede)/flocculation/decantation /clarification/coagulation/flotation/settling tank/ add aluminium sulfate;</td>
<td></td>
</tr>
<tr>
<td>(add) carbon;</td>
<td></td>
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<tr>
<td>chlorination / (add) chlorine / add Cl₂;</td>
<td></td>
</tr>
<tr>
<td>fluoridation/add fluoride;</td>
<td></td>
</tr>
<tr>
<td>ozone dosing;</td>
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<tr>
<td>desalination;</td>
<td></td>
</tr>
<tr>
<td>aeration;</td>
<td></td>
</tr>
<tr>
<td>distillation;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1(d)</th>
<th>any two from:</th>
</tr>
</thead>
<tbody>
<tr>
<td>making steel; making paper; textile; generating electricity/energy/power /turbine; HEP; water mills; steam power (e.g. steam engine); geothermal power; agriculture; livestock; irrigation; hydraulic engineering; manufacture of hydrosulfuric acid; manufacture of sulfuric acid; Contact process; manufacture of hydrogen; solvent/dissolving; coolant/cooling; cleaning/washing (supply of) drinking (water); central heating; production of slaked lime; cooking;</td>
<td></td>
</tr>
</tbody>
</table>

Topic Chem 11 Q# 118/ iGCSE Chemistry/2015/w/Paper 32/Q2

<table>
<thead>
<tr>
<th>2(a)(i)</th>
<th>combustion/burning of a motor vehicle fuel or a named fuel which can act as a motor vehicle fuel; incomplete combustion would produce CO; complete combustion would produce CO₂;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(a)(ii)</td>
<td>carbon dioxide: climate change/global warming /greenhouse effect; carbon monoxide: poisonous/toxic;</td>
</tr>
<tr>
<td>2(a)(iii)</td>
<td>nitrogen and oxygen react or combine; at high temperatures or in presence of spark;</td>
</tr>
<tr>
<td>2(a)(iv)</td>
<td>it reacts or combines with oxygen/NO + ½O₂ → NO₂;</td>
</tr>
<tr>
<td>2(b)</td>
<td>any two from:</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td>acid rain is formed;</td>
<td></td>
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<tr>
<td>lowers pH or acidifies lakes /rivers or kills fish/aquatic animals;</td>
<td></td>
</tr>
<tr>
<td>changes composition of soils or reduces fertility of soil or reduces crop yields /deforestation or kills crops or trees or plants or leaves/lowers pH of soil or increases acidity of soil;</td>
<td></td>
</tr>
<tr>
<td>attacks (limestone) buildings or statues;</td>
<td></td>
</tr>
<tr>
<td>attacks metal (structures)/bridges;</td>
<td></td>
</tr>
<tr>
<td>2(c) use of a catalytic converter;</td>
<td></td>
</tr>
<tr>
<td>2NO + 2CO → 2CO₂ + N₂</td>
<td></td>
</tr>
<tr>
<td>species; balancing;</td>
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</tr>
</tbody>
</table>

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### Topic Chem 11 Q# 119/ iGCSE Chemistry/2015/s/Paper 33/Q4

| 4(b)(i) | oxygen/air and sulfur (from fuel) react;  
(formal) sulfur (dioxide);  
(sulfur dioxide) reacts with oxygen/air and water (to form sulfuric acid)  
OR sulfur trioxide reacts with water (to form sulfuric acid)  
OR sulfuric acid reacts with oxygen (to form sulfuric acid) | A correct formulae throughout  
A sulphurous acid if sulfur reacts with oxygen and water | 3 |
| 4(b)(ii) | oxygen and nitrogen react;  
making oxides of nitrogen;  
(oxides of nitrogen) react with water (making nitric acid); | A nitrogen compound  
IF oxygen or nitrogen originate from the fuel | 3 |
| 4(b)(iii) | add sodium hydroxide (solution) and aluminium;  
(warm) and ammonia made; | A zinc or Davida’s  
A description of smell of ammonia or test for ammonia | 2 |

### Topic Chem 11 Q# 120/ iGCSE Chemistry/2015/s/Paper 32/Q7

| 7(a)(i) | living organism or named example e.g. yeast/cells/plants/animals/part of animal or plant e.g. muscle/human/micro-organisms;  
produces/releases or gain or obtain energy/exothermic/heat;  
from food/named foodstuff/carbohydrate/named carbohydrate/sugar/named sugar/glucose/nutrients; | A 'we/us' for humans | 3 |

| 7(a)(ii) | Any 2 from:  
carbon dioxide/CO₂;  
water/H₂O;  
adenosine triphosphate/ATP; | energy | 1 |

### Topic Chem 11 Q# 121/ iGCSE Chemistry/2015/s/Paper 32/Q6

| 6(a)(i) | Haber process makes ammonia/NH₃;  
(ammonia converted into) fertilisers/nitrates/ammonium salts or names or formulae of examples e.g. ammonium nitrate/NH₄NO₃/ammonium sulphate/(NH₄)₂SO₄/calcium nitrate/Ca(NO₃)₂/urea/CO(NH₂)₂; | A 2 marks for ‘ammonia is a fertiliser’  
A ammonia is used to make sodium nitrate  
Haber process used to make fertilisers gets second mark only | 2 |
| 6(a)(ii) | it (refers to sodium nitrate)/sodium nitrate would dissolve (in rain)/soluble (in water)/wash away/leach/drain off; | A reacts with water  
Reference to fertiliser  
R sodium reacts/dissolves  
A because they are not dissolved by rainfall  
(Mobilisation is in desert) | 1 |
| 6(a)(iii) | potassium (is required by plants as well as nitrogen)/NPK; | R comments about pH/better for soil/%N  
R comments about what K does for plants e.g. combat disease | 1 |

### Topic Chem 11 Q# 122/ iGCSE Chemistry/2015/s/Paper 32/Q4

| 4(a) | large surface area/large area of contact/large surface;  
more (successful) collisions (between catalyst and gas or between reacting gases) OR more active sites OR faster reaction/increase rate/increase speed; | I activation energy  
Second mark must be comparative | 2 |
| 4(b) | decrease temperature/temperature below 450 °C/quoted temperature below 450 °C;  
increase pressure/pressure above 200 atm/quoted pressure above 200 atm; | I comments about concentration  
I low temperature and high pressure, both answers must be comparative  
I explanations | 2 |
| 4(c) | decreased temperature would reduce rate/reaction slower/too slow;  
increased pressure/expensive/uneconomic/safety risks/leaks/explosions/yield or rate good enough at lower pressure/strong pipes needed/thick pipes needed/sturdy pipes needed/requires a lot of energy; | A takes longer  
I slow (unqualified)  
I answers that do not refer to decreased temperature and increased pressure e.g. it is too expensive unless this is linked with pressure | 2 |
Topic Chem 11 Q# 123/ iGCSE Chemistry/2015/m/Paper 32/Q3
3  (a) (making) fertilisers / nitric acid / nylon / explosives / urea
   (for) cleaning products (allow oven cleaner) / refrigeration [1]

   (b) equilibrium / reversible [1]

   (c) (nitrogen) air / atmosphere [1]

      (hydrogen) methane / water / steam / alkane / named alkane / hydrocarbon / crude oil
      or petroleum / natural gas [1]

   (d) iron [1]

   (e) (i) rate increases / faster [1]

      More (effective) collisions [1]

      (ii) yield decreases [1]

         (forward reaction) exothermic / reverse reaction endothermic / high temp
         favours endothermic reaction [1]

   (f) (i) yield increases [1]

      less / fewer molecules or moles or volume on RHS ORA / high pressure
      favours reaction which produces fewer molecules or moles or volume [1]

      (ii) particles / molecules closer / more particles per unit area or volume / more
           molecules per unit area or volume / more concentration / particles have less
           space between them and more collisions [1]

      (iii) safety issues / higher cost [1]

Topic Chem 11 Q# 124/ iGCSE Chemistry/2015/m/Paper 32/Q1
(b) chlorine [1]

Topic Chem 11 Q# 125/ iGCSE Chemistry/2014/s/Paper 33/Q5
5  (a) faster reaction rate (1)
   higher collision rate (1)
   greater yield or favour RHS (1)
   pressure favours products because it has lower volume / fewer product molecules (1) [4]

   (b) higher temperature favour endothermic reaction (1)
   this is the back reaction / left hand side / reactants (1)
   reduce yield (1) [3]

   (c) (i) greater surface area (1) [1]

      (ii) increase reaction rate (1)
      can use a lower temperature to have an economic rate (1)
      and not decrease yield (by increasing temperature). [2]
(d) lower the temperature (1)
only ammonia will liquefy (1)
OR
add water (1)
only ammonia will dissolve (1)
OR
increase pressure (1)
only ammonia will liquefy (1)

Topic Chem 11 Q# 126/ iGCSE Chemistry/2014/s/Paper 33/Q4
fractional distillation (1)
liquid air (1)

Topic Chem 11 Q# 127/ iGCSE Chemistry/2014/s/Paper 33/Q1
1 (a) carbon dioxide (1)

Topic Chem 11 Q# 128/ iGCSE Chemistry/2014/s/Paper 33/Q1
(d) nitrogen (1)

Topic Chem 11 Q# 129/ iGCSE Chemistry/2014/s/Paper 32/Q5
5 (a) (i) incomplete combustion or limited oxygen/less oxygen/not enough oxygen (1)

Topic Chem 11 Q# 130/ iGCSE Chemistry/2014/s/Paper 32/Q3
3 (a) (i) pressure 150–300 atmospheres/atm (1)
temperature accept in range 370 to 470°C (1)
iron (catalyst) (1)
balanced equation \( \text{N}_2 + 3\text{H}_2 = 2\text{NH}_3 \) (1)
equilibrium/ reversible (1)

(ii) potassium/K (1)
phosphorus/P (1)

(b) (i) burn fossil fuels/burn fuels containing sulfur/burn compounds containing sulfur/burn ores containing sulfur/roast metal sulfides/burn metal sulfides (1)
sulfur dioxide/\( \text{SO}_2 \) (formed) (1)
(form) sulfuric/\( \text{H}_2\text{SO}_4 \)/sulfurous acid/\( \text{H}_2\text{SO}_3 \) (1)

OR

nitrogen and oxygen (in air) react at high temperatures/in jet engines/car engines/lightning. (1)

(form) oxides of nitrogen (1)
(form) nitric acid/\( \text{HNO}_3 \)/nitrous acid/\( \text{HNO}_2 \) (1)
Topic Chem 11 Q# 131/ iGCSE Chemistry/2014/s/Paper 32/Q2
(ii) any two from:
limited or finite resource / non-renewable / will run out / depleted (1)
greenhouse effect / gas(es) / climate change / (cause) global warming (1)
acid rain (1)
production of poisonous / toxic gases (1) [2]

MS Topic Chem 12 Q# 132/ iGCSE Chemistry/2015/w/Paper 33/Q2
2(a) sulfur dioxide / SO₂
1

Topic Chem 12 Q# 133/ iGCSE Chemistry/2015/s/Paper 33/Q2
2(c) sulfur dioxide; 1 A SO₂

Topic Chem 12 Q# 134/ iGCSE Chemistry/2014/w/Paper 32/Q6
6 (a) making fertilisers or pickling metals or making fibres or making phosphoric acid/phosphates making dyes or making paints/pigments/dyes or making paper making plastics or making detergents or tanning leather or battery acid.
(ii) M1 Sulfur trioxide reacts with water to make sulfuric acid or equation [1]
M2 sulfur dioxide reacts with oxygen to form sulfur trioxide or equation [1]

Topic Chem 12 Q# 135/ iGCSE Chemistry/2014/w/Paper 32/Q4
(c) (i) sulfuric acid [1]

Topic Chem 12 Q# 136/ iGCSE Chemistry/2014/s/Paper 33/Q1
(f) sulfur dioxide (1) [1]

MS Topic Chem 13 Q# 137/ iGCSE Chemistry/2015/s/Paper 33/Q3
3(b) \( \text{CaO} \rightarrow \text{H}_2 \text{O} \rightarrow \text{Ca(OH)}_2 \) reactants; product; 2 One mark for each side correct A multiples I state symbols
3(c) \( \text{M1} \: \text{number of moles of CaCO}_3 = \frac{125000}{100} = 0.125 \text{ or } 125000 \text{ OR } \frac{56}{100} = 0.56; \)
\( \text{M2} \: \text{mass calcium oxide} = (0.125 \times 56) = 7 \) (tonnes)
\( \text{OR} \: \frac{0.56}{12.5} = 7; \) 2 Correct answer scores both marks A answers in g or kg
3(d)(i) Any two from: does not wash away / insoluble / lasts a long time; does not increase pH above 7 / neutral / has pH 7; naturally occurring / does not need to be processed; 2 A does not leach out
3(d)(ii) Any three from: (fire gas contains) sulfur dioxide; flux gas / sulfur dioxide is acidic; calcium carbonate reacts with sulfur dioxide; to make a salt / calcium sulfite OR neutralisation; A CaCO₃ is a base 3
3(d)(iii) making steel or iron in a blast furnace / toothpaste / (making) glass / building / (making) cement / treating acidic river or lakes / chalk; 1

Topic Chem 13 Q# 138/ iGCSE Chemistry/2014/s/Paper 33/Q4
4 (a) (i) heat limestone / calcium carbonate (1)

Topic Chem 13 Q# 139/ iGCSE Chemistry/2014/s/Paper 32/Q3
(ii) any two from:
calcium oxide / lime / quicklime / CaO (1)
calcium hydroxide / Ca(OH)₂ / lime / slaked lime / limewater (1)
calcium carbonate / CaCO₃ / limestone / chalk / marble (1)
guidance: ‘lime’ can only be credited once. [2]
### Topic Chem 14 Q# 140/ iGCSE Chemistry/2015/w/Paper 33/Q4

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4(a)(i)</td>
<td>3</td>
</tr>
<tr>
<td>4(a)(ii) C₂H₆</td>
<td>1</td>
</tr>
<tr>
<td>4(a)(ii) C₃H₈</td>
<td>1</td>
</tr>
<tr>
<td>4(a)(iii) alkanes all or only (C–C) single bonds/no double bonds/no multiple bonds; alkanes (at least one) C=C double bond/multiple bond;</td>
<td>1</td>
</tr>
<tr>
<td>4(b)(i) heat/high temperature/temperature between 450 °C and 800 °C; catalyst/named catalyst, e.g. zeolites or alumina or aluminium oxide or aluminosilicates or silica or oxides of chromium; or high pressure/pressure in range of 2–70 atm; or steam; absence of air/oxygen;</td>
<td>2</td>
</tr>
<tr>
<td>4(b)(ii) any correct equation producing an alkane and an alkenes adding up to seven carbon atoms in the products;</td>
<td>1</td>
</tr>
<tr>
<td>4(b)(iii) any correct equation producing two alkenes and hydrogen, e.g. → C₂H₄ + C₂H₆ + H₂ + C₂H₄ + C₂H₆ + H₂;</td>
<td>1</td>
</tr>
<tr>
<td>4(b)(iv) alkenes: more useful than alkanes used to make polymers or plastics used to make chemicals/petrochemicals; or alkenes: (balance the demand for different fuels/increase petrol (fraction) or hydrogen/produce lighter fractions from heavier fractions or suitable example, e.g. naphtha to gasoline/more useful smaller molecules or more demand for smaller molecules or more demand by smaller fractions) used as fuel/used to make ammonia/used in Haber process/used in hydrogenation of vegetable oils/used to make HCl;</td>
<td>1</td>
</tr>
</tbody>
</table>

### Topic Chem 14 Q# 141/ iGCSE Chemistry/2015/w/Paper 33/Q2

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(c)</td>
<td>1</td>
</tr>
<tr>
<td>2(f)</td>
<td>1</td>
</tr>
</tbody>
</table>

### Topic Chem 14 Q# 142/ iGCSE Chemistry/2015/w/Paper 32/Q4

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4(a)(i) CH₃CH₂CH₃</td>
<td>1</td>
</tr>
<tr>
<td>4(a)(iii) (both have) same molecular formula; different structural formula or structure;</td>
<td>2</td>
</tr>
<tr>
<td>4(c)(i) CH₃CH₂CH₃Cl + NaOH → CH₃CH₂CH₂Cl + NaCl/ NaCl as product; rest of equation;</td>
<td>2</td>
</tr>
<tr>
<td>4(c)(ii) propene; CH₂=CH₂</td>
<td>2</td>
</tr>
<tr>
<td>4(c)(iii) propane;</td>
<td>1</td>
</tr>
</tbody>
</table>

### Topic Chem 14 Q# 143/ iGCSE Chemistry/2015/s/Paper 33/Q7

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7(a)(i) alkenes have a (carbon to carbon) double bond;</td>
<td>1</td>
</tr>
<tr>
<td>7(a)(ii) alkenes; C₂H₄ or twice as many hydrogen atoms as carbon atoms;</td>
<td>2</td>
</tr>
<tr>
<td>7(a)(iii) add bromine (water); remains brown/orange/yellow/no change; becomes colourless/descoloured;</td>
<td>3</td>
</tr>
<tr>
<td>7(b)(i) correct structure with at least two carbons and single C–C bond; continuation bonds with at least 2 carbon atoms in chain; two or more correct repeat units (with correct use of n, if used) OR correct use of n;</td>
<td>3</td>
</tr>
<tr>
<td>7(b)(ii) CH₃–CH=CH–CH₂</td>
<td>2</td>
</tr>
</tbody>
</table>
### Topic Chem 14 Q# 144/ iGCSE Chemistry/2015/s/Paper 33/Q6

<table>
<thead>
<tr>
<th>7(b)(i)</th>
<th>A only one monomer</th>
</tr>
</thead>
<tbody>
<tr>
<td>7(b)(iv)</td>
<td>A protein/polysaccharide/polypeptide/complex carbohydrate names</td>
</tr>
</tbody>
</table>

### Topic Chem 14 Q# 145/ iGCSE Chemistry/2015/s/Paper 33/Q4

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4(a)(ii)</td>
<td>(burn) to release energy; take a long time to form (from organic material);</td>
</tr>
</tbody>
</table>

### Topic Chem 14 Q# 146/ iGCSE Chemistry/2015/s/Paper 32/Q7

<table>
<thead>
<tr>
<th>7(c)</th>
<th>Any two from: fuel; OR petrol additive; OR solvent/liquefiables; OR (waxing) perfumes; OR varnishes; OR preserving biological specimens/preserving food; OR essence/flavourings; OR antiseptic/kills bacteria (in medicine)/sterilizer; OR antibacterial agent; OR (in) disinfectant/hand sanitizer; OR to make esters/esterification; OR to make ether(s); OR to make amines; OR to make carboxylic acid(s)/vinegar/ethanoic acid; OR thermometers; OR alcohol lamp/spirit burners; OR any other suitable use;</th>
</tr>
</thead>
</table>

### Topic Chem 14 Q# 147/ iGCSE Chemistry/2015/m/Paper 32/Q7

<table>
<thead>
<tr>
<th>7(a)</th>
<th>Any two from: yeast/20–40 °C/anaerobic or without oxygen or without air/(aqueous) solution or water or aqueous</th>
</tr>
</thead>
<tbody>
<tr>
<td>7(c)</td>
<td>(i) Crude oil/petroleum</td>
</tr>
<tr>
<td></td>
<td>(ii) ( \text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_5\text{OH} / \text{CH}_3\text{CH}_2\text{OH} )</td>
</tr>
</tbody>
</table>
Topic Chem 14  Q# 148/ IGCSE Chemistry/2015/m/Paper 32/Q4

4  (a) (i) 82.76/12 and 17.2(4)/(1)
   or evaluation: 6.89 / 6.9(0) and 17.2(4) [1]
   C₂H₅ [1]
   OR
   82.76 / 100 × 58 = 48 and 17.24 / 100 × 58 = 10
   or evaluation i.e. 48 and 10 [1]
   C₂H₅ [1]

(ii) (C₂H₅ =) 29 [1]
   (58/29 = 2 ) C₄H₁₀ [1]
   OR:
   82.76 / 100 × 58 = 48 and 17.24 / 100 × 58 = 10
   or evaluation i.e. 48 and 10 [1]
   48/12 = 4 10/1 = 10 (therefore) C₄H₁₀ [1]

(b) (i) C₅H₂₅ [1]

(ii) CH₂ [1]

(c) (contains) double bond/triple bond/multiple bonds/not all bonds are single [1]
   (contains) carbon and hydrogen only [1]

(d) bromine/bromine water [1]
   no change/stays brown/orange/yellow/red-brown or only changes in UV [1]
   (brown/orange/yellow) to colourless/decoulourised [1]

(e) (i) circle/brackets around any 2 consecutive carbon atoms in the main chain and all attached atoms [1]
   e.g.

   \[ \text{C}_2\text{H}_5 \]
   \[ \text{C} \]
   \[ \text{C} \]
   \[ \text{H} \]
   \[ \text{H} \]
   \[ \text{C} \]
   \[ \text{H} \]
   \[ \text{C} \]
   \[ \text{H} \]

(ii) CH₃CH₂CH=CH₂ / C₂H₅CH=CH₂ (double bond must be shown) [1]
   butene/but-1-ene [1]

(iii) \( (\text{CH}_3)_2\text{C} = \text{CH}_2 / \text{CH}_2\text{CH} = \text{CHCH}_3 / (\text{CH}_2)_2\text{CHCH}_3 / (\text{CH}_2)_4 \) [1]

[Total:15]
4 (a) (i) \[ \frac{82.76}{12} \text{ and } \frac{17.24}{10} \] OR evaluation: 6.89 / 6.9(0) and \( 17.2(4) \)

\[ \text{C}_2\text{H}_5 \]

OR
\[ 82.76 / 100 \times 58 = 48 \text{ and } 17.24 / 100 \times 58 = 10 \]
OR evaluation i.e. 48 and 10

\[ \text{C}_2\text{H}_5 \]

(ii) \( (\text{C}_2\text{H}_5 = ) 29 \)

\( \frac{58}{29} = 2 \) \( \text{C}_4\text{H}_{10} \)

OR:
\[ 82.76 / 100 \times 58 = 48 \text{ and } 17.24 / 100 \times 58 = 10 \]
OR evaluation i.e. 48 and 10

\[ 48 / 12 = 4 \text{ } 10 / 1 = 10 \text{ (therefore) } \text{C}_4\text{H}_{10} \]

(b) (i) \( \text{C}_6\text{H}_{12} \)

(ii) \( \text{CH}_2 \)

(c) (contains) double bond/triple bond/multiple bond(s)/not all bonds are single
(contains) carbon and hydrogen only

(d) bromine/bromine water

no change/stays brown/orange/yellow/red-brown or only changes in UV
(brown/orange/yellow) to colourless/decolourised

(e) (i) circle/brackets around any 2 consecutive carbon atoms in the main chain and all attached atoms

\[ \text{e.g.} \]

\[ \begin{array}{c}
\text{C}_2\text{H}_5 \\
\text{H}
\end{array} \begin{array}{c}
\text{C} \\
\text{H}
\end{array} \begin{array}{c}
\text{C}_2\text{H}_5 \\
\text{H}
\end{array} \begin{array}{c}
\text{C} \\
\text{H}
\end{array} \begin{array}{c}
\text{C}_2\text{H}_5 \\
\text{H}
\end{array} \]

(ii) \( \text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2 / \text{C}_2\text{H}_5\text{CH}=\text{CH}_2 \) (double bond must be shown)

butene/but-1-ene

(iii) \( (\text{CH}_3)_2\text{C}=\text{CH}_2 / \text{CH}_3\text{CH}=	ext{CHCH}_3 / (\text{CH}_2)_2\text{CHCH}_3 / (\text{CH}_2)_4 \)

[Total:15]
7  (a) (i) butanoic acid/butyric acid

displayed formula below

\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} & \quad \text{C} & \quad \text{C} & \quad \text{C} & \quad \text{C} & \quad \text{O} \\
\text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} & \quad \text{C} & \quad \text{O} & \quad \text{H}
\end{align*}
\]

(ii) any three from:
same or similar chemical properties
(same) general (molecular) formula
(consecutive members) differ by CH₂
(same functional group)
common methods of preparation
physical properties vary in predictable manner/show trends/gradually change
or example of a physical property variation i.e. melting point/boling point/volatility

(b) (i) methyl propanoate

\[
\text{CH₃CH₂COOCH₃/CH₃CH₂CO₂CH₃/C₆H₅COOHCH₃/C₆H₅CO₂CH₃}
\]

(ii) methyl ethanoate

(c) (i) \(3\text{C}_₄\text{H}_{10} + 5 \frac{1}{2} \text{O}_₂ \rightarrow 4\text{C}_₂\text{H}_₅\text{COOH} + 3 \text{H}_₂\text{O}\)

(ii) propanol or propan-1-ol or propanal

[Total: 14]

5  (a) (i) M1 Contain carbon, hydrogen and oxygen (only)

M2 hydrogen and oxygen is in a 2:1 ratio (or in the same ratio as water)

(ii) M1 -O- linkage

M2 3 monomer units with 3 blocks and 3 Oxygen atoms Cond

\[
\begin{align*}
\text{O} & \quad \text{O} & \quad \text{O} \\
\text{O} & \quad \text{O} & \quad \text{O}
\end{align*}
\]

= 2 marks

= 1 mark
3  (a)  (i) \[ \text{C}_4\text{H}_8\text{ only} \]
    \[ \text{CH}_2 \text{ (Allow } \text{C}_3\text{H}_2) \] [2]

(ii) Any unambiguous structural formula of methyl cyclopropane or but-1-ene or but-2-ene or methyl propene [1]

(iii) M1 same molecular formula [1]
    M2 different structural formulae or different structures or different arrangement of atoms [1]

(iv) If ‘No’:
    one an alkane, the other an alkene
    or
    one is saturated / has single bonds, the other is unsaturated / has a double bond
    ignore: references to the ‘functional group’

    If ‘yes’
    both alkanes or both saturated
    ignore: references to the ‘functional group’ [1]

(b)  (i) M1 Action of heat or catalyst or thermal decomposition (on an alkane) [1]
    ignore steam. Ignore pressure.

    M2 Long-chained molecules or alkanes form smaller molecules (not smaller fraction) or forms smaller alkenes (or alkanes) [1]

(ii) \[ \text{C}_{13}\text{H}_{22} \] [1]

(c)  (i) M1 Correct structure of one repeat unit [1]

    M2 Continuation bonds COND on M1 [1]

    M3 use of brackets and subscript ‘n’ COND on M1 and M2 [1]

\[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{C} & \quad \text{C} \\
\text{CH}_3 & \quad \text{CH}_3 \\
\text{COND} & \quad \text{COND} \\
n & \quad n
\end{align*}
\]

= 3 marks

\[
\begin{align*}
\text{H} & \quad \text{H} & \text{H} & \text{H} \\
\text{C} & \quad \text{C} & \text{C} & \text{C} \\
\text{CH}_3 & \quad \text{CH}_3 & \text{CH}_3 & \text{CH}_3 \\
\text{COND} & \quad \text{COND} & \text{COND} & \text{COND} \\
n & \quad n & \text{COND} & \text{COND}
\end{align*}
\]

= 2 marks

\[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{C} & \quad \text{C} \\
\text{CH}_3 & \quad \text{CH}_3 \\
\text{COND} & \quad \text{COND}
\end{align*}
\]

= 1 mark

(ii) dibromoethane or 1,2-dibromoethane [1]
6   (a)  (i)  C and H only (1)  
     (ii) only single bonds (1)  

(b)  (i)  \( C_2H_{2n+2} \) (1)  
     (ii)  \( C_{14}H_{30} \) (1)  
          \((14 \times 12) + 30 = 198 \) (g) (1)  

(c)  (i)  \( C_2H_{20} + 14 \text{O}_2 \rightarrow 9\text{CO}_2 + 10\text{H}_2\text{O} \) (2)  
     (ii)  Volume ratio  
          \( \frac{C_2H_4(g)}{O_2(g)} \rightarrow \frac{CO_2(g)}{H_2O(l)} \)  
          \[
          \begin{array}{ccc}
          20 & 160 & 100 \\
          1 & 8 & 5 \\
          \end{array}
          \]  
          all in cm\(^3\) mole ratio  
          \( C_2H_{12} + 8O_2 \rightarrow 5\text{CO}_2 + 6\text{H}_2\text{O} \)  
          For evidence of method (1)  
          for equation as above (2)  

(d)  (i)  alkanes in petrol/fuel/solvent (1)  
        alkenes to make alcohols/plastics/polymers/solvents (1)  
        hydrogen to make ammonia/fuel/fuel cells, etc. (1)  
     (ii)  a correct equation for example:  
        \( C_{10}H_{22} \rightarrow C_8H_{16} + C_2H_4 + H_2 \) (1)  

(e)  (i)  light or lead tetraethyl/catalyst/high temperature (1)  
     (ii)  \( \text{CH}_3-\text{CHCl-CH}_3 \) (1)  

[Total: 16]
Topic Chem 14 Q# 156/ iGCSE Chemistry/2014/s/Paper 32/Q4

4  (a)  (i)  butanoic / butyric acid (1)

\[ \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} / \text{C}_4\text{H}_8\text{CH}_2\text{COOH} \] (1)

(ii) any three from:

(same) general formula (1)

(consecutive members) differ by CH\(_2\) (1)

same functional group (1)

common methods of preparation (1)

physical properties vary in predictable manner/show trends/gradually change

or example of a physical property variation i.e. melting point/boiling point/volatility (1)

(b)  (i)  displayed formula of propan-1-ol, all bonds shown separately (1)

(ii) acidified (1)

potassium manganate(VII)/potassium permanganate/KMnO\(_4\) or potassium dichromate(VI)/K\(_2\)Cr\(_2\)O\(_7\)/potassium dichromate (1)

(c)  (i)  zinc + propanoic acid → zinc propanoate (+ hydrogen) (1)

(ii) calcium oxide + propanoic acid → calcium propanoate + water (1)

(iii) LiOH + CH\(_3\)CH\(_2\)COOH → CH\(_3\)CH\(_2\)COOLi + H\(_2\)O (1)

Topic Chem 14 Q# 157/ iGCSE Chemistry/2014/s/Paper 32/Q2

2  (a)  (i)  substance/material/compound/element/mixture (burnt) to produce/release energy or heat (1)

(ii) Any two from:

coal
coke
peat
petroleum/ crude oil
refinery gas/LPG
gasoline/petrol
naptha
kerosene/paraffin
diesel (oil)/gas oil
fuel oil
propane
butane

(iii) wood/charcoal/animal dung/biomass/Uranium/U/plutonium/Pu (1)

(b)  (i)  any two from:

water/steam/water vapour/H\(_2\)O (1)
carbon dioxide/CO\(_2\) (1)
carbon monoxide/CO (1)
### Section 2: Past Exam Questions Covering Topics 8, 10, 11, 12, 13 And 14

iG Chem 8 EQ P3  Acids, bases and salts  15w to 01s NEW 188marks

<table>
<thead>
<tr>
<th>Topic</th>
<th>Core</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Acids, bases and salts</td>
<td>The characteristic properties of acids and bases</td>
<td>Define acids and bases in terms of proton transfer, limited to aqueous solutions</td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Describe the characteristic properties of acids as reactions with metals, bases, carbonates and effect on litmus and methyl orange</td>
<td>• Describe the meaning of weak and strong acids and bases</td>
</tr>
<tr>
<td></td>
<td>• Describe the characteristic properties of bases as reactions with acids and with ammonium salts and effect on litmus and methyl orange</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Describe neutrality and relative acidity and alkalinity in terms of pH measured using Universal Indicator paper (whole numbers only)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Describe and explain the importance of controlling acidity in soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Types of oxides</td>
<td>Further classify other oxides as neutral or amphoteric</td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Classify oxides as either acidic or basic, related to metallic and non-metallic character</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preparation of salts</td>
<td>Demonstrating knowledge and understanding of the preparation of insoluble salts by precipitation</td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Demonstrate knowledge and understanding of preparation, separation and purification of salts as examples of some of the techniques specified in section 2.2.2 and the reactions specified in section 8.1</td>
<td>• Suggest a method of making a given salt from a suitable starting material, given appropriate information</td>
</tr>
<tr>
<td></td>
<td>Identification of ions and gases</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Describe the following tests to identify:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• aqueous cations:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>aluminium, ammonium, calcium, chromium(III), copper(III), iron(II), iron(III) and zinc (using aqueous sodium hydroxide and aqueous ammonia as appropriate) (Formulae of complex ions are not required.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• cations:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>use of the flame test to identify lithium, sodium, potassium and copper(II)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• anions:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>carbonate (by reaction with dilute acid and then limewater), chloride, bromide and iodide (by reaction under acidic conditions with aqueous silver nitrate), nitrate (by reduction with aluminium), sulfate (by reaction under acidic conditions with aqueous barium ions) and sulfite (by reaction with dilute acids and then aqueous potassium manganate(VII))</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• gases:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ammonia (using damp red litmus paper), carbon dioxide (using limewater)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>oxygen (using a glowing splint), carbon monoxide (using limewater), hydrogen (using lighted splint)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sulfur dioxide (using aqueous potassium manganate(VII))</td>
<td></td>
</tr>
</tbody>
</table>

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## Tests for ions (Topic 8)

### Tests for anions

| anion     | test                                    | test result                                                         |
|-----------|-----------------------------------------|                                                                    |
| carbonate ([CO$_3^{2-}$]) | add dilute acid                        | effervescence, carbon dioxide produced                             |
| chloride ([Cl$^-$])     | acidify with dilute nitric acid, then add aqueous silver nitrate    | white ppt.                                                         |
| bromide ([Br$^-$])      | acidify with dilute nitric acid, then add aqueous silver nitrate    | cream ppt.                                                        |
| iodide ([I$^-$])        | acidify with dilute nitric acid, then add aqueous silver nitrate    | yellow ppt.                                                      |
| nitrate ([NO$_3^-$])    | add aqueous sodium hydroxide, then aluminium foil; warm carefully   | ammonia produced                                                   |
| sulfate ([SO$_4^{2-}$]) | acidify, then add aqueous barium nitrate                              | white ppt.                                                        |
| sulfite ([SO$_3^{2-}$]) | add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide | sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless |

### Tests for aqueous cations

| cation     | effect of aqueous sodium hydroxide | effect of aqueous ammonia                                           |
|------------|------------------------------------|                                                                     |
| aluminium ([Al$^{3+}$]) | white ppt., soluble in excess giving a colourless solution | white ppt., insoluble in excess                                     |
| ammonium ([NH$_4^+$])    | ammonia produced on warming        |                                                                     |
| calcium ([Ca$^{2+}$])    | white ppt., insoluble in excess    |                                                                     |
| chromium(III) ([Cr$^{3+}$]) | green ppt., soluble in excess    | grey-green ppt., insoluble in excess                                |
| copper ([Cu$^{2+}$])     | light blue ppt., insoluble in excess| light blue ppt., soluble in excess                                  |
| iron(II) ([Fe$^{2+}$])  | green ppt., insoluble in excess    | green ppt., insoluble in excess                                     |
| iron(III) ([Fe$^{3+}$]) | red-brown ppt., insoluble in excess| red-brown ppt., insoluble in excess                                 |
| zinc ([Zn$^{2+}$])       | white ppt., soluble in excess, giving a colourless solution        | white ppt., soluble in excess, giving a colourless solution        |

### Tests for gases

<table>
<thead>
<tr>
<th>gas</th>
<th>test and test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonia ([NH$_3$])</td>
<td>turns damp, red litmus paper blue</td>
</tr>
<tr>
<td>carbon dioxide ([CO$_2$])</td>
<td>turns limewater milky</td>
</tr>
<tr>
<td>chlorine ([Cl$_2$])</td>
<td>bleaches damp litmus paper</td>
</tr>
<tr>
<td>hydrogen ([H$_2$])</td>
<td>‘pops’ with a lighted splint</td>
</tr>
<tr>
<td>oxygen ([O$_2$])</td>
<td>relights a glowing splint</td>
</tr>
<tr>
<td>sulfur dioxide ([SO$_2$])</td>
<td>turns acidified aqueous potassium manganate(VII) from purple to colourless</td>
</tr>
</tbody>
</table>

### Flame tests for metal ions

<table>
<thead>
<tr>
<th>metal ion</th>
<th>flame colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>lithium ([Li$^+$])</td>
<td>red</td>
</tr>
<tr>
<td>sodium ([Na$^+$])</td>
<td>yellow</td>
</tr>
<tr>
<td>potassium ([K$^+$])</td>
<td>lilac</td>
</tr>
<tr>
<td>copper(II) ([Cu$^{2+}$])</td>
<td>blue-green</td>
</tr>
</tbody>
</table>
Q# 1/ iGCSE Chemistry/2015/w/Paper 31/
2 Describe how to separate the following. In each example, give a description of the procedure used and explain why this method works.

(d) Magnesium hydroxide from a mixture of magnesium hydroxide and zinc hydroxide.

procedure ...........................................................................................................................................

...........................................................................................................................................................

explanation ...........................................................................................................................................

...........................................................................................................................................................

Q# 2/ iGCSE Chemistry/2015/s/Paper 31/
6 Acid-base reactions are examples of proton transfer.

(a) Ethylamine is a weak base and sodium hydroxide is a strong base.

(i) In terms of proton transfer, explain what is meant by the term weak base.

...........................................................................................................................................................

...........................................................................................................................................................

(ii) Given aqueous solutions of both bases, describe how you could show that sodium hydroxide is the stronger base. How could you ensure a 'fair' comparison between the two solutions?

...........................................................................................................................................................

...........................................................................................................................................................

...........................................................................................................................................................

...........................................................................................................................................................

(b) Ethylamine reacts with acids to form salts.

\[ \text{CH}_3\text{CH}_2\text{NH}_2 + \text{HCl} \rightarrow \text{CH}_3\text{CH}_2\text{NH}_3\text{Cl} \]

ethylammonium chloride

(i) Complete the equation for the reaction between sulfuric acid and ethylamine. Name the salt formed.

\[ ......\text{CH}_3\text{CH}_2\text{NH}_2 + \text{........} \rightarrow \text{...............} \]

name of salt ...........................................................................................................................................

...........................................................................................................................................................

(ii) Amines and their salts have similar chemical properties to ammonia and ammonium salts. Suggest a reagent that could be used to displace the weak base, ethylamine, from its salt ethylammonium chloride.

...........................................................................................................................................................
Q# 3/ iGCSE Chemistry/2014/w/Paper 31/

1 (a) Match the following pH values to the solutions given below.

<table>
<thead>
<tr>
<th>solution</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>aqueous ammonia, a weak base</td>
<td>...</td>
</tr>
<tr>
<td>dilute hydrochloric acid, a strong acid</td>
<td>...</td>
</tr>
<tr>
<td>aqueous sodium hydroxide, a strong base</td>
<td>...</td>
</tr>
<tr>
<td>aqueous sodium chloride, a salt</td>
<td>...</td>
</tr>
<tr>
<td>dilute ethanoic acid, a weak acid</td>
<td>...</td>
</tr>
</tbody>
</table>

The solutions all have the same concentration. [5]

(b) Explain why solutions of hydrochloric acid and ethanoic acid with the same concentration, in mol/dm³, have a different pH.

... [2]

(c) Measuring pH is one way of distinguishing between a strong acid and a weak acid. Describe another method.

method ................................................................................................................

... results ............................................................................................................. [2]

Q# 4/ iGCSE Chemistry/2014/s/Paper 31/ Q4

(b) Across a period, the elements change from metallic to non-metallic.

(i) Describe how the type of oxide changes across this period.

... ......................................................................................................................... [2]

Q# 5/ iGCSE Chemistry/2013/s/Paper 31/

6 Ammonia is a compound which only contains the elements nitrogen and hydrogen. It is a weak base.

(a) (i) Define the term base.
(ii) Given aqueous solutions of ammonia and sodium hydroxide, both having a concentration of 0.1 mol/dm³, how could you show that ammonia is the weaker base?

An element, M, has the electron distribution 2 + 8 + 18 + 3.

(e) The hydroxide of M is a white powder which is insoluble in water. Describe how you could show that this hydroxide is amphoteric.

The hydroxides of the Group I metals are soluble in water. Most other metal hydroxides are insoluble in water.

(a) (i) Crystals of lithium chloride can be prepared from lithium hydroxide by titration.

25.0 cm³ of aqueous lithium hydroxide is pipetted into the conical flask. A few drops of an indicator are added. Dilute hydrochloric acid is added slowly to the alkali until the indicator just changes colour. The volume of acid needed to neutralise the lithium hydroxide is noted.

A neutral solution of lithium chloride, which still contains the indicator, is left. Describe how you could obtain a neutral solution of lithium chloride which does not contain an indicator.
(ii) You cannot prepare a neutral solution of magnesium chloride by the same method. Describe how you could prepare a neutral solution of magnesium chloride.

................................................................................................................................................. [3]

(b) The concentration of the hydrochloric acid was 2.20 mol/dm$^3$. The volume of acid needed to neutralise the 25.0 cm$^3$ of lithium hydroxide was 20.0 cm$^3$. Calculate the concentration of the aqueous lithium hydroxide.

$$\text{LiOH} + \text{HCl} \rightarrow \text{LiCl} + \text{H}_2\text{O}$$

................................................................................................................................................. [2]

(c) Lithium chloride forms three hydrates. They are LiCl$\cdot$H$_2$O, LiCl$\cdot$2H$_2$O and LiCl$\cdot$3H$_2$O. Which one of these three hydrates contains 45.9% of water? Show how you arrived at your answer.

................................................................................................................................................. [3]

Q# 8/ iGCSE Chemistry/2012/w/Paper 31/ Q7

(b) Strontium chloride-6-water can be made from the insoluble compound, strontium carbonate, by the following reactions.

$$\text{SrCO}_3(s) + 2\text{HCl(aq)} \rightarrow \text{SrCl}_2(aq) + \text{CO}_2(g) + \text{H}_2\text{O(l)}$$

$$\text{SrCl}_2(aq) + 6\text{H}_2\text{O(l)} \rightarrow \text{SrCl}_2\cdot6\text{H}_2\text{O(s)}$$

The following method was used to prepare the crystals.

1. Add excess strontium carbonate to hot hydrochloric acid.
2. Filter the resulting mixture.
3. Partially evaporate the filtrate and allow to cool.
4. Filter off the crystals of SrCl$_2$·6H$_2$O.
5. Dry the crystals between filter papers.

(i) How would you know when excess strontium carbonate had been added in step 1?
(ii) Why is it necessary to filter the mixture in step 2?

........................................................................................................ [1]

(iii) In step 3, why partially evaporate the filtrate rather than evaporate to dryness?

........................................................................................................ [1]

Q# 9/ iGCSE Chemistry/2012/w/Paper 31/

4 Silicon(IV) oxide, SiO₂, and zirconium(IV) oxide, ZrO₂, are both macromolecules. They have similar physical properties but silicon(IV) oxide is acidic and zirconium(IV) oxide is amphoteric.

(c) (i) Name a reagent that reacts with the oxides of both elements.

........................................................................................................ [1]

(ii) Name a reagent that reacts with only one of the oxides.

reagent ................................................................................................. [2]

oxide which reacts .................................................................................

Q# 10/ iGCSE Chemistry/2012/s/Paper 31/

2 Three ways of making salts are

• titration using a soluble base or carbonate
• neutralisation using an insoluble base or carbonate
• precipitation.

(a) Complete the following table of salt preparations.

<table>
<thead>
<tr>
<th>method</th>
<th>reagent 1</th>
<th>reagent 2</th>
<th>salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>titration</td>
<td></td>
<td></td>
<td>sodium nitrate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>neutralisation</td>
<td>nitric acid</td>
<td></td>
<td>copper(II) nitrate</td>
</tr>
<tr>
<td>precipitate</td>
<td></td>
<td></td>
<td>silver(I) chloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>neutralisation</td>
<td>sulfuric acid</td>
<td>zinc(II) carbonate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) (i) Write an ionic equation with state symbols for the preparation of silver(I) chloride.

........................................................................................................ [2]
(ii) Complete the following equation.

\[ \text{ZnCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \ldots + \ldots + \ldots \]  

[2]

Q# 11/ iGCSE Chemistry/2011/w/Paper 31/ Q5

(c) Describe how you could test the solution to find out which ion, Fe\(^{2+}\) or Fe\(^{3+}\), is present.

.......................................................................................................................... [3]

Q# 12/ iGCSE Chemistry/2011/w/Paper 31/ Q5

1 This question is concerned with the following oxides.

- sulfur dioxide
- carbon monoxide
- lithium oxide
- aluminium oxide
- nitrogen dioxide
- strontium oxide

(a) (i) Which of the above oxides will react with hydrochloric acid but not with aqueous sodium hydroxide?

.................................................................................................................. [1]

(ii) Which of the above oxides will react with aqueous sodium hydroxide but not with hydrochloric acid?

.................................................................................................................. [1]

(iii) Which of the above oxides will react with both hydrochloric acid and aqueous sodium hydroxide?

.................................................................................................................. [1]

(iv) Which of the above oxides will not react with hydrochloric acid or with aqueous sodium hydroxide?

.................................................................................................................. [1]

Q# 13/ iGCSE Chemistry/2011/s/Paper 31/ Q5

(d) 20.0 cm\(^3\) of aqueous sodium hydroxide, 2.00 mol/dm\(^3\), was placed in a beaker. The temperature of the alkali was measured and 1.0 cm\(^3\) portions of hydriodic acid were added. After each addition, the temperature of the mixture was measured. Typical results are shown on the graph.
Q# 14/ iGCSE Chemistry/2011/s/Paper 31/ Q2

(c) The selenide ion reacts with water.

\[ \text{Se}^{2-} + \text{H}_2\text{O} \rightarrow \text{HSe}^- + \text{OH}^- \]

What type of reagent is the selenide ion in this reaction? Give a reason for your choice.

Q# 15/ iGCSE Chemistry/2011/s/Paper 31/ NOT with Q5(a)

5 (a) (i) \( 2\text{Li} + 2\text{HI} \rightarrow 2\text{LiI} + \text{H}_2 \)

(ii) zinc carbonate + hydriodic acid \( \rightarrow \) zinc iodide + carbon dioxide + water

(iii) \( \text{MgO} + 2\text{HI} \rightarrow \text{MgI}_2 + \text{H}_2\text{O} \)

(b) Two of the reactions in (a) are acid/base and one is redox. Which one is redox? Explain your choice.

Q# 16/ iGCSE Chemistry/2011/s/Paper 31/

5 Hydriodic acid, HI(aq), is a strong acid. Its salts are iodides.

(a) It has the reactions of a typical strong acid. Complete the following equations.

\[ \text{(i)} \quad \ldots \ldots \text{Li} + \ldots \ldots \text{HI} \rightarrow \ldots \ldots \ldots \ldots + \ldots \ldots \ldots \ldots \]
Q# 17/ iGCSE Chemistry/2010/w/Paper 31/ Q6

(b) Beryllium hydroxide, a white solid, is an amphoteric hydroxide.

(i) Name another metal which has an amphoteric hydroxide.

(ii) Suggest what you would observe when an excess of aqueous sodium hydroxide is added gradually to aqueous beryllium sulfate.

Q# 18/ iGCSE Chemistry/2010/w/Paper 31/

8 Soluble salts can be made using a base and an acid.

(a) Complete this method of preparing dry crystals of the soluble salt cobalt(II) chloride-6-water from the insoluble base cobalt(II) carbonate.

Step 1
Add an excess of cobalt(II) carbonate to hot dilute hydrochloric acid.

Step 2

Step 3

Step 4

[1] [1] [2] [4]
2 Oxides are classified as acidic, basic, neutral and amphoteric.

(a) Complete the table.

<table>
<thead>
<tr>
<th>type of oxide</th>
<th>pH of solution of oxide</th>
<th>example</th>
</tr>
</thead>
<tbody>
<tr>
<td>acidic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>basic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>neutral</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) (i) Explain the term amphoteric.

........................................................................................................................................
........................................................................................................................................ [1]

(ii) Name two reagents that are needed to show that an oxide is amphoteric.

........................................................................................................................................
........................................................................................................................................ [2]

Q# 20/ iGCSE Chemistry/2009/s/Paper 31/ Q7

(b) They react with water to form acidic solutions.

\[
\text{HC}/ + \text{H}_2\text{O} \quad \text{\Rightarrow} \quad \text{H}_3\text{O}^+ + \text{Cl}^{-} \\
\text{HF} + \text{H}_2\text{O} \quad \text{\Rightarrow} \quad \text{H}_3\text{O}^+ + \text{F}^{-}
\]

(i) Explain why water behaves as a base in both of these reactions.

........................................................................................................................................ [2]

(ii) At equilibrium, only 1% of the hydrogen chloride exists as molecules, the rest has formed ions. In the other equilibrium, 97% of the hydrogen fluoride exists as molecules, only 3% has formed ions.

What does this tell you about the strength of each acid?

........................................................................................................................................ [2]

(iii) How would the pH of these two solutions differ?

........................................................................................................................................ [1]
Q# 21/ iGCSE Chemistry/2009/s/Paper 31/ Q5

(b) The formulae of insoluble compounds can be found by precipitation reactions.

To 12.0 cm$^3$ of an aqueous solution of the nitrate of metal T was added 2.0 cm$^3$ of aqueous sodium phosphate, Na$_3$PO$_4$. The concentration of both solutions was 1.00 mol/dm$^3$. When the precipitate had settled, its height was measured.

The experiment was repeated using different volumes of the phosphate solution. The results are shown on the following graph.

What is the formula of the phosphate of metal T? Give your reasoning.

[Graph showing the relationship between volume of phosphate solution and height of precipitate.]

Q# 22/ iGCSE Chemistry/2009/s/Paper 31/

5 Insoluble salts are made by precipitation.

(a) A preparation of the insoluble salt calcium fluoride is described below.

To 15 cm$^3$ of aqueous calcium chloride, 30 cm$^3$ of aqueous sodium fluoride is added. The concentration of both solutions is 1.00 mol/dm$^3$. The mixture is filtered and the precipitate washed with distilled water. Finally, the precipitate is heated in an oven.

(i) Complete the equation.

\[ \text{Ca}^{2+} + \text{.........F}^- \rightarrow \text{...........} \]
Q# 23/ iGCSE Chemistry/2008/w/Paper 31/

1. Complete the following table.

<table>
<thead>
<tr>
<th>gas</th>
<th>test for gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonia</td>
<td>bleaches damp litmus paper</td>
</tr>
<tr>
<td>hydrogen</td>
<td>relights a glowing splint</td>
</tr>
<tr>
<td></td>
<td>turns limewater milky</td>
</tr>
</tbody>
</table>

[Total: 5]
7 Crystals of sodium sulphate-10-water, \(\text{Na}_2\text{SO}_4\cdot10\text{H}_2\text{O}\), are prepared by titration.

(a) 25.0 cm\(^3\) of aqueous sodium hydroxide is pipetted into a conical flask. A few drops of an indicator are added. Using a burette, dilute sulphuric acid is slowly added until the indicator just changes colour. The volume of acid needed to neutralise the alkali is noted.

Suggest how you would continue the experiment to obtain pure, dry crystals of sodium sulphate-10-water.

...........................................................................................................................................................................

...........................................................................................................................................................................

...........................................................................................................................................................................

............................................................................................................................................................................... [4]

5 Carbonyl chloride, \(\text{COCl}_2\), is a colourless gas. It is made by the following reaction.

\[
\text{cool} \quad \text{CO(g)} + \text{Cl}_2(g) \overset{\text{heat}}{\rightarrow} \text{COCl}_2(g)
\]

(c) Carbonyl chloride reacts with water to form two acidic compounds. Suggest which acidic compounds are formed.

1. ...................................................................................................................................................

2. ................................................................................................................................................... [2]
4 Sulphuric acid is a typical strong acid.

(a) Change the equations given into a different format.

(i) \( \text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2 \)
Change into a word equation.

(ii) \( \text{lithium oxide} + \text{sulphuric acid} \rightarrow \text{lithium sulphate} + \text{water} \)
Change into a symbol equation.

(iii) \( \text{CuO} + 2\text{H}^+ \rightarrow \text{Cu}^{2+} + \text{H}_2\text{O} \)
Change the ionic equation into a symbol equation.

(iv) \( \text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{CO}_2 + \text{H}_2\text{O} \)
Change into a word equation.

(b) When sulphuric acid dissolves in water, the following reaction occurs.
\( \text{H}_2\text{SO}_4 + \text{H}_2\text{O} \rightarrow \text{HSO}_4^- + \text{H}_3\text{O}^+ \)
Explain why water is behaving as a base in this reaction.

(c) Sulphuric acid is a strong acid, ethanoic acid is a weak acid.
Explain the difference between a strong acid and a weak acid.

Q# 27/ iGCSE Chemistry/2007/w/Paper 3/
5 Methylamine, \( \text{CH}_3\text{NH}_2 \), is a weak base. Its properties are similar to those of ammonia.

(a) When methylamine is dissolved in water, the following equilibrium is set up.

\( \text{CH}_3\text{NH}_2 + \text{H}_2\text{O} \leftrightharpoons \text{CH}_3\text{NH}_3^+ + \text{OH}^- \)

base acid

(i) Suggest why the arrows are not the same length.

(ii) Explain why water is stated to behave as an acid and methylamine as a base.
(b) An aqueous solution of the strong base, sodium hydroxide, is pH 12. Predict the pH of an aqueous solution of methylamine which has the same concentration. Give a reason for your choice of pH.

..............................................................................................................  [2]

(c) Methylamine is a weak base like ammonia.

(i) Methylamine can neutralise acids.

\[ 2\text{CH}_3\text{NH}_2 + \text{H}_2\text{SO}_4 \rightarrow (\text{CH}_3\text{NH}_3)_2\text{SO}_4 \]

methylammonium sulphate

Write the equation for the reaction between methylamine and hydrochloric acid. Name the salt formed.

..............................................................................................................  [2]

(ii) When aqueous methylamine is added to aqueous iron(II) sulphate, a green precipitate is formed. What would you see if iron(III) chloride solution had been used instead of iron(II) sulphate?

..............................................................................................................  [1]

(iii) Suggest the name of a reagent that will displace methylamine from one of its salts, for example methylammonium sulphate.

..............................................................................................................  [1]

Q# 28/ iGCSE Chemistry/2007/s/Paper 3/

3  There are three methods of preparing salts.

Method A – use a burette and an indicator.

Method B – mix two solutions and obtain the salt by precipitation.

Method C – add an excess of base or a metal to a dilute acid and remove the excess by filtration.

For each of the following salt preparations, choose one of the methods A, B or C, name any additional reagent needed and then write or complete the equation.

(i) the soluble salt, zinc sulphate, from the insoluble base, zinc oxide

method ..............................................................................................................

reagent .............................................................................................................

word equation .................................................................................................  [3]
(ii) the soluble salt, potassium chloride, from the soluble base, potassium hydroxide

method ..............................................................................................................................................
reagent ............................................................................................................................................... 
equation ................................................................................................................................. $\rightarrow \text{KCl} + \text{H}_2\text{O}$ [3]

(iii) the insoluble salt, lead(II) iodide, from the soluble salt, lead(II) nitrate

method ..............................................................................................................................................
reagent ............................................................................................................................................... 
equation $\text{Pb}^{2+} + $ ......................................................................................................................... [4]

[Total: 10]

Q# 29/ iGCSE Chemistry/2006/s/Paper 3/ Q3

(d) This question is concerned with the following oxides.

aluminium oxide $\text{Al}_2\text{O}_3$
calcium oxide $\text{CaO}$
carbon dioxide $\text{CO}_2$
carbon monoxide $\text{CO}$
magnesium oxide $\text{MgO}$
sulphur dioxide $\text{SO}_2$

(i) Which of the above oxides will react with hydrochloric acid but not with aqueous sodium hydroxide?

............................................................................................................................................................... [1]

(ii) Which of the above oxides will react with aqueous sodium hydroxide but not with hydrochloric acid?

............................................................................................................................................................... [1]

(iii) Which of the above oxides will react both with hydrochloric acid and with aqueous sodium hydroxide?

............................................................................................................................................................... [1]
(iv) Which of the above oxides will react neither with hydrochloric acid nor with aqueous sodium hydroxide?

Q# 30/ iGCSE Chemistry/2006/s/Paper 3/ Q3

(b) The following apparatus was set up to investigate the electrical conductivity of dilute acids.

![Diagram of apparatus](image)

Dilute sulphuric acid is a strong acid. If it was replaced by a weak acid, what two differences in the observations would you expect to make?

Q# 31/ iGCSE Chemistry/2006/s/Paper 3/ Q2

(c) The equation for the reaction of X with cold water is given below.

\[ 2X(s) + 2H_2O(l) \rightarrow 2XOH(aq) + H_2(g) \]

(i) Describe the test you would use to show that the gas evolved is hydrogen.

(ii) How could you show that the water contained a compound of the type XOH?

(iii) In which group of the Periodic Table does metal X belong?

(iv) The ore of X is its chloride. Suggest how metal X could be extracted from its chloride.
3 (a) Four bottles were known to contain aqueous ammonia, dilute hydrochloric acid, sodium hydroxide solution and vinegar, which is dilute ethanoic acid. The bottles had lost their labels. The pH values of the four solutions were 1, 4, 10 and 13.

Complete the table.

<table>
<thead>
<tr>
<th>solution</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>aqueous ammonia</td>
<td></td>
</tr>
<tr>
<td>dilute hydrochloric acid</td>
<td></td>
</tr>
<tr>
<td>sodium hydroxide solution</td>
<td></td>
</tr>
<tr>
<td>vinegar</td>
<td></td>
</tr>
</tbody>
</table>

(b) The following apparatus was set up to investigate the electrical conductivity of dilute acids.

Dilute sulphuric acid is a strong acid. If it was replaced by a weak acid, what two differences in the observations would you expect to make?

(c) When nitric acid is added to water the following reaction occurs.

\[ \text{HNO}_3 + \text{H}_2\text{O} \rightarrow \text{NO}_3^- + \text{H}_3\text{O}^+ \]

Give the name and the formula of the particle which is transferred from nitric acid to water.

name ...........................................................................................................................................................................

formula ...........................................................................................................................................................................
Q# 33/ iGCSE Chemistry/2005/w/Paper 3/ Q6

(b) In the above method, a soluble salt was prepared by neutralising an acid with an insoluble base. Other salts have to be made by different methods.

(i) Give a brief description of how the soluble salt, rubidium sulphate could be made from the soluble base, rubidium hydroxide.

(ii) Suggest a method of making the insoluble salt, calcium fluoride.

Q# 34/ iGCSE Chemistry/2005/w/Paper 3/ Q5

(c) The major ore of strontium is its carbonate, SrCO₃. Strontium is extracted by the electrolysis of its molten chloride.

(i) Name the reagent that will react with the carbonate to form the chloride.

Q# 35/ iGCSE Chemistry/2005/s/Paper 3/ Q2

(b) Describe how you could show by adding aqueous sodium hydroxide and aqueous ammonia that a solution contained zinc ions.

result with sodium hydroxide ...........................................................................................................

excess sodium hydroxide ...................................................................................................................

result with aqueous ammonia .......................................................................................................... [3]

excess aqueous ammonia ..................................................................................................................

[3]
Q# 36/ iGCSE Chemistry/2005/s/Paper 3/Q3

(d) Propanoic acid is a weak acid.

(i) The following equation represents its reaction with ammonia.

\[
\text{CH}_3\text{CH}_2\text{COOH} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{COO}^- + \text{NH}_4^+ 
\]

Explain why propanoic acid behaves as an acid and ammonia as a base.

............................................................................................................................................ [3]

(ii) Explain the expression weak acid.

............................................................................................................................................ [1]

Q# 37/ iGCSE Chemistry/2005/s/Paper 3/

3 A South Korean chemist has discovered a cure for smelly socks. Small particles of silver are attached to a polymer, poly(propene), and this is woven into the socks.

(b) To show that the polymer contains silver the following test was carried out.

_The polymer fibres were chopped into small pieces and warmed with nitric acid. The silver atoms were oxidised to silver(I) ions. The mixture was filtered. Aqueous sodium chloride was added to the filtrate and a white precipitate formed._

(i) Why was the mixture filtered?

............................................................................................................................................ [1]

(ii) Explain why the change of silver atoms to silver ions is oxidation.

............................................................................................................................................ [1]

(iii) Give the name of the white precipitate.

............................................................................................................................................ [1]

Q# 38/ iGCSE Chemistry/2005/s/Paper 3/Q6

(c) Complete the following table by writing “reaction” or “no reaction” in the spaces provided.

<table>
<thead>
<tr>
<th>oxide</th>
<th>type of oxide</th>
<th>reaction with acid</th>
<th>reaction with alkali</th>
</tr>
</thead>
<tbody>
<tr>
<td>magnesium</td>
<td>basic</td>
<td>.....................</td>
<td>.....................</td>
</tr>
<tr>
<td>aluminium</td>
<td>amphoteric</td>
<td>.....................</td>
<td>.....................</td>
</tr>
</tbody>
</table>


Q# 39/ iGCSE Chemistry/2004/w/Paper 3/ Q2 (b)

(i) Describe how you could show that the gas collected in this experiment is oxygen.


[1]

Q# 40/ iGCSE Chemistry/2004/w/Paper 3/

2 The salt copper(II) sulphate can be prepared by reacting copper(II) oxide with sulphuric acid.

Complete the list of instructions for making copper(II) sulphate using six of the words below.

blue cool dilute filter
saturated sulphate white oxide

Instructions

1 Add excess copper(II) oxide to sulphuric acid in a beaker and boil it.

2 [ ] to remove the unreacted copper(II) oxide.

3 Heat the solution until it is [ ]

4 [ ] the solution to form [ ]

[6]

coloured crystals of copper (II)

Q# 41/ iGCSE Chemistry/2004/s/Paper 3/ Q2 (b)

(iii) Rock phosphate (calcium phosphate) is obtained by mining. It reacts with concentrated sulphuric acid to form the fertiliser, superphosphate. Predict the formula of each of these phosphates.

fertiliser ions formula

| calcium phosphate | Ca²⁺ and PO₄³⁻ |
| calcium superphosphate | Ca²⁺ and H₂PO₄⁻ |

[2]

(iv) The ionic equation for the reaction between the phosphate ion and sulphuric acid is shown below.

PO₄³⁻ + 2H₂SO₄ → H₂PO₄⁻ + 2HSO₄⁻

Explain why the phosphate ion is described as acting as a base in this reaction.

[2]
### Q# 1/

| (a) | Add sodium hydroxide solution, filter; zinc hydroxide is amphoteric it will react or will dissolve/magnesium hydroxide does not react or does not dissolve. | 1 | 1 |

### Q# 2/

| (a)(i) | M1 probn acceptor; M2 does not accept (protons) readily OR less able to accept protons (than strong bases); | 2 |
| (a)(ii) | M1 same conc of both bases; M2 measure their pH; M3 the higher pH is the stronger base; | 3 |
| (b)(i) | $2\text{CH}_2\text{CH}_2\text{NH}_2 + \text{H}_2\text{SO}_4 \rightarrow (\text{CH}_2\text{CH}_2\text{NH}_3)_2\text{SO}_4$ balanced; the salt is ethylammonium sulfate; | 3 |
| (b)(ii) | Sodium hydroxide / calcium hydroxide / NaOH / Ca(OH)$_2$; | 1 |

| 1 | A any Group 1 or Group 2 hydroxide or oxide |

### Q# 3/

1. (a) Match the following pH values to the solutions given below.

<table>
<thead>
<tr>
<th>solution</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>aqueous ammonia, weak base</td>
<td>10</td>
</tr>
<tr>
<td>dilute hydrochloric acid, a strong acid</td>
<td>1</td>
</tr>
<tr>
<td>aqueous sodium hydroxide, a strong base</td>
<td>13</td>
</tr>
<tr>
<td>aqueous sodium chloride, a salt</td>
<td>7</td>
</tr>
<tr>
<td>dilute ethanoic acid, a weak acid</td>
<td>3</td>
</tr>
</tbody>
</table>

(b) Hydrochloric acid strong acid or ethanoic acid weak acid OR: hydrochloric acid completely ionised or ethanoic acid partially ionised hydrochloric acid greater concentration of/more H$^+$ ions (than ethanoic acid) [1]

(c) Rate of reaction with Ca, Mg, Zn, Fe

- Strong (hydrochloric) acid bubbles faster or more bubbles or dissolves faster
- OR: rate of reaction with (metal) carbonate
  - strong (hydrochloric) acid faster or more bubbles or dissolves faster (only if carbonate insoluble)
  - OR: electrical conductivity strong (hydrochloric) acid better conductor
Q# 4/ iGCSE Chemistry/2014/s/Paper 31/ Q4

(b) (i) Assume change is from L to R unless clearly stated:
basic to amphoteric to acidic (2)

Q# 5/ iGCSE Chemistry/2013/s/Paper 31/

6 (a) (i) proton or H⁺ acceptor [1]

(ii) (measure) pH or (use) pH indicator
note: can be implied need not be explicit
sodium hydroxide has higher pH / ammonia(aq) has lower pH
this sentence would score 2 marks)
or
appropriate colours with pH / appropriate numerical values
ammonia is closer to green, blue-green, turquoise or lighter blue
sodium hydroxide is darker blue / purple / violet
or
measure electrical conductivity
can be implied need not be explicit
ammonia (aq) is the poorer conductor/ sodium hydroxide is the better conductor [1]

Q# 6/ iGCSE Chemistry/2013/s/Paper 31/ Q2

(e) it would react with/dissolves in a named strong acid
it would react with/dissolves in a named alkali
it shows both basic and acid properties = 1
it reacts with both acids and bases/alkalis = 1

[max 2]

Q# 7/ iGCSE Chemistry/2013/s/Paper 31/

7 (a) (i) add carbon / animal charcoal
filter [1]

OR

repeat experiment without indicator
using same quantity / volume of acid [1]

(ii) add magnesium metal / carbonate / oxide / hydroxide
to (hot) (hydrochloric) acid [1]

cond: until in excess or no more dissolves or reacts
cond: filter (to remove unreacted solid) [1]

(b) number of moles of HCl = 0.020 x 2.20 = 0.044
number of moles of LiOH = 0.044
concentration of LiOH = 0.044/0.025 = 1.769 (mol/dm³)
accept 1.75 to 1.77 need 2 dp
correct answer scores = 2

(c) (for LiCl·2H₂O)
mass of one mole = 78.5
percentage water = 36 / 78.5 x 100
45.9 so is LiCl·2H₂O
only award the marks if you can follow the reasoning and it gives 45.9% of water

note: if correct option given mark this and ignore the rest of the response

allow: max 2 for applying a correct method to another hydrate, [1] for the method and [1] for the correct value, working essential
Q# 8/ iGCSE Chemistry/2012/w/Paper 31/ Q7
(b) (i) strontium carbonate does not dissolve / no effervescence; note: not just reaction is complete
(ii) to remove excess / unreacted / undissolved strontium carbonate;
(iii) water of crystallisation needed / 6H₂O in crystals / would get anhydrous salt / would not get hydrated salt / crystals dehydrate; not: just to obtain crystals

Q# 9/ iGCSE Chemistry/2012/w/Paper 31/ Q4
(c) (i) sodium hydroxide / any named alkali / reactive metal;
(ii) named acid; zirconium oxide;

Q# 10/ iGCSE Chemistry/2012/s/Paper 31/
2 (a) nitric acid; sodium hydroxide / carbonate / hydrogen carbonate;
copper(II) oxide / hydroxide / carbonate;
any named soluble chloride;
accept: hydrochloric acid / hydrogen chloride
silver(I) nitrate / ethanoate / sulfate;
must be soluble silver salt not silver oxide / carbonate
zinc(II) sulfate
(b) (i) Ag⁺(aq) + Cl⁻(aq) → AgCl(s) equation correct state symbols missing
(ii) ZnCO₃ + H₂SO₄ → ZnSO₄ + CO₂ + H₂O correct formula for zinc sulfate = 1

[Total: 10]

Q# 11/ iGCSE Chemistry/2011/w/Paper 31/ Q5
(c) add sodium hydroxide solution / ammonia(aq)
Fe²⁺ green precipitate
Fe³⁺ brown precipitate

Q# 12/ iGCSE Chemistry/2011/w/Paper 31/
1 (a) (i) lithium oxide / strontium oxide
(ii) sulfur dioxide / nitrogen dioxide
(iii) aluminium oxide
(iv) carbon monoxide
accept: correct formulae

Q# 13/ iGCSE Chemistry/2011/s/Paper 31/ Q5(d)
(iii) 1.33 / 1.3 / 1.3333 (mol/dm³) scores both marks not 1.34 for a correct method – M₁ V₁ / moles of NaOH = 0.02 with an incorrect answer only
Q# 14/ iGCSE Chemistry/2011/s/Paper 31/ Q2

(c) base  
not alkali  
accepts a proton  
accepts hydrogen ion / H⁺ only [1]  
proton and H⁺ [2]

Q# 15/ iGCSE Chemistry/2011/s/Paper 31/ Q5

(b) reaction 1 is redox / Li/2H react  
cond reason either oxidation number/state / electron transfer [1]

Q# 16/ iGCSE Chemistry/2011/s/Paper 31/

5. (a) (i) 2Li + 2H₂ → 2Li²⁺ + H₂ [1]  
(ii) zinc carbonate + hydriodic acid → zinc iodide + carbon dioxide + water [1]  
(iii) MgO + 2HCl → MgCl₂ + H₂O [1]

Q# 17/ iGCSE Chemistry/2010/w/Paper 31/ Q6

(b) (i) zinc / aluminium / lead / tin / chromium [1]  
(ii) white precipitate  
precipitate dissolves / colourless solution forms / forms a clear solution / soluble in excess [1]

Q# 18/ iGCSE Chemistry/2010/w/Paper 31/

8. (a) filter / centrifuge / decant  
(partially) evaporate / heat / boil  
allow to crystallise / cool / let crystals form  
dry crystals / dry between filter paper / leave in a warm place to dry  
“dry” on its own must be a verb  
evaporate to dryness only marks 1 and 2  
note if discuss residue only mark 1 [1]

Q# 19/ iGCSE Chemistry/2009/w/Paper 3/

2. (a) pH < 7  
example [1]  
pH > 7  
example [1]  
NOT amphoteric oxides Be, Al, Zn, Pb, Sn etc [1]  
pH = 7  
example H₂O, CO, NO [1]  
the two marks are not linked, mark each independently  
NOT amphoteric oxides Be, Al, Zn, Pb, Sn etc.

(b) (i) shows both basic and acidic properties [1]  
(ii) a named strong acid  
a named alkali [1]

Q# 20/ iGCSE Chemistry/2009/s/Paper 31/ Q7

(b) (i) because it accepts a proton  
accepts hydrogen ion or H⁺ ONLY [1]  
proton and H⁺ [2]

(ii) hydrogen chloride is a strong acid  
hydrogen fluoride is a weak acid  
weaker or stronger correctly applied for [2]
Q# 21/ iGCSE Chemistry/2009/s/Paper 31/ Q5

(b) $T_3(PO_4)_2$ allow correct example explain why $8\ cm^3$ react fully comment about mole ratio

Q# 22/ iGCSE Chemistry/2009/s/Paper 31/

5 (a) (i) $Ca^{2+} + 2F^- \rightarrow CaF_2$
    Not balanced ONLY [1]
    Both species must be correct for first mark. Second mark is for correct balancing.

(ii) Mole ratio $Ca^{2+}$: $F^-$ is 1.2
    Answer must mention moles
    accept argument based on charges or number of ions
    accept 2 moles of NaF react with 1 mole of CaCl$_2$
    NOT just “2” in equation
    If fluorine must specify atoms or ions

(iii) to remove traces of solutions or to remove soluble impurities or to remove a named salt sodium chloride or sodium fluoride or calcium chloride
    To remove impurities is not enough

(iv) to dry (precipitate) or to remove water or to evaporate water NOT to evaporate some of water NOT to crystallise salt

Q# 23/ iGCSE Chemistry/2008/w/Paper 31/

1 red litmus paper blue
    OR white fumes/smoke with HCI (g) or (aq)
    chlorine

“pop” with a lighted splint or burn with a pop or goes pop and extinguishes flame NOT glowing splint

oxygen

carbon dioxide
    ACCEPT correct formulae

[Total: 5]

Q# 24/ iGCSE Chemistry/2008/s/Paper 31/

7 (a) repeat experiment without indicator or use carbon to remove indicator (partially) evaporate or boil or heat allow to cool or crystallise or crystals dry crystals MUST be in correct order NB evaporate to dryness, marks one and two ONLY

Q# 25/ iGCSE Chemistry/2008/s/Paper 31/

5 (c) hydrogen chloride or hydrochloric acid
    carbon dioxide or carbonic acid or hydrogen carbonate
Q# 26/ iGCSE Chemistry/2008/s/Paper 31/

4  (a) (i) magnesium + sulphuric acid = magnesium sulphate + hydrogen
   ACCEPT hydrogen sulphate  [1]

   (ii) Li₂O + H₂SO₄ → Li₂SO₄ + H₂O
        formulae correct but not balanced [1]

   (iii) CuO + H₂SO₄ → CuSO₄ + H₂O
         OR CuO + 2HCl → CuCl₂ + H₂O
         OR CuO + 2HNO₃ → Cu(NO₃)₂ + H₂O
         formulae correct but not balanced [1]

   (iv) sodium carbonate + sulphuric acid → sodium sulphate + carbon dioxide + water [1]

   (b) it accepts a proton
       it accepts a hydrogen ion [1] ONLY [2]

   (c) sulphuric acid is completely ionised
       or few molecules and many ions
       ethanoic acid is partially ionised
       or many molecules and few ions

Q# 27/ iGCSE Chemistry/2007/w/Paper 3/

5  (a) (i) equilibrium to left or many molecules and few ions or
       partially ionised or reverse reaction favoured

   (ii) Water donates proton
        methylamine accepts a proton
        NOTE if hydrogen ion then ONLY [1] provided both are correct

   (b) less than 12 more than 7
       smaller concentration of hydroxide ions or partially dissociated or
       poor proton acceptor or poor H⁺ acceptor
       NOT it is a weak base

   (c) (i) CH₃NH₂ + HCl = CH₃NH₃Cl
        methylammonium chloride
        NOTE the equation must be as written, the equation with sulphuric acid has been
        given as guidance.

   (ii) brown precipitate
        ACCEPT orange or red/brown or brick red or brown/red

   (iii) sodium hydroxide or any named strong base

Q# 28/ iGCSE Chemistry/2008/s/Paper 31/

3  (i) method C
    sulphuric acid (allow if given in equation)
    zinc oxide + sulphuric acid = zinc sulphate + water

   (ii) method A
        hydrochloric acid
        KOH + HCl = KCl + H₂O

   (iii) method B
        potassium iodide or any soluble iodide
        Pb²⁺ + 2I⁻ = Pbl₂ accepts a correct equation even if soluble iodide is wrong
        Not balanced - Pb²⁺ + I⁻ = Pbl₂ ONLY [2]
Q# 29/ iGCSE Chemistry/2006/s/Paper 3/ Q3
(d) (i) CaO and MgO
(ii) CO₂ and SO₂
(iii) Al₂O₃
(iv) CO
[1]

Q# 30/ iGCSE Chemistry/2006/s/Paper 3/ Q3
(b) With strong acid bulb brighter faster rate of bubbles OR corresponding comments for weak acid [1]
[1]

Q# 31/ iGCSE Chemistry/2006/s/Paper 3/ Q2
(c) (i) goes "pop" with burning splint or mixed with air and ignited goes pop NOT glowing splint
(ii) test and observable result universal indicator goes blue or pH paper goes blue or high pH, accept 13, 14 or ammonium ion gives off ammonia or with metallic cations forms a precipitate NOT litmus ONLY accept - neutralises acids with an observable result, e.g. becomes warm.
(iii) Group 1
[1]
(iv) electrolysis COND molten
[1]

Q# 32/ iGCSE Chemistry/2006/s/Paper 3/
3 (a) ammonia 10 hydrochloric acid 1 sodium hydroxide 13 ethanoic acid 4 All correct Two correct [1]
[2]
(b) With strong acid bulb brighter faster rate of bubbles OR corresponding comments for weak acid [1]
[1]

(c) proton NOT hydrogen ion H⁺ not conditional on proton Only way for [2] is proton and H⁺ [1]
[1]
Q# 33/ iGCSE Chemistry/2005/w/Paper 3/ Q6
(b)(i) sulphuric acid
COND description of titration
repeat without indicator or with carbon
evaporation
any TWO [3]

(ii) suitable reactants calcium chloride and sodium fluoride [1]
COND upon correct reagents
filter [1]
wash and dry precipitate [1]
OR Accept synthesis
calcium [1]
fluorine [1]
burn or heat [1] [3]

Q# 34/ iGCSE Chemistry/2005/w/Paper 3/ Q5
(c)(i) hydrochloric acid [1]

Q# 35/ iGCSE Chemistry/2005/s/Paper 3/ Q2
(b) for zinc and sodium hydroxide while precipitate [1]
dissolves in excess (only if precipitate mentioned) [1]
for zinc and ammonia same results [1]
Mark either first (sodium hydroxide or aqueous ammonia), if completely correct, then an
additional [1] can be awarded for stating that the other has the same results.

Q# 36/ iGCSE Chemistry/2005/s/Paper 3/
3
(d)(i) acid loses a proton
base accepts a proton [2]
OR same explanation but acid loses a hydrogen ion (1)
and base gains hydrogen ion (1) [1]

(ii) only partially ionised or poor hydrogen ion donor or poor proton donor [1]
NOT does not form many hydrogen ions in water or low concentration of hydrogen
ions
NOT pH

Q# 37/ iGCSE Chemistry/2005/s/Paper 3/
3
(b)(i) to remove fibres or remove solid
NOT precipitate, NOT impurities, NOT to obtain a filtrate [1]

(ii) because silver atoms have lost electrons
OR oxidation number increased [1]

(iii) silver chloride [1]

Q# 38/ iGCSE Chemistry/2005/s/Paper 3/
(c) reaction no reaction [1]
reaction reaction [1]

Q# 39/ iGCSE Chemistry/2004/w/Paper 3/ QiGCSE Chemistry/201
(d)(i) glowing splint burst into flame or rekindled
Must have glowing or equivalent idea
OR any similar description that includes the two points glowing and relights.
Q# 40/ iGCSE Chemistry/2004/w/Paper 3/

2 dilute
    filter
    saturated
    cool
    blue
    sulphate

[6]

Q# 41/ iGCSE Chemistry/2004/s/Paper 3/ Q2 (b)

(iii) Ca₃(PO₄)₂

Ca(H₂PO₄)₂

(iv) only acceptable responses are:
    accepts a proton
    accepts H⁺ [1] only

[2]

Q# 42/ iGCSE Chemistry/2004/s/Paper 3/

4 (a) (i) Named soluble zinc salt
    corresponding sodium salt
    If hydroxide or oxide then 0/2

(ii) Correct equation
    not balanced [1] only

(iii) Correct equation

(b) (i) Fe³⁺ + 3OH⁻ = Fe(OH)₃

(ii) Max at 8cm³
    Same shape of graph

[1]

Just the above shape, the height of the precipitate and the volume of sodium hydroxide are irrelevant

[1]

(iii) Maximum then height of precipitate decreases
    or graph slopes down to x axis or comes to zero
    hydroxide dissolves in excess or it is amphoteric

[1]
PAPER 6

Percentage of all marks awarded for each topic from w2001 to w2015 (red crosses) and from m2016 to w2017 (green triangles)

% of Marks awarded for each topic

1 3 4 5 6 7 8 9 10 11 12 13 14

P6 2016-17 12.1 0.0 3.2 3.1 15.7 24.7 34.2 0.0 4.9 1.1 0.0 0.0 1.1
P6 2001-15 12.9 0.0 1.9 5.5 12.1 18.7 40.1 0.0 3.6 1.7 0.6 0.4 2.5

Paper 6 Topic Number

PAPER 6 - Question types

Percentage of all marks awarded for each question type from w2001 to w2015 (red crosses) and from m2016 to w2017 (green triangles)

% of marks for each question type

Misc Graph Labelling Equipment Essay Gas test Ions test

2016-17 1 32.6 11.7 14.2 1.1 23.1
2016-17 6.5 32.6 11.7 14.2 1.1 23.1
2001-15 0.0 44.4 6.2 12.4 0.0 20.9

Paper 6 Question type
Q# 1/ iGCSE Chemistry/Paper 6/2017/w/ Time Zone 3/
3 Two solutions, Y and Z, were analysed.
Solution Y was aqueous chromium(III) nitrate.
Tests were carried out on both solutions.

**tests on solution Y**

Complete the expected observations.

The solution was divided into two equal portions in two test-tubes.

(a) (i) A few drops of aqueous sodium hydroxide were added to the first portion of solution Y and the test-tube shaken to mix the solutions.

observations .................................................................................................................. [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture.

observations .................................................................................................................. [1]

(iii) The mixture from (a)(ii) was poured into a boiling tube and a small piece of aluminium foil was added. The mixture was heated and the gas produced was tested.

observations .................................................................................................................. [3]

(b) Identify the gas produced in (a)(iii).

........................................................................................................................................ [1]

**tests on solution Z**

Tests were carried out and the following observations made.

<table>
<thead>
<tr>
<th>tests on solution Z</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution Z was divided into three equal portions in three test-tubes.</td>
<td></td>
</tr>
<tr>
<td><strong>test 1</strong></td>
<td></td>
</tr>
<tr>
<td>The pH of the first portion of solution Z was tested.</td>
<td><strong>pH 10</strong></td>
</tr>
<tr>
<td><strong>test 2</strong></td>
<td></td>
</tr>
<tr>
<td>A few drops of aqueous copper(II) sulfate were added to the second portion of solution Z.</td>
<td><strong>dark blue solution formed</strong></td>
</tr>
<tr>
<td>An excess of aqueous copper(II) sulfate was then added to the mixture.</td>
<td><strong>light blue precipitate formed</strong></td>
</tr>
</tbody>
</table>
The second portion of solution \( Y \) was added to the third portion of solution \( Z \). grey-green precipitate formed

(c) Identify solution \( Z \).

Q# 2/ iGCSE Chemistry/Paper 6/2017/w/ Time Zone 3/

1 Cerussite is a lead ore which contains lead(II) carbonate. A student obtained a solution of lead(II) nitrate from cerussite using the apparatus shown.

(c) Name the dilute acid used in step 2

Q# 3/ iGCSE Chemistry/Paper 6/2017/w/ Time Zone 2/

(ii) State the effect of a lighted spirit on the hydrogen produced.

Q# 4/ iGCSE Chemistry/Paper 6/2017/w/ Time Zone 2/

3 Two solid salts, \( U \) and \( W \), were analysed. Solid \( U \) was sodium carbonate. Tests were carried out on each solid.

(a) Describe the appearance of solid \( U \).

About half of solid \( U \) was dissolved in distilled water to produce solution \( U \). Solution \( U \) was divided into two equal portions in two test-tubes.
(b) Dilute hydrochloric acid was added to the first portion of solution U. The gas produced was tested.

observations ................................................................. [3]

(c) Name the gas produced in (b).

................................................................. [1]

(d) A flame test was carried out on solid U.

observations ................................................................. [1]

tests on solid W
Tests were carried out and the following observations made.

<table>
<thead>
<tr>
<th>tests on solid W</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance of solid W.</td>
<td>white crystals</td>
</tr>
</tbody>
</table>

Solid W was dissolved in distilled water to produce solution W. The solution was divided into two equal portions in two test-tubes.

test 1
Dilute nitric acid and aqueous silver nitrate were added to the first portion of solution W.

white precipitate formed

test 2
The second portion of solution U was added to the second portion of solution W.

An excess of dilute hydrochloric acid was then added to the mixture.

rapid effervescence
white precipitate dissolved

(e) What conclusions can you draw about solid W?

................................................................. [2]

Q# 5/ iGCSE Chemistry/Paper 6/2017/w/ Time Zone 1/

3 Two solid salts, F and G, were analysed. Solid F was iron(III) nitrate. Tests were carried out on each solid.

tests on solid F
Tests were carried out on each solid.

Solid F was dissolved in distilled water to produce solution F. Solution F was divided into three equal portions in three test-tubes.

(a) (i) A few drops of aqueous sodium hydroxide were added to the first portion of solution F until a change was seen.

observations ................................................................. [2]
(ii) An excess of aqueous sodium hydroxide was then added to the mixture from (a)(i). 
observations ................................................................. [1]

(b) An excess of aqueous ammonia was added to the second portion of solution F until a change was seen.
observations ................................................................. [1]

(c) Aluminium foil and aqueous sodium hydroxide were added to the third portion of solution F. The mixture was heated and the gas which was produced was tested.
test for gas ............................................................................ [2]
test result ................................................................................ [2]

(d) Identify the gas produced in (c).
............................................................................................... [1]

tests on solid G
Tests were carried out and the following observations made.

<table>
<thead>
<tr>
<th>tests on solid G</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>test 1</td>
<td></td>
</tr>
<tr>
<td>A flame test was carried out on solid G.</td>
<td>red colour</td>
</tr>
<tr>
<td>test 2</td>
<td></td>
</tr>
<tr>
<td>Dilute nitric acid was added to solid G.</td>
<td>rapid effervescence</td>
</tr>
<tr>
<td>The gas produced was passed through limewater.</td>
<td>limewater turned milky</td>
</tr>
</tbody>
</table>

(e) Identify solid G.
............................................................................................... [2]

Q# 6/ iGCSE Chemistry/Paper 6/2017/s/ Time Zone 3/

3 Two substances, solid J and solution K, were analysed. Solution K was hydrogen peroxide. Tests on each substance were carried out. The observations are shown.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>tests on solid J</td>
<td></td>
</tr>
<tr>
<td>Appearance of solid J.</td>
<td>black solid</td>
</tr>
<tr>
<td>test 1</td>
<td></td>
</tr>
<tr>
<td>Dilute hydrochloric acid was added to solid J.</td>
<td>blue litmus turned white</td>
</tr>
<tr>
<td>The mixture was heated and the gas given off was tested with damp litmus paper.</td>
<td></td>
</tr>
</tbody>
</table>
### Tests on Solution K

Solution K was divided into two equal portions in two test-tubes.

**Test 2**

Iron(II) sulfate crystals were added to the first portion of the solution. The mixture was shaken and aqueous sodium hydroxide was added to the mixture.

- **Red-brown precipitate formed**

**Test 3**

Solid J was added to the second portion of the solution. The gas given off was tested with a splint.

- **Glowing splint relit**
- **Solid J was unchanged**

(a) Name the gas given off in **Test 1**.

(b) (i) Name the precipitate formed in **Test 2**.

(ii) A new **Test 2** was carried out. Iron(II) sulfate crystals were added to water, the mixture was shaken and then aqueous sodium hydroxide was added.

What would be observed?

---

**Q# 7/ iGCSE Chemistry/Paper 6/2017/s/ Time Zone 1/**

Two solids, E and F, were analysed. Solid F was potassium iodide. Tests were carried out on each solid. Some of the observations on solid E are shown.

<table>
<thead>
<tr>
<th>Tests on Solid E</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance of solid E</td>
<td>Green solid</td>
</tr>
<tr>
<td><strong>Test 1</strong></td>
<td></td>
</tr>
<tr>
<td>Solid E was heated gently then strongly</td>
<td>The solid turned black</td>
</tr>
<tr>
<td><strong>Test 2</strong></td>
<td></td>
</tr>
<tr>
<td>Dilute sulfuric acid was added to solid E</td>
<td>Rapid effervescence</td>
</tr>
<tr>
<td>The gas given off was tested</td>
<td>Lime water turned milky</td>
</tr>
<tr>
<td>Excess aqueous ammonia was then added to the mixture in the test-tube</td>
<td>A pale blue precipitate formed, which then dissolved to form a dark blue solution</td>
</tr>
</tbody>
</table>
test 3
A flame test was carried out on solid E.  blue-green colour

(a) Test 1 states that the solid should be heated gently then strongly.

In terms of safety, explain why it is necessary to heat gently at first.

........................................................................................................ [1]

(b) Identify the gas given off in test 2.

........................................................................................................ [1]

(c) Identify solid E.

........................................................................................................ [2]

tests on solid F

Complete the expected observations.

(d) Describe the appearance of solid F.

........................................................................................................ [1]

Distilled water was added to solid F in a test-tube and shaken to dissolve solid F.

(e) (i) To the first portion of the solution, an excess of aqueous sodium hydroxide was added.

observations .......................................................................................... [1]

(ii) To the second portion of the solution, dilute nitric acid and aqueous silver nitrate were added.

observations .......................................................................................... [2]

(f) A flame test was carried out on solid F.

observations .......................................................................................... [1]

(g) Describe how you would carry out a flame test.

........................................................................................................ [2]
4. A sample of furniture cleaner contains aqueous sodium chloride, aqueous ammonia and sand.

(a) Give a test to show the presence of ammonia in the mixture. [1]

---

1. A student prepared strontium nitrate crystals.

The diagram shows some of the stages in this preparation.

(a)

(iii) Name the dilute acid used. [1]

(iv) Give one expected observation in stage 2. [1]

(b) Why is heat not necessary in stage 2? [1]

(c) Which of the reactants is in excess? Explain your answer. [2]

(d) Describe how crystals of strontium nitrate could be obtained from the mixture in stage 3. [3]
Q# 10/ iGCSE Chemistry/Paper 6/2017/m/ Time Zone 2/Q1

(e) Give a test for oxygen.

- test ........................................................................................................................................ [1]
- result .......................................................................................................................................... [1]

(d) The gas collected at the positive side turned limewater milky.

(i) Based on this observation, what gas was present?

Q# 11/ iGCSE Chemistry/Paper 6/2017/m/ Time Zone 2/

2 A student investigated the reaction between dilute hydrochloric acid and two different aqueous solutions of sodium hydroxide labelled solution O and solution P.

Two experiments were carried out.

Experiment 1

- A burette was filled with dilute hydrochloric acid. The initial burette reading was recorded.
- Using a measuring cylinder, 20 cm$^3$ of solution O were poured into a conical flask.
- Thymolphthalein indicator was added to the conical flask.
- The dilute hydrochloric acid was added from the burette, while swirling the flask, until the solution just changed colour. The final burette reading was recorded.

(a) Use the burette diagrams to record the readings in the table and complete the table.

<table>
<thead>
<tr>
<th>initial reading</th>
<th>final reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>-23</td>
</tr>
<tr>
<td>-4</td>
<td>-29</td>
</tr>
<tr>
<td>-5</td>
<td>-30</td>
</tr>
<tr>
<td>-25</td>
<td>-31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>final burette reading / cm$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>initial burette reading / cm$^3$</td>
</tr>
<tr>
<td>difference / cm$^3$</td>
</tr>
</tbody>
</table>

[2]

Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using solution P instead of solution O.

(b) Use the burette diagrams to record the readings in the table and complete the table.

<table>
<thead>
<tr>
<th>initial reading</th>
<th>final reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>-23</td>
<td>-29</td>
</tr>
<tr>
<td>-24</td>
<td>-30</td>
</tr>
<tr>
<td>-25</td>
<td>-31</td>
</tr>
</tbody>
</table>
(c) What type of chemical reaction occurs when dilute hydrochloric acid reacts with sodium hydroxide solution?

(d) (i) Which solution of sodium hydroxide, solution O or solution P, is the more concentrated? Explain your answer.

(ii) How many times more concentrated is this solution of sodium hydroxide than the other solution of sodium hydroxide?

(e) If Experiment 2 were repeated using 10 cm$^3$ of solution P, what volume of dilute hydrochloric acid would be needed?

(f) What would be the effect, if any, on the volume of dilute hydrochloric acid used in Experiment 1 if the solution of sodium hydroxide were warmed before adding the dilute hydrochloric acid? Give a reason for your answer.

(g) (i) What would be a more accurate method of measuring the volume of the aqueous sodium hydroxide solution?

(ii) Suggest how the reliability of the results could be checked.

(h) Aqueous sodium hydroxide reacts with aqueous calcium chloride to form a precipitate of calcium hydroxide.

Use this information to suggest a different method of finding out which of the solutions of sodium hydroxide is the more concentrated.
Q# 12/ iGCSE Chemistry/Paper 6/2017/m/ Time Zone 2/

4 When solid barium hydroxide is added to solid ammonium chloride a reaction takes place.
   (b) How could you show whether or not the final mixture contains ammonium ions?

Q# 13/ iGCSE Chemistry/Paper 6/2017/m/ Time Zone 2/

3 Two solids, Q and R, which are both salts, were analysed. Solid Q was zinc bromide. Tests were carried out on each solid.

**Tests on solid Q**

Solid Q was dissolved in distilled water. The solution was divided into three equal portions in three test-tubes, and the following tests were carried out.

Complete the expected observations.

(a) (i) Drops of aqueous sodium hydroxide were added to the first portion of the solution until a change was seen.

   observations .......................................................... [2]

   (ii) Excess aqueous sodium hydroxide was then added to the mixture.

   observations .......................................................... [1]

(b) (i) Drops of aqueous ammonia were added to the second portion of the solution until a change was seen.

   observations .......................................................... [1]

   (ii) Excess aqueous ammonia was then added to the mixture.

   observations .......................................................... [1]

(c) Dilute nitric acid and aqueous silver nitrate were added to the third portion of the solution.

   observations .......................................................... [2]

**Tests on solid R**

Tests were carried out and the following observations made.

<table>
<thead>
<tr>
<th>tests on solid R</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>test 1</td>
<td></td>
</tr>
<tr>
<td>A flame test was carried out on solid R.</td>
<td>yellow colour</td>
</tr>
</tbody>
</table>
Q# 14/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 3/

Two solutions, solution Q and solution R, were analysed. Solution Q was aqueous sulfuric acid.

**tests on solution Q**

(a) Solution Q was divided into four equal portions in four test-tubes. The following tests were carried out.

Complete the observations for **tests 1–4**.

(i)  **test 1**

The pH of the first portion of solution Q was measured.

pH .................................................................................................................................. [1]

(ii)  **test 2**

Magnesium ribbon was added to the second portion of solution Q. The gas given off was tested.

observations ............................................................................................................................ [3]

(iii)  **test 3**

Sodium carbonate was added to the third portion of solution Q. The gas given off was tested.

observations ............................................................................................................................ [3]
(iv) test 4

Dilute nitric acid and aqueous barium nitrate were added to the fourth portion of solution Q.

observations ........................................................................................................... [1]

tests on solution R

Solution R was divided into three equal portions in three test tubes. The following tests were carried out.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>test 5</td>
<td></td>
</tr>
<tr>
<td>The pH of the first portion of solution R was measured.</td>
<td>pH = 10</td>
</tr>
<tr>
<td>test 6</td>
<td></td>
</tr>
<tr>
<td>Drops of aqueous sodium hydroxide were added to the second portion of</td>
<td>white precipitate</td>
</tr>
<tr>
<td>solution R and the test-tube shaken.</td>
<td></td>
</tr>
<tr>
<td>Excess aqueous sodium hydroxide was then added to the test-tube.</td>
<td>no visible change</td>
</tr>
<tr>
<td>test 7</td>
<td>green precipitate formed</td>
</tr>
<tr>
<td>Aqueous iron(II) sulfate was added to the third portion of solution R</td>
<td></td>
</tr>
<tr>
<td>and the mixture shaken.</td>
<td></td>
</tr>
</tbody>
</table>

(b) Identify solution R.

................................................................................................................... [2]

Q# 15/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 2/Q3

3 Two solutions, solution S and solution T, were analysed. Solution S was dilute hydrochloric acid. The tests on solution S and solution T, and some of the observations, are shown.

tests on solution S

(a) Solution S was divided into four equal portions in four test-tubes. The following tests were carried out.

Complete the observations for tests 1–4.

(i) test 1

The pH of the first portion of solution S was tested.

pH .................................................................................................................. [1]
(ii) test 2

Copper(II) oxide was added to the second portion of the solution. The mixture was heated.

observations ................................................................. [2]

(iii) test 3

Solid sodium carbonate was added to the third portion of the solution. The gas given off was tested.

observations ................................................................. [3]

(iv) test 4

Dilute nitric acid and aqueous silver nitrate were added to the fourth portion of the solution.

observations ................................................................. [1]

tests on solution T

(b) Tests were carried out on solution T and the following observations made.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution T was divided into three equal portions in three test-tubes.</td>
<td></td>
</tr>
<tr>
<td>Appearance of the solution.</td>
<td>yellow solution</td>
</tr>
<tr>
<td>Drops of aqueous sodium hydroxide were added to the second portion of the solution and the test-tube shaken.</td>
<td>red-brown precipitate</td>
</tr>
<tr>
<td>Excess aqueous sodium hydroxide was then added to the test-tube.</td>
<td>no visible change</td>
</tr>
<tr>
<td>Aqueous sodium hydroxide and aluminium foil were added to the third portion of the solution and the mixture heated. The gas given off was tested with pH indicator paper.</td>
<td>pungent gas formed, pH 10</td>
</tr>
</tbody>
</table>
Q# 16/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 1/Q3

3 Solid P, which is an aluminium salt, was analysed. The tests on solid P, and some of the observations, are shown.

tests on solid P

(a) test 1

Solid P was divided into three portions. The first portion of solid P was heated.

observations condensation formed on the sides of the test-tube

Any gases given off were tested with cobalt(II) chloride paper.

observations cobalt(II) chloride paper turned from blue to pink

What does test 1 tell you about solid P?

-------------------------------------------------------------------------------------------------------------------------- [1]

(b) test 2

A flame test was carried out on the second portion of solid P.

observations ......................................................................................................................................................... [1]

tests on a solution of P

Distilled water was added to the rest of solid P in a test-tube and shaken to dissolve.

(c) The solution was divided into four equal portions in four test-tubes. The following tests were carried out.

(i) test 3

Several drops of aqueous sodium hydroxide were added to the first portion of the solution.

Excess aqueous sodium hydroxide was then added to the mixture.

observations .........................................................................................................................................................

................................................................................................................................................................................................................. [3]

(ii) test 4

Several drops of aqueous ammonia were added to the second portion of the solution.

Excess aqueous ammonia was then added to the mixture.

observations .............................................................................................................................................................. [2]
Two further tests were carried out and the following observations made.

<table>
<thead>
<tr>
<th>test</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Dilute nitric acid and aqueous silver nitrate were added to the third portion of the solution.</td>
</tr>
<tr>
<td>6</td>
<td>Dilute nitric acid and aqueous barium nitrate were added to the fourth portion of the solution.</td>
</tr>
</tbody>
</table>

(d) What does test 5 tell you about solid P?

........................................................................................................................................ [1]

(e) Identify solid P.

........................................................................................................................................ [1]

(f) Describe the appearance of solid P.

........................................................................................................................................ [1]

Q# 17/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 1/Q1

(d) Give one test to distinguish between oxygen and hydrogen.

test ..................................................................................................................................

result with oxygen ......................................................................................................................

result with hydrogen .................................................................................................................... [2]

Q# 18/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 1/

2 A student investigated what happened when dilute nitric acid reacted with aqueous solutions of two different alkalis, solution N and solution O.

Two experiments were carried out.

(a) Experiment 1

A measuring cylinder was used to pour 50 cm$^3$ of solution N into a polystyrene cup. The initial temperature of the solution was measured.

A burette was filled with nitric acid to the 0.0 cm$^3$ mark.

5.0 cm$^3$ of nitric acid were added to solution N in the polystyrene cup and the solution stirred. The maximum temperature of the solution was measured.

A further 5.0 cm$^3$ of nitric acid were added to the polystyrene cup and the solution stirred. The maximum temperature of the solution was measured.

The student continued to add 5.0 cm$^3$ portions of nitric acid to the polystyrene cup, until a total volume of 40 cm$^3$ of nitric acid had been added. After each addition, the solution was stirred and the maximum temperature measured.
Use the thermometer diagrams to record the maximum temperatures in the table.

<table>
<thead>
<tr>
<th>volume of nitric acid added/cm³</th>
<th>0.0</th>
<th>5.0</th>
<th>10.0</th>
<th>15.0</th>
<th>20.0</th>
<th>25.0</th>
<th>30.0</th>
<th>35.0</th>
<th>40.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>thermometer diagram</td>
<td>35</td>
<td>30</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

maximum temperature of the solution in the polystyrene cup/°C

(b) Experiment 2

Experiment 1 was repeated using solution O instead of solution N.
Use the thermometer diagrams to record the maximum temperatures in the table.

<table>
<thead>
<tr>
<th>volume of nitric acid added/cm³</th>
<th>0.0</th>
<th>5.0</th>
<th>10.0</th>
<th>15.0</th>
<th>20.0</th>
<th>25.0</th>
<th>30.0</th>
<th>35.0</th>
<th>40.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>thermometer diagram</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

maximum temperature of the solution in the polystyrene cup/°C

(c) Plot the results for Experiments 1 and 2 on the grid and draw two smooth line graphs. Clearly label your graphs.
(d) Use your graph to estimate the maximum temperature of the solution when 13 cm³ of nitric acid were added to 50 cm³ of solution N in Experiment 1. Show clearly on the grid how you worked out your answer.

.................................................. °C [2]

(e) Name a suitable indicator that could be used in Experiment 1.

........................................................................................................ [1]

(f) Solution N and solution O were the same concentration.

In which experiment is the temperature change greater? Suggest why the temperature change is greater in this experiment.

........................................................................................................ [2]

(g) How would the results differ in Experiment 1 if 100 cm³ of solution N were used?

........................................................................................................ [1]

(h) Suggest why a polystyrene cup was used in these experiments and not a copper can.

........................................................................................................ [1]

(i) State one source of error in the experiments. Suggest an improvement to reduce this source of error.

source of error .......................................................................................... [1]

improvement ............................................................................................ [1]

Q# 19/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 1/

4 Agri Limes are mixtures of calcium carbonate and calcium oxide. Farmers use Agri Limes on fields to neutralise acidity.

Plan an investigation to find out which of two different Agri Limes, Q or R, will neutralise more acid. You are provided with common laboratory apparatus and chemicals, including dilute nitric acid.

........................................................................................................ [5]
Q# 20/ iGCSE Chemistry/Paper 6/2016/s/ Time Zone 3/Q2

(b) The gas produced in experiment 3 was tested with a lighted splint and the result recorded below.

| test | lighted splint | result | popped |

Name the gas given off in experiment 3.  


Q# 21/ iGCSE Chemistry/Paper 6/2016/s/ Time Zone 3/

3 A mixture of two solids, G and H, was analysed. Solid G was zinc nitrate, which is water soluble, and solid H is insoluble in water.
The tests on the mixture, and some of the observations, are shown.
Distilled water was added to the mixture in a boiling tube and shaken. The contents of the boiling tube were filtered keeping the filtrate and the residue.

tests on filtrate

(a) The filtrate was divided into four test-tubes and the following tests carried out.

(i) Drops of aqueous sodium hydroxide were added to the first portion of the solution. Excess aqueous sodium hydroxide was then added to the test-tube.

observations

.......................................................................................................................... [3]

(ii) Using the second portion of the solution, the test in (a)(i) was repeated using aqueous ammonia instead of aqueous sodium hydroxide.

observations  

.......................................................................................................................... [2]

(iii) Dilute nitric acid was added to the third portion of the solution followed by aqueous silver nitrate.

observations  

.......................................................................................................................... [1]

(iv) Aqueous sodium hydroxide and aluminium foil were added to the fourth portion of the solution. The mixture was warmed and the gas given off was tested.

observations  

.......................................................................................................................... [3]
tests on residue

Two tests are carried out and the following observations made.

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A spatula was used to transfer some of the residue into a test-tube.</td>
<td>rapid effervescence, limewater turned milky</td>
</tr>
<tr>
<td>Dilute hydrochloric acid was added to the residue. The gas given off was tested.</td>
<td></td>
</tr>
<tr>
<td>A flame test was carried out on the residue.</td>
<td>red flame colour</td>
</tr>
</tbody>
</table>

(b) Identify solid H.

Q# 22/ iGCSE Chemistry/Paper 6/2016/s/ Time Zone 2/

4 Potassium sulfate is the salt produced when sulfuric acid is neutralised by potassium hydroxide solution. The correct amount of potassium hydroxide solution must be added to neutralise all of the sulfuric acid. Plan an experiment to obtain pure crystals of potassium sulfate from sulfuric acid and potassium hydroxide solution. You are provided with common laboratory apparatus.

Q# 23/ iGCSE Chemistry/Paper 6/2016/s/ Time Zone 2/

3 Two solids, E and F, were analysed. Solid E was sodium sulfite. Both solids were found to be water soluble. The tests on the solids, and some of the observations, are shown below.

tests on solid E

(a) Describe the appearance of the solid.
(b) Distilled water was added to solid E in a test-tube and shaken to dissolve.

The solution was divided into two portions in two test-tubes and the following tests carried out.

(i) Aqueous sodium hydroxide was added to the first portion of the solution.

observations ........................................................................................................................... [1]

(ii) Dilute hydrochloric acid was added to the second portion of the solution. The mixture was warmed. The gas given off was tested with a piece of filter paper soaked in aqueous acidified potassium manganate(VII) solution.

observations ........................................................................................................................... [2]

(c) A flame test was carried out on solid E.

observations ........................................................................................................................... [1]

tests on solid F

<table>
<thead>
<tr>
<th>tests</th>
<th>observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>The solid was heated. The gas given off was tested with damp, red litmus paper.</td>
<td>pungent gas evolved</td>
</tr>
<tr>
<td></td>
<td>red litmus paper turned blue</td>
</tr>
<tr>
<td>Aqueous sodium hydroxide was added to solid F and the mixture heated. The gas given off was tested.</td>
<td>pungent gas evolved</td>
</tr>
<tr>
<td></td>
<td>Universal Indicator paper showed pH 10</td>
</tr>
</tbody>
</table>

(d) Identify the gas given off in the tests on solid F. ........................................................................................................................... [1]

(e) Identify one of the ions in solid F. ........................................................................................................................... [1]

Mark Scheme iG Chem 8 EQ P6 Tests for Ions

Q# 1/ iGCSE Chemistry/Paper 6/2017/w/ Time Zone 3/

| 3(a)(i) | green      | 1 |
| 3(a)(ii) | precipitate | 1 |
| 3(a)(iii) | green solution / precipitate dissolves | 1 |
| 3(a)(iii) | bubbles / fizzing / effervescence | 1 |
| 3(b) | (red) litmus paper / Universal Indicator paper | 1 |
| 3(c) | (red) litmus paper turns blue / (Universal Indicator paper) turns purple | 1 |
| 3(b) | ammonia / NH₃ | 1 |
| 3(c) | (aqueous) ammonia / NH₃ | 1 |

Q# 2/ iGCSE Chemistry/Paper 6/2017/w/ Time Zone 3/

<p>| 1(c) | nitric (acid) | 1 |</p>
<table>
<thead>
<tr>
<th>Q# 3/</th>
<th>iGCSE Chemistry/Paper 6/2017/w/ Time Zone 2/</th>
</tr>
</thead>
<tbody>
<tr>
<td>(d)(ii)</td>
<td>bopp’s</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q# 4/</th>
<th>iGCSE Chemistry/Paper 6/2017/w/ Time Zone 2/</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>white (crystals)</td>
</tr>
<tr>
<td>(b)</td>
<td>bubbles / fizzy</td>
</tr>
<tr>
<td>(c)</td>
<td>limewater</td>
</tr>
<tr>
<td>(d)</td>
<td>(turns) milky</td>
</tr>
<tr>
<td>(c)</td>
<td>carbon dioxide</td>
</tr>
<tr>
<td>(c)</td>
<td>yellow</td>
</tr>
<tr>
<td>(e)</td>
<td>non-transition metal / Group II metal / barium / calcium / magnesium</td>
</tr>
<tr>
<td>(e)</td>
<td>chloride</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q# 5/</th>
<th>iGCSE Chemistry/Paper 6/2017/w/ Time Zone 1/</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)(i)</td>
<td>red-brown</td>
</tr>
<tr>
<td></td>
<td>precipitate</td>
</tr>
<tr>
<td>(a)(ii)</td>
<td>insoluble / no change</td>
</tr>
<tr>
<td>(b)</td>
<td>red-brown precipitate</td>
</tr>
<tr>
<td>(c)</td>
<td>(red) litmus paper</td>
</tr>
<tr>
<td></td>
<td>turns blue</td>
</tr>
<tr>
<td>(d)</td>
<td>ammonia</td>
</tr>
<tr>
<td>(e)</td>
<td>lithium</td>
</tr>
<tr>
<td></td>
<td>carbonate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q# 6/</th>
<th>iGCSE Chemistry/Paper 6/2017/s/ Time Zone 3/</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>chlorine</td>
</tr>
<tr>
<td>(b)(i)</td>
<td>iron(III)</td>
</tr>
<tr>
<td></td>
<td>hydroxide</td>
</tr>
<tr>
<td>(b)(ii)</td>
<td>green</td>
</tr>
<tr>
<td></td>
<td>precipitate</td>
</tr>
<tr>
<td>(c)</td>
<td>oxygen</td>
</tr>
<tr>
<td>(d)</td>
<td>catalyst</td>
</tr>
<tr>
<td></td>
<td>transition element compound / manganese oxide</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q# 7/</th>
<th>iGCSE Chemistry/Paper 6/2017/s/ Time Zone 1/</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>solid splits out of the tube / the tube might crack</td>
</tr>
<tr>
<td>(b)</td>
<td>carbon dioxide</td>
</tr>
<tr>
<td>(c)</td>
<td>copper / Cu²⁺</td>
</tr>
<tr>
<td></td>
<td>carbonate / CO₃²⁻</td>
</tr>
<tr>
<td>(d)</td>
<td>white</td>
</tr>
<tr>
<td>(a)(i)</td>
<td>no reaction / change</td>
</tr>
<tr>
<td>(e)(i)</td>
<td>yellow</td>
</tr>
<tr>
<td></td>
<td>precipitate</td>
</tr>
<tr>
<td>(f)</td>
<td>lilac</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q# 8/</th>
<th>iGCSE Chemistry/Paper 6/2017/s/ Time Zone 1/</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(red) litmus turns blue</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q# 9/</th>
<th>iGCSE Chemistry/Paper 6/2017/s/ Time Zone 1/</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)(ii)</td>
<td>nitric (acid)</td>
</tr>
<tr>
<td>(a)(iv)</td>
<td>bubbles / fizzy / effervescence</td>
</tr>
<tr>
<td>(b)</td>
<td>the reaction is (fast) at room temperature</td>
</tr>
</tbody>
</table>
Q# 10/ iGCSE Chemistry/Paper 6/2017/m/ Time Zone 2/
1(a) fast: glowing splint
result: relights
1
1(d)(w) carbon dioxide
1

Q# 11/ iGCSE Chemistry/Paper 6/2017/m/ Time Zone 2/
2(a) initial and final readings completed correctly: 20.6; 4.1
1
difference completed correctly: 26.5
1
2(b) initial and final readings and difference completed correctly: 29.1; 24.0; 5.1
1
all readings to 1 d.p.
1
2(c) neutralisation
1
2(d)(i) solution O
1
greater volume of acid was used in the titration
1
2(d)(ii) five times as concentrated
1
2(e) 2.5–2.6
1
unit: cm³
1
2(f) effect on volume: no effect
1
reason: temperature would only affect the rate
1
2(g)(i) use a pipette/tuorute
1
2(g)(ii) repeat experiments (and compare/average)
1
2(h) M1 fair test to equal volumes of each sodium hydroxide solution/solutions O and P add an equal volume/measured volumes of aqueous calcium chloride
1
M2 dependent variable measured
1
measure mass /height of precipitate formed/volume of calcium chloride used
1
M3 conclusion
1
the more concentrated sodium hydroxide solution would form the most precipitate (mass /height) would require a smaller volume of calcium chloride
1

Q# 12/ iGCSE Chemistry/Paper 6/2017/m/ Time Zone 2/
4(b) M1 add (aqueous) sodium hydroxide (and warm)
1
M2 gas produced turns (red) limuus blue
1

Q# 13/ iGCSE Chemistry/Paper 6/2017/m/ Time Zone 2/
3(a)(i) white precipitate
1
3(a)(ii) (white precipitate) dissolves
1
3(b)(i) white precipitate
1
3(b)(ii) (white precipitate) dissolves
1
3(c) cream precipitate
1
3(d) sodium iodide
1

Q# 14/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 3/
3(a)(i) pH 1–3
1
3(a)(ii) effervescence /fizzing /bubbling /solid disappears /dissolves lightened solnt/pops
1
1
1
Q# 15/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 2/

3(a)(i) pH 1–3
3(a)(ii) solid disappears/dissolves blue/green colour
3(a)(ii) solid dissolves limewater turns milky
3(a)(iv) white precipitate
3(b) iron(III) nitrate

Q# 16/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 1/

3(a) water present/hydrated
3(b) no change/colour
3(c)(i) white precipitate dissolves
3(c)(ii) white precipitate no change
3(d) not a halide
3(e) (aluminium) sulfate
3(f) white (crystals)

Q# 17/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 1/

1(d) lighted splint
  no effect/brighter light for oxygen
  OR
  glowing splint
  reacts with oxygen
  no effect for hydrogen

Q# 18/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 1/

2(a) table of results for Experiment 1
    all temperature boxes completed correctly
    22, 24, 26, 28, 30, 31, 32, 29, 28
2(b) table of results for Experiment 2
    initial and other temperature boxes completed correctly
    20, 21, 22, 23, 24, 25, 24, 23, 22
2(c) all points correctly plotted
    best-fit smooth line graphs
    labels
2(d) value from graph (27°C)
    shown clearly
2(e) phenolphthalein/litmus/suitable named indicator
2(f) Experiment 1/solution N
    solution N is a stronger acid/has a higher pH
2(g) measured results/temperature changes/results would be smaller
    OR
    larger/double volume needed to reach same temperature changes
2(h) polystyrene is an insulator/copper is a (good) conductor
Q# 19/ iGCSE Chemistry/Paper 6/2016/w/ Time Zone 1/

method adding Agri Lime to acid
add weighed amount/know mass of Agri Lime Q
to a known volume of acid
with a named indicator added to the acid
until the indicator changes colour
note the mass of Agri Lime Q added
repeat with Agri Lime R

OR
method adding acid to Agri Lime
use weighed amount/know mass of Agri Lime Q
add acid to it gradually/from a burette
with a named indicator added to the acid
until the indicator changes colour
note volume of acid added
repeat with Agri Lime R

Q# 20/ iGCSE Chemistry/Paper 6/2016/s/ Time Zone 3/

Q# 21/ iGCSE Chemistry/Paper 6/2016/s/ Time Zone 3/

Q# 22/ iGCSE Chemistry/Paper 6/2016/s/ Time Zone 2/

Q# 23/ iGCSE Chemistry/Paper 6/2016/s/ Time Zone 2/
### 10 Metals

#### 10.1 Properties of metals

**Core**
- List the general physical properties of metals
- Describe the general chemical properties of metals, e.g., reaction with dilute acids and reaction with oxygen
- Explain in terms of their properties why alloys are used instead of pure metals
- Identify representations of alloys from diagrams of structure

#### 10.2 Reactivity series

**Core**
- Place in order of reactivity: potassium, sodium, calcium, magnesium, zinc, iron, (hydrogen) and copper, by reference to the reactions, if any, of the metals with:
  - water or steam
  - dilute hydrochloric acid
  - and the reduction of their oxides with carbon

**Supplement**
- Describe the reactivity series as related to the tendency of a metal to form its positive ion, illustrated by its reaction, if any, with:
  - the aqueous ions
  - the oxides
  - of the other listed metals
- Describe and explain the action of heat on the oxides, carbonates, and nitrates of the listed metals
- Account for the apparent unreactivity of aluminium in terms of the oxide layer which adheres to the metal
10.3 Extraction of metals

Core
- Describe the ease in obtaining metals from their ores by relating the elements to the reactivity series
- Describe and state the essential reactions in the extraction of iron from hematite
- Describe the conversion of iron into steel using basic oxides and oxygen
- Know that aluminium is extracted from the ore bauxite by electrolysis
- Discuss the advantages and disadvantages of recycling metals, limited to iron/steel and aluminium

Supplement
- Describe in outline, the extraction of zinc from zinc blende
- Describe in outline, the extraction of aluminium from bauxite including the role of cryolite and the reactions at the electrodes

10.4 Uses of metals

Core
- Name the uses of aluminium:
  - In the manufacture of aircraft because of its strength and low density
  - In food containers because of its resistance to corrosion
- Name the uses of copper related to its properties (electrical wiring and in cooking utensils)
- Name the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)

Supplement
- Explain the uses of zinc for galvanising and for making brass
- Describe the idea of changing the properties of iron by the controlled use of additives to form steel alloys

Topic Chem 10 Subtopic: Alloys Q# 1/ iGCSE Chemistry/2015/s/Paper 31/
2 Iron from the Blast Furnace is impure. It contains about 5% of impurities, mainly carbon, sulfur, silicon and phosphorus, which have to be removed when this iron is converted into steel.

(b) Mild steel is the most common form of steel. Mild steel contains a maximum of 0.3% of carbon.

High carbon steel contains 2% of carbon. It is less malleable and much harder than mild steel.

(i) Give a use of mild steel.

..................................................................................................................................................... [1]

(ii) Suggest a use of high carbon steel.

..................................................................................................................................................... [1]

(iii) Explain why metals are malleable.

..................................................................................................................................................... [3]
(iv) Suggest an explanation why high carbon steel is less malleable and harder than mild steel.

(b) (i) Why are steel alloys used in preference to iron? 

(ii) State a use of the following alloys.

- mild steel
- stainless steel

(b) Impure copper is extracted from the ore. This copper is refined by electrolysis.

(iii) One use of this pure copper is electrical conductors, another is to make alloys. Name the metal that is alloyed with copper to make brass.

3 Aluminium is extracted by the electrolysis of a molten mixture of alumina, which is aluminium oxide, and cryolite.

(a) (i) Alumina is obtained from the main ore of aluminium. Name this ore.

(ii) Explain why it is necessary to use a mixture, alumina and cryolite, rather than just alumina.
(iii) Copper can be extracted by the electrolysis of an aqueous solution. Suggest why the electrolysis of an aqueous solution cannot be used to extract aluminium.

(b) The ions which are involved in the electrolysis are Al\(^{3+}\) and O\(^{2-}\). The products of this electrolysis are given on the diagram. Explain how they are formed. Use equations where appropriate.

6 Aluminium is extracted by the electrolysis of a molten mixture that contains alumina, which is aluminium oxide, Al\(_2\)O\(_3\).

(a) The ore of aluminium is bauxite. This contains alumina, which is amphoteric, and iron(III) oxide, which is basic. The ore is heated with aqueous sodium hydroxide. Complete the following sentences.

The ........................................... dissolves to give a solution of .................................................................

The ........................................... does not dissolve and can be removed by ...................................................... [4]

(b) Complete the labelling of the diagram.

waste gases

...........................................

...........................................

carbon anode (+)

mixture of aluminium oxide and ...........................................

temperature is ...........................................
(c) The ions that are involved in the electrolysis are $\text{Al}^{3+}$ and $\text{O}^{2-}$.

(i) Write an equation for the reaction at the cathode.

(ii) Explain how carbon dioxide is formed at the anode.

Topic Chem 10 Subtopic : Blast furnace Q# 6/ iGCSE Chemistry/2015/s/Paper 31/

2 Iron from the Blast Furnace is impure. It contains about 5% of impurities, mainly carbon, sulfur, silicon and phosphorus, which have to be removed when this iron is converted into steel.

(a) Explain how the addition of oxygen and calcium oxide removes these impurities. Include an equation for a reaction of oxygen and a word equation for a reaction of calcium oxide in this process.

Topic Chem 10 Subtopic : Blast furnace Q# 7/ iGCSE Chemistry/2014/w/Paper 31/

4 Iron is extracted from the ore hematite in the Blast Furnace.

(a) The coke reacts with the oxygen in the air to form carbon dioxide.

\[ \text{C} + \text{O}_2 \rightarrow \text{CO}_2 \]

(i) Explain why carbon monoxide is formed higher in the Blast Furnace.
Iron is extracted from the ore hematite in the Blast Furnace.

(a) The coke reacts with the oxygen in the air to form carbon dioxide.

\[ C + O_2 \rightarrow CO_2 \]

(i) Explain why carbon monoxide is formed higher in the Blast Furnace.

(ii) Write an equation for the reduction of hematite, Fe₂O₃, by carbon monoxide.

(b) (i) Limestone decomposes to form two products, one of which is calcium oxide. Name the other product.

(ii) Calcium oxide reacts with silicon(IV) oxide, an acidic impurity in the iron ore, to form slag. Write an equation for this reaction.

(iii) Explain why the molten iron and the molten slag form two layers and why molten iron is the lower layer.

(iv) Suggest why the molten iron does not react with the air.
3 Iron from the blast furnace is impure. It contains about 4% carbon and 0.5% silicon. Most of this impure iron is used to make mild steel, an alloy of iron containing less than 0.25% carbon.

(a) A jet of oxygen is blown through the molten iron in the presence of a base, usually calcium oxide. Explain how the percentage of carbon is reduced and how the silicon is removed.

(b) (i) Name a reagent that can reduce iron(III) oxide to iron.

(ii) Write a symbol equation for the reduction of iron(III) oxide, Fe₂O₃, to iron.

(d) Iron from the blast furnace is impure. Two of the impurities are carbon and silicon. These are removed by blowing oxygen through the molten iron and adding calcium oxide.

(i) Explain how the addition of oxygen removes carbon.

(ii) Explain how the addition of oxygen and calcium oxide removes silicon.

(c) Iron is extracted in a blast furnace. The list below gives some of the substances used or formed in the extraction.

carbon monoxide   coke   iron ore   limestone   slag

(i) Which substance is a mineral containing largely calcium carbonate?
(d) State two functions of the coke used in the blast furnace.

(b) State two major uses of zinc.

2 (a) Give three differences in physical properties between the Group I metal, potassium, and the transition element, iron.

1. .................................................................................................................................

2. .................................................................................................................................

3. ................................................................................................................................. [3]

(c) The uses of a metal are determined by its properties.

(i) Foods which are acidic can be supplied in aluminium containers.

![Diagram of chicken in lemon sauce in an aluminium container]

Explain why the acid in the food does not react with the aluminium.

................................................................................................................................. [1]
(ii) Explain why overhead electrical power cables are made from aluminium with a steel core.

![Diagram of aluminium and steel core]

---

Topic Chem 10 Subtopic: Properties and uses of metals **Q# 16/ iGCSE Chemistry/2010/s/Paper 31/**

7. Titanium is a transition element. It is isolated by the following reactions.

\[
\text{titanium ore} \rightarrow \text{titanium(IV) oxide} \rightarrow \text{titanium(IV) chloride} \rightarrow \text{titanium} \\
\text{TiO}_2 \rightarrow \text{TiCl}_4 \rightarrow \text{Ti}
\]

(d) Complete the table which shows some of the properties of titanium and its uses. The first line has been completed as an example.

<table>
<thead>
<tr>
<th>property</th>
<th>related use</th>
</tr>
</thead>
<tbody>
<tr>
<td>soluble in molten steel</td>
<td>making steel titanium alloys</td>
</tr>
<tr>
<td>making aircraft and space vehicles</td>
<td></td>
</tr>
<tr>
<td>resistant to corrosion, especially in sea water</td>
<td></td>
</tr>
</tbody>
</table>

---

Topic Chem 10 Subtopic: Properties and uses of metals **Q# 17/ iGCSE Chemistry/2008/s/Paper 31/ Q3**

(c) **(i)** Give **two** reasons why copper is used,

- in electric wiring.

---

- in cooking utensils.

---

(iii) Give another use of copper.

---

[1]
(d) Give two uses of zinc.

1. ................................................................................................................................. [2]
2. ................................................................................................................................. [2]

(i) Aluminium is used extensively in the manufacture of aircraft. .......................................................... [1]

(ii) Aluminium is used to make food containers. .................................................................................. [2]

(iii) Aluminium electricity cables have a steel core. .............................................................................. [1]

(e) Most of the iron is converted into mild steel or stainless steel. Give one use for each.

mild steel ........................................................................................................................................... [2]

stainless steel ....................................................................................................................................... [2]

2. Describe how to separate the following. In each example, give a description of the procedure used and explain why this method works.

(a) Copper powder from a mixture containing copper and zinc powders.

procedure ...................................................................................................................................................

explanation ............................................................................................................................................... [3]

7. One way of establishing a reactivity series is by displacement reactions.

(a) A series of experiments was carried out using the metals lead, magnesium, zinc and silver. Each metal was added in turn to aqueous solutions of the metal nitrates.

The order of reactivity was found to be:

magnesium most reactive
zinc
lead
silver least reactive
(i) Complete the table.

\[ \checkmark = \text{reacts} \]
\[ \times = \text{does not react} \]

<table>
<thead>
<tr>
<th>Metal</th>
<th>Lead Pb</th>
<th>Magnesium Mg</th>
<th>Zinc Zn</th>
<th>Silver Ag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead(II) nitrate</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td>×</td>
</tr>
<tr>
<td>Magnesium nitrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc nitrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver nitrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(ii) Displacement reactions are redox reactions.
On the following equation, draw a **ring** around the reducing agent and an **arrow** to show the change which is oxidation.

\[
\text{Zn} + \text{Pb}^{2+} \rightarrow \text{Zn}^{2+} + \text{Pb}
\]

(iii) Complete the following ionic equation.

\[
\text{Zn} + 2\text{Ag}^+ \rightarrow \ldots \ldots + \ldots \ldots
\]

(b) Another way of determining the order of reactivity of metals is by measuring the voltage and polarity of simple cells. The polarity of a cell is shown by which metal is the positive electrode and which metal is the negative electrode. An example of a simple cell is shown below.

![Simple cell diagram]

(i) Mark on the above diagram the direction of the electron flow.
(ii) Explain, in terms of electron transfer, why the more reactive metal is always the negative electrode.

............................................................................................................................................ [2]

(iii) The following table gives the polarity of cells using the metals zinc, lead, copper and manganese.

<table>
<thead>
<tr>
<th>cell</th>
<th>electrode 1</th>
<th>polarity</th>
<th>electrode 2</th>
<th>polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>zinc</td>
<td>-</td>
<td>lead</td>
<td>+</td>
</tr>
<tr>
<td>B</td>
<td>manganese</td>
<td>-</td>
<td>lead</td>
<td>+</td>
</tr>
<tr>
<td>C</td>
<td>copper</td>
<td>+</td>
<td>lead</td>
<td>-</td>
</tr>
</tbody>
</table>

What information about the order of reactivity of these four metals can be deduced from the table?

............................................................................................................................................ [2]

(iv) What additional information is needed to establish the order of reactivity of these four metals using cells?

........................................................................................................................................... [1]

Topic Chem 10 Subtopic : Reactivity Q# 23/ iGCSE Chemistry/2013/w/Paper 31/Q2

(b) The following metals are in order of reactivity.

potassium
zinc
copper

For those metals which react with water or steam, name the products of the reaction, otherwise write 'no reaction'.

potassium .................................................................................................................................

............................................................................................................................................

zinc ...........................................................................................................................................

............................................................................................................................................

copper ....................................................................................................................................... [5]

Topic Chem 10 Subtopic : Reactivity Q# 24/ iGCSE Chemistry/2013/s/Paper 31/
5 The reactivity series shows the metals in order of reactivity.

(a) The reactivity series can be established using displacement reactions. A piece of zinc is added to aqueous lead nitrate. The zinc becomes coated with a black deposit of lead.

\[ \text{Zn} + \text{Pb}^{2+} \rightarrow \text{Zn}^{2+} + \text{Pb} \]

Zinc is more reactive than lead.

The reactivity series can be written as a list of ionic equations.

\[ \ldots \rightarrow \ldots + \ldots \] most reactive metal: the best reductant (reducing agent)

\[ \text{Zn} \rightarrow \text{Zn}^{2+} + 2e^- \]
\[ \text{Fe} \rightarrow \text{Fe}^{2+} + 2e^- \]
\[ \text{Pb} \rightarrow \text{Pb}^{2+} + 2e^- \]
\[ \text{Cu} \rightarrow \text{Cu}^{2+} + 2e^- \]
\[ \text{Ag} \rightarrow \text{Ag}^+ + e^- \]

(i) In the space at the top of the list, write an ionic equation for a metal which is more reactive than zinc. [1]

(ii) Write an ionic equation for the reaction between aqueous silver(I) nitrate and zinc. [2]

(iii) Explain why the positive ions are likely to be oxidants (oxidising agents). [1]

(iv) Deduce which ion is the best oxidant (oxidising agent). [1]

(v) Which ion(s) in the list can oxidise lead metal? [1]

Topic Chem 10 Subtopic: Reactivity Q# 25/ iGCSE Chemistry/2013/s/Paper 31/

(b) A reactivity series can also be established by measuring the voltage of simple cells. The diagram shows a simple cell.

![Diagram of a simple cell with voltmeter, cadmium electrode, copper electrode, and sulfuric acid]
Results from cells using the metals tin, cadmium, zinc and copper are given in the table below.

<table>
<thead>
<tr>
<th>cell</th>
<th>electrode 1 positive electrode</th>
<th>electrode 2 negative electrode</th>
<th>voltage/volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>copper</td>
<td>cadmium</td>
<td>0.74</td>
</tr>
<tr>
<td>2</td>
<td>copper</td>
<td>tin</td>
<td>0.48</td>
</tr>
<tr>
<td>3</td>
<td>copper</td>
<td>zinc</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Write the four metals in order of increasing reactivity and explain how you used the data in the table to determine this order.

---

5 Reactive metals tend to have unreactive compounds. The following is part of the reactivity series.

sodium \rightarrow calcium \rightarrow zinc \rightarrow copper \rightarrow silver

(c) Which of the metals in the list on page 5 have oxides which are not reduced by carbon?

---

(d) Choose from the list on page 5, metals whose ions would react with zinc.

---

7 Excess hydrochloric acid was added to powdered zinc. The hydrogen evolved was collected and its volume measured every 20 seconds.

The experiments were repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.
(a) Identify metals A, B and C by choosing from zinc, magnesium and aluminium. Give a reason for each choice.

metal A

metal B

metal C [5]

(b) Using ‘moles’, explain why two of the metals form the same volume of hydrogen but the third metal forms a larger volume.

................................................................. [3]

(c) The common ore of tin is tin(IV) oxide and an ore of copper is malachite, CuCO₃,Cu(OH)₂.

(i) Write a word equation for the reduction of tin(IV) oxide by carbon. [1]

(ii) Malachite is heated to form copper oxide and two other chemicals. Name these chemicals.

................................................................. and ................................................................. [2]

(iii) Copper oxide is reduced to copper which is then refined by electrolysis. Label the diagram of the apparatus which could be used to refine copper.
(iv) Give one use of copper, other than making alloys.

Topic Chem 10 Subtopic : Reactivity Q# 29/ iGCSE Chemistry/2010/s/Paper 31/

7 Titanium is a transition element. It is isolated by the following reactions.

\[
\text{titanium ore} \rightarrow \text{titanium(IV) oxide} \rightarrow \text{titanium(IV) chloride} \rightarrow \text{titanium}
\]

\[
\text{TiO}_2 \quad \text{TiCl}_4 \quad \text{Ti}
\]

(a) Why is it usually necessary to include a number in the name of the compounds of transition elements?

(b) Titanium(IV) chloride is made by heating the oxide with coke and chlorine.

\[
\text{TiO}_2 + 2\text{Cl}_2 \rightleftharpoons \text{TiCl}_4 + \text{O}_2
\]

\[
2\text{C} + \text{O}_2 \rightleftharpoons 2\text{CO}
\]

Explain why the presence of coke ensures the maximum yield of the metal chloride.

(c) Explain why the change, titanium(IV) chloride to titanium, is reduction.

Topic Chem 10 Subtopic : Reactivity Q# 30/ iGCSE Chemistry/2010/s/Paper 31/

3 A diagram of the apparatus which could be used to investigate the rate of reaction between magnesium and an excess of an acid is drawn below.
(a) The magnesium kept rising to the surface. In one experiment, this was prevented by twisting the magnesium around a piece of copper. In a second experiment, the magnesium was held down by a plastic net fastened to the beaker.

(i) Suggest a reason why magnesium, which is denser than water, floated to the surface.

(ii) Iron, zinc and copper have similar densities. Why was copper a better choice than iron or zinc to weigh down the magnesium?

Topic Chem 10 Subtopic : Reactivity Q# 31/ iGCSE Chemistry/2009/s/Paper 31/

4 The reactivity series of metals given below contains both familiar and unfamiliar elements. For most of the unfamiliar elements, which are marked *, their common oxidation states are given.

<table>
<thead>
<tr>
<th>* barium</th>
<th>Ba</th>
</tr>
</thead>
<tbody>
<tr>
<td>* lanthanum</td>
<td>La (+3)</td>
</tr>
<tr>
<td>magnesium</td>
<td></td>
</tr>
<tr>
<td>zinc</td>
<td></td>
</tr>
<tr>
<td>* chromium</td>
<td>Cr (+2), (+3), (+6)</td>
</tr>
<tr>
<td>iron</td>
<td></td>
</tr>
<tr>
<td>copper</td>
<td></td>
</tr>
<tr>
<td>* palladium</td>
<td>(+2)</td>
</tr>
</tbody>
</table>

Choose metal(s) from the above list to answer the following questions.

(i) Which two metals would not react with dilute hydrochloric acid?

(ii) Which two unfamiliar metals (*) would react with cold water?

(iii) What is the oxidation state of barium?

(iv) Name an unfamiliar metal (*) whose oxide cannot be reduced by carbon.
(v) Why should you be able to predict that metals such as iron and chromium have more than one oxidation state?

6 The reactivity series lists metals in order of reactivity.

(a) To find out which is the more reactive metal, zinc or tin, the following experiment could be carried out.

This experiment could be carried out with other metals and the results recorded in a table. Then the order of reactivity can be deduced.

(i) The order was found to be:
- manganese most reactive
- zinc
- tin
- silver least reactive

Complete the table of results from which this order was determined.

<table>
<thead>
<tr>
<th>aqueous solution</th>
<th>tin (Sn)</th>
<th>manganese (Mn)</th>
<th>silver (Ag)</th>
<th>zinc (Zn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tin(II) nitrate</td>
<td>R</td>
<td>NR</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>manganese(II) nitrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silver(I) nitrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>zinc nitrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(ii) Write the ionic equation for the reaction between tin atoms and silver(I) ions.
(iii) The following is a redox reaction.

\[ \text{Mn} + \text{Sn}^{2+} \rightarrow \text{Mn}^{2+} + \text{Sn} \]

Indicate on the equation the change which is oxidation. Give a reason for your choice.

(iv) Explain why experiments of this type cannot be used to find the position of aluminium in the reactivity series.

(c) The remaining zinc oxide reacts with sulphuric acid to give aqueous zinc sulphate. This is electrolysed with inert electrodes (the electrolysis is the same as that of copper(II) sulphate with inert electrodes). Ions present: \( \text{Zn}^{2+}(aq) \), \( \text{SO}_4^{2-}(aq) \), \( \text{H}^+(aq) \), \( \text{OH}^-(aq) \)

(i) Zinc forms at the negative electrode (cathode). Write the equation for this reaction.

(ii) Write the equation for the reaction at the positive electrode (anode).

(iii) The electrolyte changes from aqueous zinc sulphate to

5 (a) Titanium is produced by the reduction of its chloride. This is heated with magnesium in an inert atmosphere of argon.

\[ \text{TiCl}_4 + 2\text{Mg} \rightarrow \text{Ti} + 2\text{MgCl}_2 \]

(i) Explain why it is necessary to use argon rather than air.

(ii) Name another metal that would reduce titanium chloride to titanium.
(b) All nitrates decompose when heated.

(i) The equation for the thermal decomposition of silver(I) nitrate is given below.

\[ 2\text{AgNO}_3 \rightarrow 2\text{Ag} + 2\text{NO}_2 + \text{O}_2 \]

What are the products formed when copper(II) nitrate is heated?

................................................................................................................................. [1]

(ii) Complete the equation for the action of heat on sodium nitrate.

\[ \text{NaNO}_3 \rightarrow \text{ } + \text{ } \]

................................................................................................................................. [2]

7 Some hydroxides, nitrates and carbonates decompose when heated.

(a) (i) Name a metal hydroxide which does not decompose when heated.

................................................................................................................................. [1]

(ii) Write the equation for the thermal decomposition of copper(II) hydroxide.

................................................................................................................................. [2]

(iii) Suggest why these two hydroxides behave differently.

................................................................................................................................. [1]

(b) (i) Metal nitrates, except those of the Group 1 metals, form three products when heated. Name the products formed when zinc nitrate is heated.

................................................................................................................................. [2]

(ii) Write the equation for the thermal decomposition of potassium nitrate.

................................................................................................................................. [2]

(ii) Their hydroxides are heated.
If the compound decomposes, complete the word equation.
If it does not decompose, write “no reaction”.

\[ \text{Potassium hydroxide} \rightarrow \text{ } \]

................................................................................................................................. [2]

\[ \text{Calcium hydroxide} \rightarrow \text{ } \]

................................................................................................................................. [2]
(iii) Complete the equations for the decomposition of their nitrates.

$$2\text{KNO}_3 \rightarrow \text{__________________________} + \text{__________________________}$$

$$2\text{Ca(NO}_3)_2 \rightarrow \text{__________________________} + \text{__________________________} + \text{__________________________} \quad [4]$$


Topic Chem 10 Subtopic: Zinc extraction Q# 38/ iGCSE Chemistry/2014/s/Paper 31/

5 Zinc is obtained from the ore, zinc blende, ZnS.

(a) Describe the extraction of zinc from its ore, zinc blende. Include at least one balanced equation in your description.

............................................................................................................................................ 
............................................................................................................................................ 
............................................................................................................................................ 
............................................................................................................................................ 
............................................................................................................................................ 
............................................................................................................................................ [5]

Topic Chem 10 Subtopic: Zinc extraction Q# 39/ iGCSE Chemistry/2011/s/Paper 31/

4 A major ore of zinc is zinc blende, ZnS. A by-product of the extraction of zinc from this ore is sulfur dioxide which is used to make sulfonic acid.

(a) (i) Zinc blende is heated in air. Zinc oxide and sulfur dioxide are formed. Write the balanced equation for this reaction.

............................................................................................................................................ [2]

(ii) Zinc oxide is reduced to zinc by heating with carbon. Name two other reagents which could reduce zinc oxide.

............................................................................................................................................ [2]

(iii) The zinc obtained is impure. It is a mixture of metals. Explain how fractional distillation could separate this mixture. zinc bp = 908°C, cadmium bp = 765°C, lead bp = 1751°C

............................................................................................................................................ [2]

............................................................................................................................................

Topic Chem 10 Subtopic: Zinc extraction Q# 40/ iGCSE Chemistry/2009/w/Paper 3/

3 (a) An important ore of zinc is zinc blende, ZnS.

(i) How is zinc blende changed into zinc oxide?

............................................................................................................................................ [1]

(ii) Write a balanced equation for the reduction of zinc oxide to zinc by carbon.

............................................................................................................................................ [2]
(b) Some of the zinc oxide was mixed with an excess of carbon and heated to 1000 °C. Zinc distils out of the furnace.

\[ 2\text{ZnO} + \text{C} \rightleftharpoons 2\text{Zn} + \text{CO}_2 \]
\[ \text{C} + \text{CO}_2 \rightarrow 2\text{CO} \]

(ii) Why is it necessary to use an excess of carbon?

Mark Scheme iG Chem 10 P3 Metals 15w to 06s

Q# 1/ iGCSE Chemistry/2015/s/Paper 31/

<table>
<thead>
<tr>
<th>2(b)(i)</th>
<th>Any one from: (making) car (bodies); machinery; chains; pylons; white goods; nails; screws; as a building material; sheds/tools; reinforcing concrete;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A bridges A tools A cutlery</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2(b)(ii)</th>
<th>Any one from: knives; drills; railway tracks; machine/cutting tools/hammers; razor blades; chisels;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A cutlery items A bridges</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2(b)(ii)</th>
<th>M1 atoms or cations or (positive) ions or metal ions; M2 arranged in a lattice or in layers or in rows or in a regular structure; M3 rows or layers slide over one another;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A (sea of) electrons A protons or nuclei for M1 A M2 non-directional forces A ECF on particle named in M1 for M3 A atoms’ slide over one another</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2(b)(iv)</th>
<th>M1 carbon atoms or particles in structure different size (b cations); M2 so reduce moving or interrupt movement;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R ions and molecules for M1 A M2 for prevents sliding A M2 for 'stop' sliding</td>
</tr>
</tbody>
</table>

Q# 2/ iGCSE Chemistry/2011/s/Paper 31/Q3

(b) (i) any sensible suggestion – harder/stronger/can be tailored for a specific use/more resistant to corrosion not steel does not rust [1]

(ii) mild steel – cars or any vehicle/bicycles/white goods/screws or nails/too/bridges/tools/buildings/ships/pipes/machinery etc. [1]

stainless steel – chemical plants/cooking utensils/jewellery/cutlery/surgical equipment/kitchen sinks/pipes/etc. [1]

Q# 3/ iGCSE Chemistry/2006/w/Paper 3/ Q6 (b)

(iii) Zinc [1]
Q# 4/ iGCSE Chemistry/2011/w/Paper 31/  
3  
(a) (i) bauxite  
(ii) lowers melting point  
    better conductor / reduces amount of energy needed / reduces cost / more economic / makes process viable / conserves energy  
(iii) aluminium more reactive than copper / aluminium higher in reactivity series  
    hydrogen not aluminium formed at cathode  

(b) $Al^{3+} + 3e^- \rightarrow Al$  
$2CO_2^2- \rightarrow O_2 + 4e^-$  
note: not balanced = 1  
oxygen reacts with carbon (anode) to form carbon dioxide / $C + O_2 \rightarrow CO_2$  
note: if mark(s) for an electrode reaction are not awarded then allow aluminium ions accept electrons / are reduced  
oxide ion loses electrons / is oxidised  
max 4

Q# 5/ iGCSE Chemistry/2008/s/Paper 31/  
6  
(a) alumina or aluminium oxide  
sodium aluminate  
Iron(III) oxide  
filtration or centrifuge NOT conditional  

(b) from left to right:  
carbon cathode or carbon negative electrode  
900 to 1000°C  
aluminium  
cyolite  

(c) (i) $Al^{2+} + 3e^- \rightarrow Al$  
not balanced  
$Al^{3+}(aq) = 0$  

(ii) oxygen is formed NOT oxide  
reacts with carbon anode

Q# 6/ iGCSE Chemistry/2015/s/Paper 31/  

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
<th>Guidance</th>
</tr>
</thead>
</table>
| 2a) M1 Forming an oxide  
(all) elements or (all) impurities become oxides; | | | (All) elements or (all) impurities react with oxygen  
A M1 for any one element becoming an oxide |
| M2 Gasous oxides  
carbon dioxide or sulfur (dioxide) oxides escape / are removed as gases; | | | A formulae / carbon monoxide  
A oxides of sulfur / carbon  
H2S / sulfur trioxide |
| M3 Acidic oxides  
silicon (IV) oxide or phosphorus (III/IV) oxide react / are neutralised by calcium oxide / lime; | | | A silicon (dioxide) for silicon (IV) oxide  
A phosphorus (triphosphorus) oxide for phosphorus (III/IV) oxide  
A multiples  
1 state symbols  
fformulae / balanced equations  
r other comb. equations with incorrect species |
| M4 Equation mark  
y any one of the following equations:  
$S + O_2 \rightarrow SO_2$  
$C + O_2 \rightarrow CO_2$ or $2C + O_2 \rightarrow 2CO$;  
$Si + O_2 \rightarrow SiO_2$  
$4P + 5O_2 \rightarrow 2P_2O_5$ or $P_{4s} + 5O_2 \rightarrow 2P_2O_5$;  
$4P + 3O_2 \rightarrow 2P_2O_3$ or $P_{4s} + 3O_2 \rightarrow 2P_2O_3$; | | | A calcium oxide + silicon (IV) oxide $\rightarrow$ slag  
A correct symbol equation for M5 but others with incorrect species used as M5 |
| M5 Word equation mark  
y any one of the following word equations:  
calcium oxide + silicon (IV) oxide $\rightarrow$ calcium silicate;  
calcium oxide + phosphorus (III/IV) oxide $\rightarrow$ calcium phosphide; | | | A calcium oxide + silicon (IV) oxide $\rightarrow$ slag  
A correct symbol equation for M5 but others with incorrect species used as M5 |
Q# 7/ iGCSE Chemistry/2014/w/Paper 31/

4 (a) (i) insufficient/limited oxygen
or \( 2C + O_2 \rightarrow 2CO \) [1]
coke/carbon reacts with carbon dioxide
or \( C + CO_2 \rightarrow 2CO \) [1]

(ii) \( Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2 \)
species (1) balancing (1) [2]

(b) (i) carbon dioxide [1]

(ii) \( CaO + SiO_2 \rightarrow CaSiO_3 \)

(iii) (molten) iron higher density (than slag) [2]

(iv) No oxygen in contact with iron or layer of slag prevents hot iron reacting with oxygen/air or (all) oxygen reacts with carbon (so no oxygen left to react with iron) [1]

Q# 8/ iGCSE Chemistry/2011/s/Paper 31/

3 (a) any four max 4

- carbon forms carbon dioxide / carbon monoxide
  this is a gas it escapes / blown out / diffuses [1]
- silicon forms silicon(IV) oxide / silica [1]
- silicon(IV) oxide present in impure iron [1]
- silicon(IV) oxide reacts with calcium oxide to form slag or calcium silicate
- slag removed from surface
- accept skimmed, syphoned, poured off
- not tapped

- accept correct formula or equations
- not calcium oxide reacts with silicon max [4]

Q# 9/ iGCSE Chemistry/2008/w/Paper 31/ Q3

(b) (i) hydrogen or carbon or carbon monoxide or methane
  or more reactive metal NOT Group I [1]

(ii) any correct equation
  only error not balanced [1]

Q# 10/ iGCSE Chemistry/2008/w/Paper 31/ Q3

(d) (i) forms carbon dioxide/carbon monoxide (which escapes) [1]

(ii) forms silicon(IV) oxide or silicon oxide or silica
  OR CaO reacts with SiO_2
  to form slag or calcium silicate
  ignore an incorrect formula if a correct name “slag” given
  NOT Si + O_2 + CaO form slag, this gains mark for slag only [1]

Q# 11/ iGCSE Chemistry/2006/s/Paper 3/ Q1

(c) (i) limestone [1]

(ii) slag [1]

(iii) iron ore [1]
Q# 12/ iGCSE Chemistry/2006/s/Paper 3/ Q1
(d) to burn or provide heat
to make carbon monoxide

Q# 13/ iGCSE Chemistry/2014/s/Paper 31/
(b) Any two from:
- (making) brass or alloys (1)
- galvanising (1)
- sacrificial protection (1)
- batteries (1)

Q# 14/ iGCSE Chemistry/2013/w/Paper 31/
2 (a) Any three of:
iron is harder
iron has higher density
ACCEPT: heavier or potassium lighter
iron has higher mp or bp
iron has higher tensile strength or stronger
iron has magnetic properties
NOTE: has to be comparison, e.g. iron is hard (0) but iron is harder (1)
NOT: appearance e.g. shiny
ACCEPT: comparative statements relating to potassium

Q# 15/ iGCSE Chemistry/2011/w/Paper 31/ Q3
(c) (i) protective oxide layer
(ii) aluminium low density / light
aluminium is a good conductor
strength / prevent sagging / allows greater separation of pylons / core made of
steel because it is strong

Q# 16/ iGCSE Chemistry/2010/s/Paper 31/
(d) low density / lightweight / light
propellers / fittings on ships / inert anodes in electrolysis / hip replacements/
ship building / chemical plants / cathodic protection / diving equipment

Q# 17/ iGCSE Chemistry/2008/s/Paper 31/ Q3
(c) (i) good conductor
malleable or ductile
good conductor of heat
high melting point (and high boiling point)
unreactive or resists corrosion
appearance
any TWO
do not accept malleable or ductile if either is given for wiring

(ii) alloys or named alloy or pipes or ornaments or jewellery or integrated circuit boards or
electroplating or roofs, etc.

Q# 18/ iGCSE Chemistry/2007/w/Paper 3/ Q4
(d) prevent iron from rusting NOT with galvanising or sacrificial protection
making brass or making alloys NOT bronze
electroplating or as an electrode in electrolysis
cells
roofing
sacrificial protection
coinage
TWO uses
Q# 19/ iGCSE Chemistry/2008/s/Paper 31/Q6
(d) (i) low density or light or resistant to corrosion accept strength/weight ratio or alloys are strong on its own is neutral

(ii) not attacked or corroded or unreactive oxide layer easily shaped or malleable or ductile any TWO

(iii) for strength or so it does not break or does not sag or can have pylons further apart NOT steel is a better conductor NOT aluminium protects steel from rusting

Q# 20/ iGCSE Chemistry/2006/s/Paper 3/ Q1
(e) mild steel cars or machinery or fridges etc.
stainless steel cutlery or chemical plants etc.

Q# 21/ iGCSE Chemistry/2015/w/Paper 31/

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(a)</td>
<td>add a (dilute) acid; filter; copper does not react or dissolve/zinc reacts or dissolves or forms a salt;</td>
<td>1 1 1</td>
</tr>
</tbody>
</table>

Q# 22/ iGCSE Chemistry/2014/s/Paper 31/
7 (a) (i) aqueous solution lead Pb magnesium Mg zinc Zn silver Ag lead (II) nitrate

<table>
<thead>
<tr>
<th></th>
<th>Pb</th>
<th>Mg</th>
<th>Zn</th>
<th>Ag</th>
</tr>
</thead>
<tbody>
<tr>
<td>lead (II) nitrate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>magnesium nitrate</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>zinc nitrate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>silver(I) nitrate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

each horizontal line correct (1)

(ii) Zn (1)
An arrow from Zn to Zn²⁺ (1)

(iii) Zn + 2Ag⁺ → Zn²⁺ + 2Ag (1)

(b) (i) correct direction from zinc to lead (1)

(ii) metals react by losing electrons (1)

the more reactive metal/zinc will lose electrons more readily (making the electrode negatively charged). (1)
(iii) manganese and zinc are more reactive than lead (and/or copper) (1)

lead is more reactive than copper (1)

(iv) the polarity of a Mn/Zn (cell)
or the voltages of Zn/Pb and Mn/Pb (cells) (1)

(b) potassium hydrogen (1) and potassium hydroxide (1)

zinc hydrogen (1) and zinc oxide (1)
copper no reaction (1)

Q# 23/ iGCSE Chemistry/2013/w/Paper 31/

(b) potassium hydrogen (1) and potassium hydroxide (1)

zinc hydrogen (1) and zinc oxide (1)
copper no reaction (1)

Q# 24/ iGCSE Chemistry/2013/s/Paper 31/

5 (a) (i) any metal above zinc

\[ \text{Mg} \rightarrow \text{Mg}^{2+} + 2e^- \] (1)

(ii) \[ \text{Zn} + 2\text{Ag}^+ \rightarrow \text{Zn}^{2+} + 2\text{Ag} \]

Note: not balanced only [1]

(iii) because they can accept or gain electrons / change into atoms or can be reduced (1)

(iv) \( \text{Ag}^+ \) or silver

charge not essential but if given must be correct (1)

(v) \( \text{Ag}^+ \) and \( \text{Cu}^{2+} \) or silver and copper

charge not essential but if given must be correct (1)

Q# 25/ iGCSE Chemistry/2013/s/Paper 31/

(b) Cu Sn Cd Zn (i.e. all 4 in correct order)

relates order to voltage (1)

one relevant comment from:

higher reactivity metals are the negative electrode / copper is least reactive because it is the positive electrode because copper would have the lowest voltage / copper cell V = 0 / the bigger the difference in reactivity, the bigger the voltage / zinc has highest voltage because it is most reactive / more reactive metals have higher voltage (1)

Q# 26/ iGCSE Chemistry/2012/s/Paper 31/ Q5

(c) Na / Ca;

(1)

(d) Cu; Ag;

accept: ions \( \text{Cu}^{2+} \) and \( \text{Ag}^+ \)

(2)

Q# 27/ iGCSE Chemistry/2011/s/Paper 31/

7 (a) metal A is magnesium

most reactive or fastest reaction (1)

metal B is aluminium

faster reaction after removal of oxide layer / it would give more hydrogen / aluminium more reactive than zinc (1)

metal C is zinc

least reactive (1)

NOTE MAX [5]

If you encounter different reasoning which is correct, please award the appropriate marks.
(b) for magnesium and zinc same volume of hydrogen
because both have valency of 2 / 1 mole of metal gives 1 mole of hydrogen / 1 mole of metal
reacts with 2 moles of acid

bigger volume for aluminium because its valency is 3 / 1 mole of metal gives 1.5 moles of
hydrogen / 1 mole of metal reacts with 3 moles of acid

If you encounter different reasoning which is correct, please award the appropriate marks.

accept balanced equations
accept ionic charges as alternative to valency

Q# 28/ iGCSE Chemistry/2010/w/Paper 31/ Q2
(c) (i) tin(IV) oxide + carbon → tin + carbon dioxide
not carbon monoxide as a reductant
accept carbon monoxide as a product
not tin(IV)
accept correct symbol equation

(ii) water
carbon dioxide

(iii) correct labels for
(pure) copper cathode
impure copper anode
electrolyte copper(II) sulfate / any soluble copper(II) salt / Cu^{2+}
if labels on electrodes reversed [0]

(iv) wires / pipes / jewellery / nails / roofing / ammunition / coins / cookware / catalyst / sculpture

Q# 29/ iGCSE Chemistry/2010/s/Paper 31/
7 (a) a transition element has more than one oxidation state or valency
accept different oxidation states

(b) by removing oxygen concentration of O₂ decreases
prevents the back reaction / equilibrium shifts to right

(c) oxidation number reduced (from (+) 4 to 0)
accept accepts electrons or accepts four electrons
if number given must be 4

Q# 30/ iGCSE Chemistry/2010/s/Paper 31/
3 (a) (i) bubbles / effervescence / hydrogen / gas pushes up / lifts metal

(ii) does not react with acid / zinc and iron react with acid
not just unreactive
Q# 31/ iGCSE Chemistry/2009/s/Paper 31/

4  (i) Cu and Pd
(ii) Ba and La
(iii) +2 or 2+ or Ba^{2+}
(iv) Ba or La
(v) it is a transition metal or a d block element

Q# 32/ iGCSE Chemistry/2008/w/Paper 31/

6 (a) (i)

<table>
<thead>
<tr>
<th></th>
<th>tin Sn</th>
<th>manganese Mn</th>
<th>silver Ag</th>
<th>zinc Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>tin(II) nitrate</td>
<td>R</td>
<td>NR</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>manganese(II) nitrate</td>
<td>NR</td>
<td></td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>silver(I) nitrate</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>zinc nitrate</td>
<td>NR</td>
<td>R</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[1] for each row
ignore anything written in blank space

(ii) Sn + 2Ag^{+} → Sn^{2+} + 2Ag
    all species correct [1]
    accept equation with Sn^{4+}

(iii) Mn to Mn^{2+} need both species
electron loss or oxidation number increases

(iv) covered with oxide layer
    makes it unreactive or protects or aluminium oxide unreactive

Q# 33/ iGCSE Chemistry/2007/w/Paper 3/ Q4

(c) (i) Zn^{2+} + 2e = Zn

(ii) 4OH^{-} - 4e = O_{2} + 2H_{2}O
    or 4OH^{-} = O_{2} + 2H_{2}O + 4e
    or 2H_{2}O = 4H^{+} + O_{2} + 4e
    or 2H_{2}O - 4e = 4H^{+} + O_{2}
    oxygen as product [1]

(iii) sulphuric acid
    NOTE there are no alternative answers to the above

Q# 34/ iGCSE Chemistry/2008/s/Paper 31/

5 (a) (i) air would react (with the magnesium or titanium)
    OR argon would not react (with the metels)
    NOT argon is inert

(ii) any metal higher than magnesium in reactivity series

Q# 35/ iGCSE Chemistry/2012/s/Paper 31/

(b) (i) CuO and NO_{2} and O_{2};
    accept: names or correct formulae

(ii) 2NaNO_{3} → 2NaNO_{2} + O_{2}
    accept: NaNO_{3} → NaNO_{2} + 1/2 O_{2}
    not balanced = [1]
Q# 36/ iGCSE Chemistry/2011/w/Paper 31/  
7  (a) (i) any Group 1 metal  
   accept: LiOH  
   (ii) Cu(OH)$_2$ → CuO + H$_2$O  
   note: products only = 1  
   (iii) reactivity of metals / metals have different reactivities  
   (b) (i) zinc oxide, nitrogen dioxide, oxygen  
   note: two correct = 1  
   (ii) 2KNO$_3$ → 2KNO$_2$ + O$_2$  
   note: unbalanced = 1, correct word equation = 1  

Q# 37/ iGCSE Chemistry/2008/w/Paper 31/ 6 (b)  
(ii) potassium hydroxide → no reaction  
   calcium hydroxide → calcium oxide and water  
   ACCEPT metal oxide  
   (iii) 2KNO$_3$ → 2KNO$_2$ + O$_2$  
   [1] for formula of either product  
   2Ca(NO$_3$)$_2$ → 2CaO + 4NO$_2$ + O$_2$  
   [1] for formulae of any TWO products  

Q# 38/ iGCSE Chemistry/2014/s/Paper 31/  
5  (a) M1: (zinc sulfide) heated / roasted / burnt in air (1)  
   M2: zinc oxide formed (1)  
   M3: zinc oxide reduced (1)  
   M4: (by adding) coke or carbon (1)  
   M5: Balanced equation (any one of) (1)  
   2ZnS + 3O$_2$ → 2ZnO + 2SO$_2$  
   2ZnO + C → 2Zn + CO$_2$  
   ZnO + C → Zn + CO  
   ZnO + CO → Zn + CO$_2$  

Q# 39/ iGCSE Chemistry/2011/s/Paper 31/  
4  (a) (i) 2ZnS + 3O$_2$ → 2ZnO + 2SO$_2$  
   not balanced only [1]  
   (ii) two reagents from named metal(s) more reactive than zinc / carbon monoxide not hydrogen  
   (iii) they have different boiling points  
   cadmium will distil first then zinc leaving lead / lead distilled last  

Q# 40/ iGCSE Chemistry/2009/w/Paper 3/  
3  (a) (i) heat or roast or burn in air  
   need both points for mark  
   (ii) ZnO + C → Zn + CO  
   or 2ZnO + C → 2Zn + CO$_2$  
   unbalanced ONLY [1]
Q# 41/ iGCSE Chemistry/2007/w/Paper 3/ Q4 (b)

(ii) to get maximum yield of zinc or reduce all zinc oxide  
NOTE the above mark is awarded for why add excess carbon moves equilibrium to right or to favours the products or removes CO₂ from equilibrium  
NOTE this mark is awarded for how does the addition of excess carbon give max yield of zinc  
NOTE Allow any coherent explanation flexibly based on the above ideas  
EXAMPLES: 
moves equilibrium to right [1] because carbon dioxide removed [1] 
to get maximum yield of zinc [1] as equilibrium moves to right [1]  
NOT just to make CO from CO₂

iG Chem 11 EQ P5 15w to 01w Air and Water Broken down by subtopic 124marks

<table>
<thead>
<tr>
<th>Sub Topic Name</th>
<th>TOPIC 11 Air and water PAPER 4 (pre2016 called Paper 3)</th>
<th>Percentage of all marks awarded for each SUB topic from w2001 to w2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Rusting</td>
<td>Nitrogen &amp; Fertilisers</td>
</tr>
<tr>
<td>Sub Topic Name</td>
<td>% of Marks awarded for each SUB-topic</td>
<td>% of Marks awarded for each SUB-topic</td>
</tr>
<tr>
<td>T11 w01 to w15</td>
<td>32.9</td>
<td>13.6</td>
</tr>
</tbody>
</table>

11. Air and water
11.1. Water

Core
- Describe chemical tests for water using cobalt(II) chloride and copper(II) sulfate
- Describe, in outline, the treatment of the water supply in terms of filtration and chlorination
- Name some of the uses of water in industry and in the home

Supplement
- Discuss the implications of an inadequate supply of water, limited to safe water for drinking and water for irrigating crops
11.2 Air

Core

- State the composition of clean, dry air as being approximately 78% nitrogen, 21% oxygen and the remainder as being a mixture of noble gases and carbon dioxide
- Name the common pollutants in the air as being carbon monoxide, sulfur dioxide, oxides of nitrogen and lead compounds
- State the source of each of these pollutants:
  - carbon monoxide from the incomplete combustion of carbon-containing substances
  - sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds (leading to ‘acid rain’)
  - oxides of nitrogen from car engines
  - lead compounds from leaded petrol
- State the adverse effect of these common pollutants on buildings and on health and discuss why these pollutants are of global concern
- State the conditions required for the rusting of iron
- Describe and explain methods of rust prevention, specifically paint and other coatings to exclude oxygen

Supplement

- Describe the separation of oxygen and nitrogen from liquid air by fractional distillation
- Describe and explain the presence of oxides of nitrogen in car engines and their catalytic removal
- Describe and explain sacrificial protection in terms of the reactivity series of metals and galvanising as a method of rust prevention

11.3 Nitrogen and fertilisers

Core

- Describe the need for nitrogen-, phosphorus- and potassium-containing fertilisers
- Describe the displacement of ammonia from its salts

Supplement

- Describe and explain the essential conditions for the manufacture of ammonia by the Haber process including the sources of the hydrogen and nitrogen, i.e. hydrocarbons or steam and air

11.4 Carbon dioxide and methane

Core

- State that carbon dioxide and methane are greenhouse gases and explain how they may contribute to climate change
- State the formation of carbon dioxide:
  - as a product of complete combustion of carbon-containing substances
  - as a product of respiration
  - as a product of the reaction between an acid and a carbonate
  - from the thermal decomposition of a carbonate
- State the sources of methane, including decomposition of vegetation and waste gases from digestion in animals

Supplement

- Describe the carbon cycle, in simple terms, to include the processes of combustion, respiration and photosynthesis

1. (a) The major gases in unpolluted air are 79% nitrogen and 20% oxygen.
   
   (i) Name another gaseous element in unpolluted air. ................................. [1]
   
   (ii) Name two compounds in unpolluted air. .............................................. [2]


(c) It is now known that the smell of the seaside is due to the chemical dimethyl sulfide, (CH₃)₂S.

(ii) Name the three compounds formed when dimethyl sulfide is burnt in excess oxygen. .......................................................................................................................... [2]


(b) Two common pollutants in air are carbon monoxide and the oxides of nitrogen.

   (i) Name another pollutant in air. ................................................................. [1]

   (ii) Describe how carbon monoxide is formed. ............................................ [2]

   (iii) How are the oxides of nitrogen formed? .............................................. [2]
(iv) Explain how a catalytic converter reduces the emission of these two gases.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................ [2]


(ii) Chloromethane is formed when seaweed decomposes. Name the compounds in the environment from which seaweed might have obtained the following elements:

carbon; ..................................................................................................................

hydrogen; .............................................................................................................

chlorine. ................................................................................................................. [3]


(iv) The oxides of nitrogen are atmospheric pollutants. Describe how they are formed.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................ [2]

(v) Complete the equation for the decomposition of ozone.

.................. O₃ → ............. [2]

Topic Chem 11 SubTopic: Air Q# 6/ iGCSE Chemistry/2011/w/Paper 31/ Q1

1 This question is concerned with the following oxides.

sulfur dioxide
carbon monoxide
lithium oxide
aluminium oxide
nitrogen dioxide
strontium oxide
(b) Two of the oxides are responsible for acid rain. Identify the two oxides and explain their presence in the atmosphere.

(c) (i) Explain how acid rain is formed.

(c) Catalytic converters reduce the pollution from motor vehicles.

(i) Describe how carbon monoxide and the oxides of nitrogen are formed in car engines.
(ii) Describe the reaction(s) inside the catalytic converter which change these pollutants into less harmful gases. Include at least one equation in your description.


Three common pollutants in the air are carbon monoxide, the oxides of nitrogen, NO and NO₂, and unburnt hydrocarbons. They are all emitted by motor vehicles.

(a) Describe how the oxides of nitrogen are formed.


(b) Describe how a catalytic converter reduces the emission of these three pollutants.


(c) Other atmospheric pollutants are lead compounds from leaded petrol. Explain why lead compounds are harmful.


Sulfur, present in coal, is one major cause of acid rain. Sulfur burns to form sulfur dioxide which reacts with rain water to form sulfuric acid.

(i) Describe how the high temperatures in vehicle engines are another cause of acid rain.


(ii) Give two harmful effects of acid rain.
Topic Chem 11 SubTopic: Air Q# 11/ iGCSE Chemistry/2015/w/Paper 31/

2 Describe how to separate the following. In each example, give a description of the procedure used and explain why this method works.

(b) Nitrogen from a mixture of nitrogen and oxygen.

procedure .............................................................................................................

explanation .......................................................................................................... [3]

Topic Chem 11 SubTopic: Carbon cycle Q# 12/ iGCSE Chemistry/2009/s/Paper 31/ Q4

(b) Explain the role of chlorophyll in green plants.

.................................................................................................................................

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................................................................................................................................. [3]

Topic Chem 11 SubTopic: Carbon cycle Q# 13/ iGCSE Chemistry/2010/w/Paper 31/

7 The diagram shows part of the carbon cycle. This includes some of the processes which determine the percentage of carbon dioxide in the atmosphere.

![Diagram of carbon cycle]

(i) Carbon dioxide is one greenhouse gas. Name another one.

................................................................................................................................. [1]

(ii) Explain the term respiration and how this process increases the percentage of carbon dioxide in the atmosphere.

.................................................................................................................................

................................................................................................................................. [3]
(iii) Explain why the combustion of waste crop material should not alter the percentage of carbon dioxide in the atmosphere.


[2]

(iv) In 1960 the percentage of carbon dioxide in the atmosphere was 0.032% and in 2008 it was 0.038%. Suggest an explanation for this increase.


[2]

2 Selenium and sulfur are in Group VI. They have similar properties.

(a) One of the main uses of selenium is in photoelectric cells. These cells can change light into electrical energy.

(i) Name a process which can change light into chemical energy.

Topic Chem 11 SubTopic: Carbon cycle Q# 14/ iGCSE Chemistry/2011/s/Paper 31/

2 Two important greenhouse gases are methane and carbon dioxide.

(a) Methane is twenty times more effective as a greenhouse gas than carbon dioxide. The methane in the atmosphere comes from both natural and industrial sources.

(i) Describe two natural sources of methane.


[2]

(ii) Although methane can persist in the atmosphere for up to 15 years, it is eventually removed by oxidation. What are the products of this oxidation?


[2]

(b) How do the processes of respiration, combustion and photosynthesis determine the percentage of carbon dioxide in the atmosphere?
Topic Chem 11 SubTopic: Carbon cycle Q# 16/ iGCSE Chemistry/2015/s/Paper 31/  
1  (a) Coal is a solid fossil fuel.

Name two other fossil fuels.  
......................................................................................................................... [2]

(b) Two of the elements present in a sample of coal are carbon and sulfur.

A sample of coal was heated in the absence of air and the products included water, ammonia and hydrocarbons.

Name three other elements present in this sample of coal.  
......................................................................................................................... [2]

(d) In 2010, a large coal-burning power station in the UK was converted to burn both coal and wood.

Explain why the combustion of wood rather than coal can reduce the effect of the emissions from this power station on the level of carbon dioxide in the atmosphere.  
......................................................................................................................... [3]

Topic Chem 11 SubTopic: Nitrogen and fertilisers Q# 17/ iGCSE Chemistry/2010/w/Paper 31/ Q4  
(b) Ammonia is made by the Haber Process.

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \]  forward reaction is exothermic

The percentage of ammonia in the equilibrium mixture varies with conditions.

<table>
<thead>
<tr>
<th>pressure/atmospheres</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
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</thead>
<tbody>
<tr>
<td>% ammonia at 300 °C</td>
<td>45</td>
<td>65</td>
<td>72</td>
<td>78</td>
</tr>
<tr>
<td>% ammonia at 500 °C</td>
<td>9</td>
<td>18</td>
<td>25</td>
<td>31</td>
</tr>
</tbody>
</table>

The conditions actually used are 200 atmospheres, 450 °C and an iron catalyst.

(i) The original catalyst was platinum. Suggest a reason why it was changed to iron.  
......................................................................................................................... [1]

(ii) Explain why the highest pressure gives the highest percentage of ammonia in the equilibrium mixture.  
......................................................................................................................... [2]
(iii) What happens to the unreacted nitrogen and hydrogen?

(iv) State one advantage and one disadvantage of using a lower temperature.

(b) Ammonia is manufactured by the Haber Process. The economics of this process require that as much ammonia as possible is made as quickly as possible. Explain how this can be done using the following information.

The conditions for the following reversible reaction are:

- 450°C
- 200 atmospheres pressure
- iron catalyst

\[
\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \quad \text{the reaction is exothermic}
\]
3 Ammonia is manufactured by the Haber process.

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \]

The forward reaction is exothermic.

(a) Describe how the reactants are obtained.

(i) Nitrogen

(ii) Hydrogen

(b) The percentage of ammonia in the equilibrium mixture varies with temperature and pressure.

(i) Which pair of graphs, A, B or C, shows correctly how the percentage of ammonia at equilibrium varies with temperature and pressure?

The pair with both graphs correct is .......................................................... [1]
(ii) Give a full explanation of why the pair of graphs you have chosen in (i) is correct.

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........................................................................................................................................................................ [6]

(iii) Catalysts do not alter the position of equilibrium. Explain why a catalyst is used in this process.

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........................................................................................................................................................................ [2]


(b) A major use of zinc is galvanizing; steel objects are coated with a thin layer of zinc. This protects the steel from rusting even when the layer of zinc is broken.

explain, by mentioning ions and electrons, why the exposed steel does not rust.
(e) Hydrazine is a weak base and it removes dissolved oxygen from water. It is added to water in steel boilers to prevent rusting.

(i) One way it reduces the rate of rusting is by changing the pH of water. What effect would hydrazine have on the pH of water? 

(ii) Give a reason, other than pH, why hydrazine reduces the rate of rusting. 

(c) Iron and steel rust. Iron is oxidised to hydrated iron(III) oxide, Fe₂O₃·2H₂O, which is rust.

(i) Name the two substances which cause iron to rust. 

(ii) Explain why an aluminium article coated with aluminium oxide is protected from further corrosion but a steel article coated with rust continues to corrode. 

(d) There are two electrochemical methods of rust prevention.

(i) The first method is sacrificial protection.

Explain why the steel article does not rust.

connected electrically to steel pipe

block of zinc

steel pipe
1. The diagram below shows part of the Water Cycle.

(a) (i) State the name of each of the following changes of state.

\[ \text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g) \]

name ............................................................................................................................

\[ \text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l) \]

name ............................................................................................................................ [2]

(ii) Which one of the above changes of state is exothermic? Explain your choice.

........................................................................................................................................ [1]

(b) The rain drains into rivers and then into reservoirs. Describe how water is treated before it enters the water supply.

........................................................................................................................................ [2]

2. (a) Water is needed for industry and in the home.

(i) Rain water is collected in reservoirs. How is it treated before entering the water supply?

........................................................................................................................................ [2]

(ii) State two industrial uses of water.

........................................................................................................................................ [2]
(iii) State **two** uses of water in the home.

Mark Scheme iG Chem 11 EQ P5 15w to 01w Air and Water

Q# 1/ iGCSE Chemistry/2009/w/Paper 3/ 1 (a) (i) argon or krypton or helium
   Accept xenon and radon even though percentages are very small
   NOT hydrogen
   (ii) water and carbon dioxide

Q# 2/ iGCSE Chemistry/2009/w/Paper 3/ 4 (c)
(ii) water
   carbon dioxide
   sulfur dioxide
   all three
   any two [1]
   Accept correct formulae

Q# 3/ iGCSE Chemistry/2009/w/Paper 3/ QiGCSE Chemistry/201
(b) (i) sulfur dioxide or lead compounds or CFCs or methane or particulates
   or unburnt hydrocarbons or ozone etc.
   [1]
   (ii) incomplete combustion
   of a fossil fuel or a named fuel or a fuel that contains carbon
   [1]
   (iii) at high temperature or inside engine
   nitrogen and oxygen (from the air) react
   [1]
   (iv) it changes carbon monoxide to carbon dioxide
   oxides of nitrogen to nitrogen
   [1]
   OR symbol or word equation of the type:
   \[2NO + 2CO \rightarrow CO_2 + N_2\]
   [2]
   OR a redox explanation – the oxides of nitrogen oxidise carbon monoxide to carbon dioxide,
   they are reduced to nitrogen
   [1]
   \[2NO \rightarrow N_2 + O_2\]
   \[2CO + O_2 \rightarrow 2CO_2\]
   [1]

Q# 4/ iGCSE Chemistry/2010/s/Paper 31/ Q2
(ii) carbon dioxide / calcium carbonate
   not methane
   water
   sodium chloride / brine / seawater
   [1]

Q# 5/ iGCSE Chemistry/2010/s/Paper 31/ Q2
(iv) oxygen and nitrogen (in air)
   not from fuel, negates mark 1
   (react) at high temperatures / lightning / in engine
   not combustion or exhaust, negates mark 2
   \[2O_3 \rightarrow 3O_2\]
   not balanced = [1]
Q# 6/ IGCSE Chemistry/2011/w/Paper 31/ Q1

(b) sulfur dioxide
   burn (fossil) fuel containing sulfur / volcanoes
   nitrogen dioxide
   reaction of nitrogen and oxygen
   high temperatures / in car engine
   not: exhaust

Q# 7/ IGCSE Chemistry/2012/s/Paper 31/

(c) (i) combustion of fossil fuels;
      (which contain) sulfur;
      sulfur dioxide formed;
      (reacts in air / with water to form) sulfurous / sulfuric acid;
      OR
      nitrogen and oxygen in air;
      react at high temperatures / in engines;
      to form oxides of nitrogen or named oxide of nitrogen;
      (reacts in air / with water to form) nitrous / nitric acid;

Q# 8/ IGCSE Chemistry/2012/w/Paper 31/ Q3

(c) (i) carbon monoxide-incomplete combustion;
      carbon - containing fuel / fossil fuel / petrol;
      oxides of nitrogen - oxygen and nitrogen react;
      at high temperature / in engine;
      not: in exhaust

(ii) carbon monoxide to carbon dioxide;
      oxides of nitrogen to nitrogen;
      correct balanced equation;

Q# 9/ IGCSE Chemistry/2014/w/Paper 31/

5 (a) nitrogen and oxygen react
    at high temperatures (in engine)

(b) M1 carbon monoxide (converted to) carbon dioxide or
    2CO + O₂ → 2CO₂

M2 (by) oxides of nitrogen (which are reduced to) nitrogen
    or
    2NO → N₂ + O₂ or
    2NO₂ → N₂ + 2O₂

M3 hydrocarbons (burn) making water

M4 products: any two from:
    carbon dioxide, water, nitrogen

(c) lead compounds are toxic or brain damage or reduce IQ or nausea or kidney
    failure or anaemia

Q# 10/ IGCSE Chemistry/2015/s/Paper 31/

<table>
<thead>
<tr>
<th>1(c)()</th>
<th>M1 oxygen and nitrogen (from air) react</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2 oxides of nitrogen OR nitrogen oxide(s) are formed;</td>
<td></td>
</tr>
<tr>
<td>M3 nitrogen oxides formed react with water (to form acid);</td>
<td></td>
</tr>
</tbody>
</table>

A nitrogen compound for M1
R M1 if oxygen or nitrogen originate from the fuel
A named oxide of nitrogen e.g. nitrogen dioxide
A correct formulae
A NOₓ
Q# 11/ iGCSE Chemistry/2015/w/Paper 31/

2(b) diffusion (through a membrane).
   nitrogen diffuses faster;
   because it has the smaller M_r;
   or
   (turn into) liquid;
   (fractional) distillation;
   different boiling points;
   or
   burn a named substance to make non-gaseous product;
   oxygen reacts/nitrogen does not react;
   name of product of combustion;

Q# 12/ iGCSE Chemistry/2009/s/Paper 31/

(b) catalyst
   photosynthesis or chloroplasts
   photochemical reaction or needs light
carbon dioxide + water form
   glucose or starch or oxygen NOT sugar
   Any THREE correct points ignore incorrect answers

Q# 13/ iGCSE Chemistry/2010/w/Paper 31/

7  (i) methane / water vapour / oxides of nitrogen / hydrofluorocarbons / perfluorocarbons / ozone
   not sulfur dioxide

   (ii) living organisms / plants and animals / cells
        produce energy (from food / glucose / carbohydrates)
        this forms carbon dioxide (could be in an equation)

   (iii) when growing the crop removed carbon dioxide from atmosphere
        / crop photosynthesised and used carbon dioxide
        combustion returned the carbon dioxide

   (iv) increased combustion
        of fossil fuels / named fossil fuel

to deforestation
less photosynthesis
not greater population

[Total: 8]

Q# 14/ iGCSE Chemistry/2011/s/Paper 31/

2  (a) (i) photosynthesis or a photochemical reaction
not an example, question requires a process
not devices which convert light into electricity
Q# 15/ iGCSE Chemistry/2011/w/Paper 31/

2 (a) (i) (waste gases) from animals decaying vegetation / anaerobic decay accept: decomposition of organic material / natural gas

(ii) carbon dioxide
water

(b) photosynthesis removes carbon dioxide from the atmosphere both respiration and combustion produce carbon dioxide any two of the following: plants photosynthesis changes carbon dioxide into carbohydrates (burning) of fossil fuels / named fuel / petrol / alkanes respiration by living organisms to obtain energy from carbon-containing compounds comment that the balance between these processes determines the percentage of carbon dioxide

Q# 16/ iGCSE Chemistry/2015/s/Paper 31/

1(a) Any two fossil fuels from:
- crude oil / petroleum;
- natural gas / methane;
- petrol / gasoline;
- kerosene / paraffin;
- diesel (oil) / gas oil;
- fuel oil;
- refinery gas / LPG;
- propane;
- butane;

1(b) hydrogen, oxygen, nitrogen;
All three for 2 marks two for 1 mark

1(d) Any three from:
- M1 wood burns to produce (less) carbon dioxide;
- M2 trees (wood) take in carbon dioxide;
- M3 by photosynthesis;
- M4 wood is carbon neutral fuel;

2 (i) ethane / oil / naphtha / coal / gas
- R coke / bitumen / lubricating oil / wood

2 A H, O, N
- I H2, O2, N2

Q# 17/ iGCSE Chemistry/2010/w/Paper 31/ Q4

(b) (i) expensive metal / iron cheaper / better catalyst

(ii) high pressure favours side with smaller volume / fewer moles this is right hand side / product / ammonia side

(iii) recycled / sent over catalyst again accept used again

(iv) advantage high yield disadvantage slow reaction rate etc
Q# 18/ iGCSE Chemistry/2013/s/Paper 31/ Q6
(b) any five from:

- high pressure favours lower volume side / movement to right / ammonia side, or high pressure increases the yield
- high pressure increases rate
- low temperature favours exothermic reaction / increases yield / favours the forward reaction
- low temperature gives low rate or vice versa
- catalyst increases rate or lowers activation energy
- 450 °C low enough to give an economic yield but with catalyst gives a fast enough rate note need whole concept to get this compromise temperature point [5]

Q# 19/ iGCSE Chemistry/2013/w/Paper 31/
3 (a) (i) fractional distillation
   (liquid) air [1]
   (ii) cracking / heat in presence of catalyst
        of alkane / petroleum
        to give an alkene and hydrogen
        OR: electrolysis (1)
        named electrolyte (1)
        hydrogen at cathode (1)
        OR: from methane (1)
        react water / steam (1)
        heat catalyst (1)
        only ACCEPT: water with methane or electrolysis

(b) (i) the pair with both graphs correct is C
       NOTE: mark (b)(ii) independent of (b)(i)

(ii) high pressure favours side with lower volume / fewer moles
     this is RHS / product / ammonia
     %NH₃ / yield increases as pressure increases
     the forward reaction is exothermic
     exothermic reactions favoured by low temperatures
     %NH₃ / yield decreases as temperature increases
     ACCEPT: reverse arguments

(iii) increases reaction rate
     ACCEPT: reduces activation energy
     OR: decreases the amount of energy particles need to react
     OR: economic rate at lower temperature so higher yield

Q# 20/ iGCSE Chemistry/2009/w/Paper 3/ Q3
(b) zinc is more reactive
   it loses electrons and forms ions in preference to iron
   zinc corrodes not iron
   NOT zinc rusts

   OR zinc loses electrons and forms ions
   the electrons move on to the iron
   the iron cannot be oxidised or it cannot rust or it cannot lose electrons
   CREDIT correct Chemistry that includes the above ideas
Q# 21/ iGCSE Chemistry/2013/s/Paper 31/ Q6

(e) (i) pH increases [1]
(ii) oxygen needed for rusting / removes oxygen / reacts with oxygen [1]

Q# 22/ iGCSE Chemistry/2014/w/Paper 31/ Q4

(c) (i) air/oxygen and water (need both) [1]
(ii) aluminium oxide layer is impervious or non-porous or passive or unreactive or will not allow water/air to pass through it (rust allows passage of water or air it flakes off) [1]

(d) (i) zinc more reactive (then iron/steel) loses electrons [1]
electrons move (from zinc) to iron [1]
Zinc reacts (with air and water) or zinc corrodes or zinc is oxidised or zinc is anodic or zinc forms positive ions or zinc forms Zn²⁺ or iron and steel don’t react with air/water or iron and steel are not oxidised or iron and steel do not form ions or iron and steel do not lose electrons or iron and steel are cathodic [1]

Q# 23/ iGCSE Chemistry/2012/s/Paper 31/

1 (a) (i) evaporation / boiling / vaporisation / evaporate / vaporise; condensation / liquefaction / condense / liquefy; [1]
(ii) condensation accept: correct equation \( H_2O(g) \rightarrow H_2O(l) \)
because energy / heat is given out / gas has more energy than liquid / need to supply energy to change liquid to gas so reverse must give out energy / bonds form; [1]

(b) chlorination / chlorine to kill microbes; [1]
filtration or filter; accept: sedimentation or sand or gravel or grit [1]

Q# 24/ iGCSE Chemistry/2014/s/Paper 31/

2 (a) (i) filtration (1) [2]

(ii) Any two from: [2]
- manufacture of ethanol
- used in the manufacture of sulfuric acid or in the Contact process
- manufacture of hydrogen or ammonia or for the Haber process

(iii) Any two from: [2]
- cooking
- washing or laundry
- drinking
- toilets
- watering plants
- (domestic) heating
12  Sulfur
12.1  Sulfur

Core
- Name some sources of sulfur
- Name the use of sulfur in the manufacture of sulfuric acid
- State the uses of sulfur dioxide as a bleach in the manufacture of wood pulp for paper and as a food preservative (by killing bacteria)

Supplement
- Describe the manufacture of sulfuric acid by the Contact process, including essential conditions and reactions
- Describe the properties and uses of dilute and concentrated sulfuric acid

13  Carbonates
13.1  Carbonates

Core
- Describe the manufacture of lime (calcium oxide) from calcium carbonate (limestone) in terms of thermal decomposition
- Name some uses of lime and slaked lime such as in treating acidic soil and neutralising acidic industrial waste products, e.g. flue gas desulphurisation
- Name the uses of calcium carbonate in the manufacture of iron and cement

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0620 PAPER 4 (pre2016 called Paper 3)
Percentage of all marks awarded for each topic from s2013 to w2015 (red cross) and for 2016m to 2017w (green triangle)

<table>
<thead>
<tr>
<th>Topic Number</th>
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<th>2</th>
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<th>4</th>
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<td>P3 2001-15</td>
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</table>
3  The main use of sulfur dioxide is the manufacture of sulfuric acid.
   
   (a) State two other uses of sulfur dioxide.

   ............................................................................................................................................. [2]

   (b) One source of sulfur dioxide is burning sulfur in air. Describe how sulfur dioxide can be made from the ore zinc sulfide.

   ............................................................................................................................................. [2]

   (c) The Contact process changes sulfur dioxide into sulfur trioxide.
   \[ 2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g) \]
   the forward reaction is exothermic
   temperature 400 to 450 °C
   low pressure 1 to 10 atmospheres
   catalyst vanadium(V) oxide
   
   (i) What is the formula of vanadium(V) oxide?

   ............................................................................................................................................. [1]

   (ii) Vanadium(V) oxide is an efficient catalyst at any temperature in the range 400 to 450 °C. Scientists are looking for an alternative catalyst which is efficient at 300 °C. What would be the advantage of using a lower temperature?

   ............................................................................................................................................. [2]

   (iii) The process does not use a high pressure because of the extra expense. Suggest two advantages of using a high pressure? Explain your suggestions.

   ............................................................................................................................................. [4]

   (d) Sulfuric acid is made by dissolving sulfur trioxide in concentrated sulfuric acid to form oleum. Water is reacted with oleum to form more sulfuric acid. Why is sulfur trioxide not reacted directly with water?
(b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.

(i) Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink. Suggest a reason.

(ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

(iii) Name two substances formed when soda lime reacts with carbon dioxide.

(b) Sulfur dioxide is used to make sulfur trioxide in the Contact Process.

\[ 2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g) \]

The forward reaction is exothermic. The conditions used are:

- temperature: 450°C
- pressure: 2 atmospheres
- catalyst: vanadium(V) oxide

Explain, mentioning both position of equilibrium and rate, why these conditions give the most economic yield.
6 (a) Sulfuric acid is made by the Contact process.

\[ 2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3 \]

This is carried out in the presence of a catalyst at 450 °C and 2 atmospheres pressure.

(i) How is the sulfur dioxide made?

(ii) Give another use of sulfur dioxide.

(iii) Name the catalyst used.

(iv) If the temperature is decreased to 300 °C, the yield of sulfur trioxide increases. Explain why this lower temperature is not used.

(v) Sulfur trioxide is dissolved in concentrated sulfuric acid. This is added to water to make more sulfuric acid. Why is sulfur trioxide not added directly to water?

1 For each of the following select an element from Period 4, potassium to krypton, that matches the description.

(g) One of its oxides is the catalyst in the Contact Process.
4 Zinc is extracted from zinc blende, ZnS.

(a) Zinc blende is heated in air to give zinc oxide and sulphur dioxide. Most of the sulphur dioxide is used to make sulphur trioxide. This is used to manufacture sulphuric acid. Some of the acid is used in the plant, but most of it is used to make fertilisers.

(i) Give another use of sulphur dioxide.

................................................................................................................................. [1]

(ii) Describe how sulphur dioxide is converted into sulphur trioxide.

................................................................................................................................. [3]

(iii) Name a fertiliser made from sulphuric acid.

................................................................................................................................. [1]

Topic Chem 12 Q# 7/ iGCSE Chemistry/2006/s/Paper 3/ Q5 (b)

(iii) Explain, mentioning both rate and percentage yield, why the temperature used in the Contact process is 450°C.

................................................................................................................................. [2]

(iv) Describe how the sulphur trioxide is changed into concentrated sulphuric acid.

................................................................................................................................. [2]

Topic Chem 12 Q# 8/ iGCSE Chemistry/2006/s/Paper 3/

5 Sulphuric acid is made by the Contact process in the following sequence of reactions.

sulphur $\rightarrow$ sulphur dioxide $\rightarrow$ sulphur trioxide $\rightarrow$ sulphuric acid

(a) (i) How is sulphur dioxide made from sulphur?

................................................................................................................................. [1]

(ii) Sulphur dioxide has other uses. Why is it used in the manufacture of paper?

................................................................................................................................. [1]

(iii) How does it preserve food?

................................................................................................................................. [1]
(b) The equation for a stage of the Contact process is

\[ 2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3 \]

The percentage of sulphur trioxide in the equilibrium mixture varies with temperature.

(i) How does the percentage of sulphur trioxide in the equilibrium mixture vary as the temperature increases? Circle the correct answer.

- increases
- stays the same
- decreases [1]

(ii) Is the forward reaction in the equilibrium \( 2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3 \) exothermic or endothermic? Give a reason for your choice.

............................................................................................................................................................................. [2]

(c) Sulphuric acid is manufactured by the Contact Process. Sulphur dioxide is oxidised to sulphur trioxide by oxygen.

\[ 2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3 \]

(i) Name the catalyst used in this reaction.

............................................................................................................................................................................. [1]

(ii) What temperature is used for this reaction?

............................................................................................................................................................................. [1]

(iii) Describe how sulphur trioxide is changed into sulphuric acid.

............................................................................................................................................................................. [2]
4 The Carlsbad caverns in New Mexico are very large underground caves. Although the walls of these caves are coated with gypsum (hydrated calcium sulphate), the caves have been formed in limestone.

(a) It is believed that the caves were formed by sulphuric acid reacting with the limestone.

(i) Complete the word equation.

\[
\text{calcium carbonate} + \text{sulphuric acid} \rightarrow \text{calcium sulphate} + \text{..........................} + \text{..........................} \quad [1]
\]

(ii) Describe how you could test the water entering the cave to show that it contained sulphate ions.

test .................................................................................................................................................. result .................................................................................................................................................. [2]

(iii) How could you show that the water entering the cave has a high concentration of hydrogen ions?

.................................................................................................................................................. [1]

(b) Hydrogen sulphide gas which was escaping from nearby petroleum deposits was being oxidised to sulphuric acid.

(i) Complete the equation for this reaction forming sulphuric acid.

\[
\text{H}_2\text{S} + \text{..........................} \rightarrow \text{SO}_2 \quad [2]
\]

(ii) Explain why all the hydrogen sulphide should be removed from the petroleum before it is used as a fuel.

.................................................................................................................................................. [1]


2 Sulphur is used to make sulphuric acid. In the UK, the annual production of the acid is about 2.5 million tonnes.

(a) The reactions in the manufacture of sulphuric acid by the Contact Process are shown below.

\[
\begin{align*}
\text{Sulphur} & \quad \text{S} & \quad \text{Sulphur dioxide} & \quad \text{SO}_2 \\
\text{reaction 1} & \quad 2\text{SO}_2 & \quad \text{Sulphur trioxide} & \quad 2\text{SO}_3 \\
\text{Sulphur dioxide + oxygen} & \quad 2\text{SO}_2 + \text{O}_2 & \quad \text{reaction 2} & \quad 2\text{SO}_3
\end{align*}
\]
Topic Chem 12 Q# 12/ iGCSE Chemistry/2003/w/Paper 3/

5 Sulphur dioxide, SO₂, and sulphur trioxide, SO₃, are the two oxides of sulphur.

(a) Sulphur dioxide can kill bacteria and has bleaching properties. Give a use of sulphur dioxide that depends on each of these properties.

(i) ability to kill bacteria .................................................................[1]
(ii) bleaching properties ...............................................................[1]

(b) Sulphur trioxide can be made from sulphur dioxide.

(i) Why is this reaction important industrially?
.....................................................................................................................[1]
(ii) Complete the word equation.

\[ \text{sulphur dioxide} + \text{.................................} \rightarrow \text{sulphur trioxide} \quad [1] \]

(iii) What are the conditions for this reaction?

..........................................................................................................................................[2]

1 (a) Sulphuric acid is made by the Contact Process.

\[ 2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g) \quad \text{forward reaction is exothermic} \]

(i) What are the reaction conditions for the Contact Process?

..........................................................................................................................................[3]

(ii) Would the yield of sulphur trioxide increase, decrease or stay the same when the temperature is increased? Explain your answer.

..........................................................................................................................................[2]

(iii) Describe how sulphur trioxide is changed into concentrated sulphuric acid.

..........................................................................................................................................[2]

5 (a) In the USA, sulphur is obtained from underground deposits. It burns to form sulphur dioxide. This is used in paper making, to preserve food and in the manufacture of sulphuric acid.

(i) Why is sulphur dioxide needed in paper making?

..........................................................................................................................................[1]

(ii) How does sulphur dioxide preserve food?

..........................................................................................................................................[1]
Sulfuric acid is made by the Contact process.

(a) Sulfur is burned by spraying droplets of molten sulfur into air.

Suggest and explain an advantage of using this method.

(b) The following equation represents the equilibrium in the Contact process.

\[ 2\text{SO}_3(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) \]

Oxygen is supplied from the air.
The composition of the reaction mixture is 1 volume of sulfur dioxide to 1 volume of oxygen.

What volume of air contains 1 dm$^3$ of oxygen?

(c) Sulfur dioxide is more expensive than air.

What is the advantage of using an excess of air?

(d) The forward reaction is exothermic. The reaction is usually carried out at a temperature between 400 and 450 °C.

(i) What is the effect on the position of equilibrium of using a temperature above 450 °C? Explain your answer.

(ii) What is the effect on the rate of using a temperature below 400 °C? Explain your answer.
(e) A low pressure, 2 atmospheres, is used. At equilibrium, about 98% SO₃ is present.

(i) What is the effect on the position of equilibrium of using a higher pressure?

(ii) Explain why a higher pressure is not used.

(f) Name the catalyst used in the Contact process.

(g) Describe how concentrated sulfuric acid is made from sulfur trioxide.

(ii) Fish live in water which is neutral (neither acidic nor alkaline). Acid rain decreases the pH of water in lakes and rivers. Both of the bases, calcium oxide and calcium carbonate, can neutralise this acid and increase the pH. Explain why calcium carbonate is a better choice.

5 Reactive metals tend to have unreactive compounds. The following is part of the reactivity series.

\[
\text{sodium} \quad \text{calcium} \quad \text{zinc} \quad \text{copper} \quad \text{silver} \quad \text{most reactive} \quad \text{least reactive}
\]

(a) Sodium hydroxide and sodium carbonate do not decompose when heated. The corresponding calcium compounds do decompose when heated. Complete the following equations.

\[
\text{calcium carbonate} \rightarrow \text{________________} + \text{________________}
\]

\[
\text{Ca(OH)}_2 \rightarrow \text{________} + \text{________}
\]
(c) Calcium carbonate is used to control soil acidity.

(i) Why is it important to control soil acidity?

.................................................................................................................. [1]

(ii) Both calcium carbonate, insoluble in water, and calcium oxide, slightly soluble, are used to increase soil pH. Suggest two advantages of using calcium carbonate.

.................................................................................................................. [2]

(iii) Give one use of calcium carbonate other than for making calcium oxide and controlling soil pH.

.................................................................................................................. [1]

Topic Chem 13 Q# 19/ iGCSE Chemistry/2006/w/Paper 3/

3 Calcium carbonate is an important raw material.

(a) Name a rock which is made up of calcium carbonate.

.................................................................................................................. [1]

Mark Scheme iG Chem 12 13 EQ P3 15w to 01w 100marks

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/
3 (a) Any two from:
bleach/making wood pulp/making paper
food/fruit juice/wine preservative
fumigant/sterilising/insecticide [2]

(b) heating/roasting/burning (zinc sulfides)
in air/oxygen COND on M1 [1]

(c) (i) $V_2O_5$ [1]

(ii) position of equilibrium shifts right/yield increases to save energy [1]

(iii) faster reaction/rate
more collisions per second/higher collision frequency [1]
fewer moles/molecules (of gas) on right [1]
(so) position of equilibrium shifts right/yield increases [1]

(d) (the reaction is) too violent/too exothermic or produces mist/fumes (of acid) [1]

Q# 2/ iGCSE Chemistry/2013/w/Paper 31/ Q6
Q# 3/  iGCSE Chemistry/2011/s/Paper 31/ Q4

(b) (i) anhydrous cobalt chloride becomes hydrated
    ACCEPT: hydrous [1]

(ii) carbon dioxide is acidic
    sodium hydroxide and calcium oxide are bases / alkalis [1]

(iii) Any two of:
    water, calcium carbonate and sodium carbonate
    ACCEPT: sodium bicarbonate [2]

Q# 4/  iGCSE Chemistry/2009/w/Paper 3/

6 (a) (i) burn sulfur in air or oxygen
    or heat a metal sulfide in air [1]

(ii) bleach for wood pulp/cloth/straw or preserve food or sterilising
    or making wine or fumigant or refrigerant
    Accept making paper [1]

(iii) vanadium(V) oxide accept vanadium oxide or V₂O₅
     or vanadium pentoxide
     oxidation state not essential but if given it has to be (V) [1]

(iv) rate too slow or rate not economic [1]

(v) reaction too violent or forms a mist [1]

Q# 5/  iGCSE Chemistry/2008/s/Paper 31/ QiGCSE Chemistry/201

(g) vanadium

ACCEPT name or symbol

Q# 6/  iGCSE Chemistry/2007/w/Paper 3/

4 (a) (i) bleach for wood pulp or preserving food or sterilising
    or in wine making or as a refrigerant or in metallurgy or
    (liquid) sulphur dioxide is used in the petroleum industry
    or kill microbes/etc or insecticide [1]

(ii) (react with) oxygen or air
    NOT burnt/burn in air/oxygen
    450°C
    vanadium oxide catalyst (if oxidation state given has to be correct) or platinum
    If four conditions are given which include high pressure then MAX [2]
    High pressure is incorrect MAX 10 atm. [1]

(iii) ammonium sulphate or superphosphate
     or potassium sulphate or magnesium sulphate [1]
(iii) Low enough for good yield
    High enough for (economic) rate
    Any similar explanation will be awarded the mark
    NOT just that it is the optimum temperature

(iv) bubble into (conc) sulphuric acid
    add water
    NOT consequentail

Q# 8/  iGCSE Chemistry/2006/s/Paper 3/
5  (a) (i) Burn sulphur in air (or oxygen)
    (ii) as a bleach
    (iii) kill bacteria/micro-organisms
         NOT prevents food going bad or rotten or decaying
(b) (i) decrease
    (ii) exothermic
         COND increase temperature favours back reaction so it is
         endothermic, so forward reaction must be exothermic
         OR any similar explanation will be awarded the mark, for example
         The forward reaction is not favoured by an increase in temperature
         so it is exothermic (rather than endothermic)

(ii) COND Low enough for good yield
     High enough for (economic) rate
     Any similar explanation will be awarded the mark
     NOT just that it is the optimum temperature

Q# 9/  iGCSE Chemistry/2005/s/Paper 3/
(c) (i) vanadium oxide or vanadium(V) oxide or vanadium pentoxide or V₂O₅
       Must be correct oxidation state if one given
    (ii) 400 to 500°C
    (iii) add to (concentrated) sulphuric acid NOT dilute
         COND (upon sulphuric acid) above then add water

Q# 10/  iGCSE Chemistry/2005/s/Paper 3/
4  (a) (i) correct word equation (carbon dioxide and water)
     Accept correct symbol equation
     (ii) Must have a correct reagent otherwise wc = 0
          add (acidified) barium chloride(aq) or nitrate or add barium ions
          COND white precipitate
          NOT lead(II) compounds
     (iii) low pH or universal indicator turns red(aq)
          pH 3 or less
(b) (i) H₂S + 2O₂ = H₂SO₄
       unbalanced [1]
(ii) unpleasant smell or it is poisonous or when burnt forms acid rain or forms sulphur dioxide or forms sulphuric acid [1]

NOT it is a pollutant

(iii) 2H to 1S
COND 8e around sulphur atom
2e per hydrogen atom
THREE correct
TWO from above [1]
Ionic structure = [0]

Q# 11/ iGCSE Chemistry/2004/s/Paper 3/

2. (a) (i) USA or Texas or Poland or Mexico or Japan or Ethiopia [1]
accept other sources of sulphur eg petroleum
or natural gas or metal sulphides or volcanoes
NOT coal, NOT underground [1]

(ii) Preserving food or bleaching or sterilising or
disinfecting or making paper or bleaching wood pulp
or wine or jam or fumigation or making paper
NOT making wood pulp [1]

(iii) burnt roast in oxygen or air [1]

(iv) vanadium(V) oxide or vanadium oxide or platinum
ignore oxidation state of vanadium [1]

(v) Increase temperature (increases rate) but reduces yield
Catalyst only increases rate or a catalyst does not influence position of equilibrium
NOT a definition of a catalyst [1]

(vi) sulphur trioxide + sulphuric acid = oleum
Correct symbol equation acceptable [1]

(vii) H₂SO₄ + H₂O = 2H₂SO₄ [1]

Q# 12/ iGCSE Chemistry/2003/w/Paper 3/

5 (a) (i) preserve food or sterilising [1]
(ii) making paper [1]

(b) (i) making sulphuric acid or Contact Process [1]
(ii) oxygen [1]
(iii) vanadium oxide as catalyst (ignore oxidation state)
400 to 500 °C
Pressure less than 10 atm
Any TWO [2]

Q# 13/ iGCSE Chemistry/2002/w/Paper 3/

1 (a) (i) vanadium(V) oxide as catalyst - ignore oxidation state
and accept no oxidation state
Temperature 300 to 600 °C
Pressure up to 10 atmos, accept atmospheric pressure
Volume ratio of gases either 2:1 or slight excess of oxygen
Any three [3]

(ii) decrease [1]
COND back reaction is endothermic or same argument based on
Forward reaction is exothermic [1]
or increase in temp favours back reaction [1]

(iii) dissolve in (conc) sulphuric acid NOT dilute [1]
Add water or dilute [1]
Q# 14/ iGCSE Chemistry/2001/w/Paper 3/Q4

5 (a) (i) bleach
(ii) kills bacteria or germs or micro organisms

Q# 15/ iGCSE Chemistry/2015/w/Paper 31/

<table>
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<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
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<tr>
<td>3(a)</td>
<td>last(en) reaction; large(r) surface area</td>
<td>1</td>
</tr>
<tr>
<td>3(b)</td>
<td>4.76(εm²)²</td>
<td>1</td>
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<tr>
<td>3(c)</td>
<td>moves equilibrium to right; increase yield (of sulfur trioxide)/uses up more sulfur dioxide</td>
<td>1</td>
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<tr>
<td>3(d)(i)</td>
<td>moves equilibrium to left; (forward reaction) exothermic</td>
<td>1</td>
</tr>
<tr>
<td>3(d)(ii)</td>
<td>decrease rate; molecules have less energy/move slower; fewer collisions (per second)/fewer particles have the activation energy / fewer collisions have the activation energy</td>
<td>1</td>
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<tr>
<td>3(e)(i)</td>
<td>moves to right</td>
<td>1</td>
</tr>
<tr>
<td>3(e)(ii)</td>
<td>high yield at 12 atm</td>
<td>1</td>
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<tr>
<td>3(f)</td>
<td>vanadium(V) oxide/vanadium pentoxide;</td>
<td>1</td>
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<tr>
<td>3(g)</td>
<td>M₁ dissolve/react sulfur trioxide in (concentrated) sulfuric acid; add water to product of M₁;</td>
<td>1</td>
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Q# 16/ iGCSE Chemistry/2012/s/Paper 31/ QiGCSE Chemistry/201(c)

(ii) calcium oxide is soluble in water / reacts with water to form calcium hydroxide;
     pH above 7 / the water becomes alkaline;
     OR
     calcium carbonate insoluble in water;
     pH cannot be above 7 / water is neutral / does not make water alkaline;  [max 2]

Q# 17/ iGCSE Chemistry/2012/s/Paper 31/

5 (a) calcium carbonate → calcium oxide + carbon dioxide
   accept: correct symbol equation
   Ca(OH)₂ → CaO + H₂O

Q# 18/ iGCSE Chemistry/2006/w/Paper 3/Q3

(c) (i) Any reasonable explanation
     Plants prefer soil pH about 7
     Plants do not grow (well) in acidic soils/plants grow better
     To increase crop yields
     Any ONE
     Do NOT accept in acidic soils plants die

(ii) With calcium carbonate, pH cannot go above 7
     It is not washed away by the rain/remains longer in the soil
     It is not absorbed by the plant
     OR
     With calcium oxide, pH can go above 7
     It is washed away by the rain

(iii) Any correct use - making steel/furn, making cement, making glass,
      disposing of acid wastes, removing sulphur dioxide from flue gases, (stone in) building, indigestion tablets, toothpaste, cosmetics etc

Q# 19/ iGCSE Chemistry/2006/w/Paper 3/

3 (a) limestone or marble or chalk or coral or calcite or aragonite

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12 Sulfur

12.1 Sulfur

Core
- Name some sources of sulfur
- Name the use of sulfur in the manufacture of sulfuric acid
- State the uses of sulfur dioxide as a bleach in the manufacture of wood pulp for paper and as a food preservative (by killing bacteria)

Supplement
- Describe the manufacture of sulfuric acid by the Contact process, including essential conditions and reactions
- Describe the properties and uses of dilute and concentrated sulfuric acid

13 Carbonates

13.1 Carbonates

Core
- Describe the manufacture of lime (calcium oxide) from calcium carbonate (limestone) in terms of thermal decomposition
- Name some uses of lime and slaked lime such as in treating acidic soil and neutralising acidic industrial waste products, e.g. flue gas desulphurisation
- Name the uses of calcium carbonate in the manufacture of iron and cement

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**0620 PAPER 4 (pre2016 called Paper 3)**

Percentage of all marks awarded for each topic from s2013 to w2015 (red cross) and for 2016m to 2017w (green triangle)

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Topic Chem 12 Q# 1/ iGCSE Chemistry/2014/w/Paper 31/
3  The main use of sulfur dioxide is the manufacture of sulfuric acid.

(a) State two other uses of sulfur dioxide.

........................................................................................................................................................................ [2]

(b) One source of sulfur dioxide is burning sulfur in air. Describe how sulfur dioxide can be made from the ore zinc sulfide.

........................................................................................................................................................................ [2]

(c) The Contact process changes sulfur dioxide into sulfur trioxide.

\[2\text{SO}_2(g) + 1/2\text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)\]

the forward reaction is exothermic

- temperature 400 to 450 °C
- low pressure 1 to 10 atmospheres
- catalyst vanadium(V) oxide

(i) What is the formula of vanadium(V) oxide?

........................................................................................................................................................................ [1]

(ii) Vanadium(V) oxide is an efficient catalyst at any temperature in the range 400 to 450 °C. Scientists are looking for an alternative catalyst which is efficient at 300 °C. What would be the advantage of using a lower temperature?

........................................................................................................................................................................ [2]

(iii) The process does not use a high pressure because of the extra expense. Suggest two advantages of using a high pressure? Explain your suggestions.

........................................................................................................................................................................ [4]

(d) Sulfuric acid is made by dissolving sulfur trioxide in concentrated sulfuric acid to form oleum. Water is reacted with oleum to form more sulfuric acid. Why is sulfur trioxide not reacted directly with water?

........................................................................................................................................................................ [1]
Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.

Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink. Suggest a reason.

Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

Name two substances formed when soda lime reacts with carbon dioxide.

Sulfur dioxide is used to make sulfur trioxide in the Contact Process.

$$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$$

The forward reaction is exothermic. The conditions used are:

- Temperature: 450°C
- Pressure: 2 atmospheres
- Catalyst: Vanadium(V) oxide

Explain, mentioning both position of equilibrium and rate, why these conditions give the most economic yield.
6. (a) Sulfuric acid is made by the Contact process.

\[ 2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3 \]

This is carried out in the presence of a catalyst at 450°C and 2 atmospheres pressure.

(i) How is the sulfur dioxide made?

(ii) Give another use of sulfur dioxide.

(iii) Name the catalyst used.

(iv) If the temperature is decreased to 300°C, the yield of sulfur trioxide increases. Explain why this lower temperature is not used.

(v) Sulfur trioxide is dissolved in concentrated sulfuric acid. This is added to water to make more sulfuric acid. Why is sulfur trioxide not added directly to water?

1. For each of the following select an element from Period 4, potassium to krypton, that matches the description.

(g) One of its oxides is the catalyst in the Contact Process.
4 Zinc is extracted from zinc blende, ZnS.

(a) Zinc blende is heated in air to give zinc oxide and sulphur dioxide. Most of the sulphur dioxide is used to make sulphur trioxide. This is used to manufacture sulphuric acid. Some of the acid is used in the plant, but most of it is used to make fertilisers.

(i) Give another use of sulphur dioxide. .......................................................... [1]

(ii) Describe how sulphur dioxide is converted into sulphur trioxide. .......................................................... [3]

(iii) Name a fertiliser made from sulphuric acid. ......................................................................................... [1]

5 Sulphuric acid is made by the Contact process in the following sequence of reactions.

\[
\text{sulphur} \rightarrow \text{sulphur dioxide} \rightarrow \text{sulphur trioxide} \rightarrow \text{sulphuric acid}
\]

(a) (i) How is sulphur dioxide made from sulphur? .................................................................................. [1]

(ii) Sulphur dioxide has other uses. Why is it used in the manufacture of paper? .............................. [1]

(iii) How does it preserve food? ........................................................................................................... [1]
(b) The equation for a stage of the Contact process is

\[ 2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3 \]

The percentage of sulphur trioxide in the equilibrium mixture varies with temperature.

(i) How does the percentage of sulphur trioxide in the equilibrium mixture vary as the temperature increases? Circle the correct answer.

- increases
- stays the same
- decreases

[1]

(ii) Is the forward reaction in the equilibrium \(2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3\) exothermic or endothermic? Give a reason for your choice.

........................................................................................................................................ [2]

(c) Sulphuric acid is manufactured by the Contact Process. Sulphur dioxide is oxidised to sulphur trioxide by oxygen.

\[ 2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3 \]

(i) Name the catalyst used in this reaction.

........................................................................................................................................ [1]

(ii) What temperature is used for this reaction?

........................................................................................................................................ [1]

(iii) Describe how sulphur trioxide is changed into sulphuric acid.

........................................................................................................................................ [2]
4 The Carlsbad caverns in New Mexico are very large underground caves. Although the walls of these caves are coated with gypsum (hydrated calcium sulphate), the caves have been formed in limestone.

(a) It is believed that the caves were formed by sulphuric acid reacting with the limestone.

(i) Complete the word equation.

\[
\text{calcium carbonate} + \text{sulphuric acid} \rightarrow \text{calcium sulphate} + \text{..................} + \text{..................} \quad [1]
\]

(ii) Describe how you could test the water entering the cave to show that it contained sulphate ions.

\[
\text{test} \quad \text{..........................................................} \quad [2]
\]

result \[.................................\]

(iii) How could you show that the water entering the cave has a high concentration of hydrogen ions?

\[.................................\] [1]

(b) Hydrogen sulphide gas which was escaping from nearby petroleum deposits was being oxidised to sulphuric acid.

(i) Complete the equation for this reaction forming sulphuric acid.

\[
\text{H}_2\text{S} + \text{..................} \rightarrow \text{..................} \quad [2]
\]

(ii) Explain why all the hydrogen sulphide should be removed from the petroleum before it is used as a fuel.

\[.................................\] [1]

Topic Chem 12 Q# 11/ iGCSE Chemistry/2004/s/Paper 3/ 2 Sulphur is used to make sulphuric acid. In the UK, the annual production of the acid is about 2.5 million tonnes.

(a) The reactions in the manufacture of sulphuric acid by the Contact Process are shown below.

\[
\begin{align*}
\text{Sulphur} & \quad \rightarrow & \quad \text{Sulphur dioxide} \\
\text{S} & \quad \text{reaction 1} & \quad \text{SO}_2 \\
\text{Sulphur dioxide} + \text{oxygen} & \quad \rightarrow & \quad \text{Sulphur trioxide} \\
2\text{SO}_2 + \text{O}_2 & \quad \text{reaction 2} & \quad 2\text{SO}_3
\end{align*}
\]
(i) Give a large scale source of the element sulphur.
........................................................................................................................................... [1]

(ii) State another use of sulphur dioxide.
........................................................................................................................................... [1]

(iii) How is sulphur changed into sulphur dioxide?
........................................................................................................................................... [1]

(iv) Name the catalyst used in reaction 2.
........................................................................................................................................... [1]

(v) Reaction 2 is exothermic. Why is a catalyst, rather than a higher temperature, used to increase the rate of this reversible reaction?
.................................................................................................................................................... [2]

(vi) Write a word equation for reaction 3.
........................................................................................................................................... [1]

(vii) Write a symbol equation for reaction 4.
........................................................................................................................................... [1]

5 Sulphur dioxide, SO₂, and sulphur trioxide, SO₃, are the two oxides of sulphur.

(a) Sulphur dioxide can kill bacteria and has bleaching properties. Give a use of sulphur dioxide that depends on each of these properties.

(i) ability to kill bacteria ...........................................................................................................[1]

(ii) bleaching properties ...........................................................................................................[1]

(b) Sulphur trioxide can be made from sulphur dioxide.

(i) Why is this reaction important industrially?
...........................................................................................................................................[1]
(ii) Complete the word equation.

\[ \text{sulphur dioxide} + \text{ } \rightarrow \text{sulphur trioxide} \quad [1] \]

(iii) What are the conditions for this reaction?

.............................................................................................................[2]

1 (a) Sulphuric acid is made by the Contact Process.

\[ 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2\text{SO}_3(\text{g}) \quad \text{forward reaction is exothermic} \]

(i) What are the reaction conditions for the Contact Process?

.............................................................................................................[3]

(ii) Would the yield of sulphur trioxide increase, decrease or stay the same when the temperature is increased? Explain your answer.

.............................................................................................................[2]

(iii) Describe how sulphur trioxide is changed into concentrated sulphuric acid.

.............................................................................................................[2]

5 (a) In the USA, sulphur is obtained from underground deposits. It burns to form sulphur dioxide. This is used in paper making, to preserve food and in the manufacture of sulphuric acid.

(i) Why is sulphur dioxide needed in paper making?

.............................................................................................................[1]

(ii) How does sulphur dioxide preserve food?

.............................................................................................................[1]
Sulfuric acid is made by the Contact process.

(a) Sulfur is burned by spraying droplets of molten sulfur into air.

Suggest and explain an advantage of using this method.

(b) The following equation represents the equilibrium in the Contact process.

\[ 2\text{SO}_3(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_4(g) \]

Oxygen is supplied from the air.
The composition of the reaction mixture is 1 volume of sulfur dioxide to 1 volume of oxygen.

What volume of air contains 1 dm\(^3\) of oxygen?

(c) Sulfur dioxide is more expensive than air.

What is the advantage of using an excess of air?

(d) The forward reaction is exothermic. The reaction is usually carried out at a temperature between 400 and 450 °C.

(i) What is the effect on the position of equilibrium of using a temperature above 450 °C? Explain your answer.

(ii) What is the effect on the rate of using a temperature below 400 °C? Explain your answer.
(e) A low pressure, 2 atmospheres, is used. At equilibrium, about 98% $\text{SO}_3$ is present.

(i) What is the effect on the position of equilibrium of using a higher pressure?

........................................................................................................................................ [1]

(ii) Explain why a higher pressure is not used.

........................................................................................................................................ [1]

(f) Name the catalyst used in the Contact process.

........................................................................................................................................ [1]

(g) Describe how concentrated sulfuric acid is made from sulfur trioxide.

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................ [2]

Topic Chem 13 Q# 16/ iGCSE Chemistry/2012/s/Paper 31/ QiGCSE Chemistry/201(c)

(ii) Fish live in water which is neutral (neither acidic nor alkaline). Acid rain decreases the pH of water in lakes and rivers. Both of the bases, calcium oxide and calcium carbonate, can neutralise this acid and increase the pH. Explain why calcium carbonate is a better choice.

........................................................................................................................................ [2]

Topic Chem 13 Q# 17/ iGCSE Chemistry/2012/s/Paper 31/

5 Reactive metals tend to have unreactive compounds. The following is part of the reactivity series.

\[
\text{sodium} \quad \text{calcium} \quad \text{zinc} \quad \text{copper} \quad \text{silver} \quad \text{most reactive} \\
\text{least reactive}
\]

(a) Sodium hydroxide and sodium carbonate do not decompose when heated. The corresponding calcium compounds do decompose when heated. Complete the following equations.

\[
\text{calcium carbonate} \rightarrow \quad + \quad \\
\text{Ca(OH)}_2 \rightarrow \quad + \quad 
\]

........................................................................................................................................ [2]
(c) Calcium carbonate is used to control soil acidity.

(i) Why is it important to control soil acidity?

........................................................................................................................................... [1]

(ii) Both calcium carbonate, insoluble in water, and calcium oxide, slightly soluble, are used to increase soil pH. Suggest two advantages of using calcium carbonate.

........................................................................................................................................... [2]

(iii) Give one use of calcium carbonate other than for making calcium oxide and controlling soil pH.

........................................................................................................................................... [1]

Topic Chem 13 Q# 19/ iGCSE Chemistry/2006/w/Paper 3/

3 Calcium carbonate is an important raw material.

(a) Name a rock which is made up of calcium carbonate.

........................................................................................................................................... [1]

Mark Scheme iG Chem 12 13 EQ P3 15w to 01w 100marks

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/

3 (a) Any two from:
   bleach/making wood pulp/making paper
   food/fruit juice/wine preservative
   fumigant/sterilising/insecticide [2]

(b) heating/roasting/burning (zinc sulfides)
   in air/oxygen COND on M1 [1]

(c) (i) \( \text{V}_2\text{O}_5 \) [1]

   (ii) position of equilibrium shifts right/yield increases to save energy [1]

   (iii) faster reaction/rate
   more collisions per second/higher collision frequency
   fewer moles/molecules (of gas) on right [1]

   (so) position of equilibrium shifts right/yield increases [1]

(d) (the reaction is) too violent/too exothermic or produces mist/fumes (of acid) [1]
(b) (i) anhydrous cobalt chloride becomes hydrated
    ACCEPT: hydrous

(ii) carbon dioxide is acidic
    sodium hydroxide and calcium oxide are bases / alkalis

(iii) Any two of:
    water, calcium carbonate and sodium carbonate
    ACCEPT: sodium bicarbonate

Q# 3/ iGCSE Chemistry/2011/s/Paper 31/ Q4

(b) for a high yield need low temperature
    then rate would be too slow or uneconomic
    a discussion of optimum temperature could score mark 1 and 2

    presence of catalyst would increase rate (at same temperature)
    does not alter the yield (at that temperature)
    / economic rate at lower temperature, therefore higher yield

    higher pressure which would increase yield / rate
    yield high enough / high pressure expensive

    accept reverse arguments
    note increase yield = position of equilibrium to right

Q# 4/ iGCSE Chemistry/2009/w/Paper 3/

6 (a) (i) burn sulfur in air or oxygen
    or heat a metal sulfide in air

(ii) bleach for wood pulp/cloth/straw or preserve food or sterilising
    or making wine or fumigant or refrigerant
    Accept making paper

(iii) vanadium(V) oxide accept vanadium oxide or V₂O₅
    or vanadium pentoxide
    oxidation state not essential but if given it has to be (V)

(iv) rate too slow or rate not economic

(v) reaction too violent or forms a mist

Q# 5/ iGCSE Chemistry/2008/s/Paper 31/ Q

5 (b) vanadium

ACCEPT name or symbol

Q# 6/ iGCSE Chemistry/2007/w/Paper 3/

4 (a) (i) bleach for wood pulp or preserving food or sterilising
    or in wine making or as a refrigerant or in metallurgy or
    (liquid) sulphur dioxide is used in the petroleum industry
    or kill microbes/etc or insecticide

(ii) (react with) oxygen or air
    NOT burnt/burnt in air/oxygen
    450°C
    vanadium oxide catalyst (if oxidation state given has to be correct) or platinum
    If four conditions are given which include high pressure then MAX [2]
    High pressure is incorrect MAX 10 atm.

(iii) ammonium sulphate or superphosphate
    or potassium sulphate or magnesium sulphate

(iii) Low enough for good yield
    High enough for (economic) rate
    Any similar explanation will be awarded the mark
    NOT just that it is the optimum temperature

(iv) bubble into (conc) sulphuric acid
    add water
    NOT consequential

Q# 8/  iGCSE Chemistry/2006/s/Paper 3/

5 (a) (i) Burn sulphur in air (or oxygen)
    (ii) as a bleach
    (iii) kill bacteria/micro-organisms
         NOT prevents food going bad or rotten or decaying

(b) (i) decrease
    (ii) exothermic
         COND increase temperature favours back reaction so it is
         endothermic, so forward reaction must be exothermic
         OR any similar explanation will be awarded the mark, for example
         The forward reaction is not favoured by an increase in temperature
         so it is exothermic (rather than endothermic)

(iii) Low enough for good yield
    High enough for (economic) rate
    Any similar explanation will be awarded the mark
    NOT just that it is the optimum temperature

Q# 9/  iGCSE Chemistry/2005/s/Paper 3/

(c) (i) vanadium oxide or vanadium(V) oxide or vanadium pentoxide or V₂O₅
       Must be correct oxidation state if one given

(ii) 400 to 500°C

(iii) add to (concentrated) sulphuric acid NOT dilute
     COND (upon sulphuric acid) above then add water

Q# 10/  iGCSE Chemistry/2005/s/Paper 3/

4 (a) (i) correct word equation (carbon dioxide and water)
    Accept correct symbol equation

(ii) Must have a correct reagent otherwise wc = 0
    add (acidified) barium chloride(aq) or nitrate or add barium ions
    COND white precipitate
    NOT lead(II) compounds

(iii) low pH or universal indicator turns red(aq)
     pH 3 or less

(b) (i) H₂S + 2O₂ = H₂SO₄
       unbalanced [1]
Q# 11/ iGCSE Chemistry/2004/s/Paper 3/
2. (a) (i) USA or Texas or Poland or Mexico or Japan or Ethiopia 
Australia or Sicly 
accept other sources of sulphur eg petroleum 
or natural gas or metal sulphides or volcanoes 
NOT coal, NOT underground [1]
(ii) Preserving food or bleaching or sterilising or disinfecting or making paper or bleaching wood pulp or wine or jam or fumigation or making paper 
NOT making wood pulp [1]
(iii) burnt roast in oxygen or air [1]
(iv) vanadium(V) oxide or vanadium oxide or platinum 
ignore oxidation state of vanadium [1]
(v) Increase temperature (increases rate) but reduces yield 
catalyst only increases rate or a catalyst does not 
influence position of equilibrium 
NOT a definition of a catalyst [1]
(vi) sulphur trioxide + sulphuric acid = oleum 
correct symbol equation acceptable [1]
(vii) \( \text{H}_2\text{SO}_3 + \text{H}_2\text{O} = 2\text{H}_2\text{SO}_4 \) [1]

Q# 12/ iGCSE Chemistry/2003/w/Paper 3/
5 (a) (i) preserve food or sterilising [1]
(ii) making paper [1]

(b) (i) making sulphuric acid or Contact Process [1]
(ii) oxygen [1]
(iii) vanadium oxide as catalyst (ignore oxidation state) 
400 to 500 °C 
pressure less than 10 atm 
Any TWO [2]

Q# 13/ iGCSE Chemistry/2002/w/Paper 3/
1 (a) (i) vanadium(V) oxide as catalyst - ignore oxidation state 
and accept no oxidation state 
temperature 300 to 600 °C 
pressure up to 10 atmos, accept atmospheric pressure 
volume ratio of gases either 2:1 or slight excess of oxygen 
ANY three [3]

(ii) decrease [1]
COND back reaction is endothermic or same argument based on 
forward reaction is exothermic [1]
or increase in temp favours back reaction [1]

(iii) dissolve in (conc) sulphuric acid NOT dilute [1]
add water or dilute [1]
Q#14/ iGCSE Chemistry/2001/w/Paper 3/Q4

5 (a) (i) bleach
(ii) kills bacteria or germs or micro organisms

Q#15/ iGCSE Chemistry/2015/w/Paper 31/

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>3(a)</td>
<td>1.14 (cm²)²</td>
</tr>
<tr>
<td>3(b)</td>
<td>4.76 (cm²)²</td>
</tr>
</tbody>
</table>
| 3(c)     | moves equilibrium to right;
           | increases yield (of sulfur trioxide) uses up more sulfur dioxide;
| 3(d)     | moves equilibrium to left;
           | (forward reaction) exothermic;
| 3(e)     | decrease rate;
           | molecules have less energy/move slower;
           | fewer collisions (per second)/fewer particles have the activation energy fewer collisions have the activation energy;
| 3(f)     | moves to right;
| 3(g)     | high yield at 12 atm; |
| 3(h)     | vanadium(V) oxide/vanadium pentoxide; |
| 3(i)     | insoluble/react sulfur trioxide in (concentrated) sulfuric acid;
           | add water to product of M₁; |

Q#16/ iGCSE Chemistry/2012/s/Paper 31/ QiGCSE Chemistry/201(c)

(ii) calcium oxide is soluble in water / reacts with water to form calcium hydroxide;
     pH above 7 / the water becomes alkalinene;
     OR
     calcium carbonate insoluble in water;
     pH cannot be above 7 / water is neutral / does not make water alkalinene;

Q#17/ iGCSE Chemistry/2012/s/Paper 31/

5 (a) calcium carbonate → calcium oxide + carbon dioxide
accept: correct symbol equation
Ca(OH)₂ → CaO + H₂O

Q#18/ iGCSE Chemistry/2006/w/Paper 3/Q3

(c) (i) Any reasonable explanation
     Plants prefer soil pH about 7
     Plants do not grow (well) in acidic soils/plants grow better
     To increase crop yields
     Any ONE
     Do NOT accept in acidic soils plants die

(ii) With calcium carbonate, pH cannot go above 7
     It is not washed away by the rain/remains longer in the soil
     It is not absorbed by the plant
     OR
     With calcium oxide, pH can go above 7
     It is washed away by the rain

(iii) Any correct use - making steel/iron, making cement, making glass,
     disposing of acid wastes, removing sulphur dioxide from flue
     gases, (stone in) building, indigestion tablets, toothpaste, cosmetics etc

Q#19/ iGCSE Chemistry/2006/w/Paper 3/

3 (a) limestone or marble or chalk or coral or calcite or aragonite
### 14. Organic Chemistry

#### 14.1 Names of compounds

**Core**
- Name and draw the structures of methane, ethane, ethene, ethanol, ethanoic acid and the products of the reactions stated in sections 14.4–14.6.
- State the type of compound present, given a chemical name ending in -ane, -ene, -ol, or -oic acid or a molecular structure.

**Supplement**
- Name and draw the structures of the unbranched alkanes, alkenes (not cis-trans), alcohols and acids containing up to four carbon atoms per molecule.
- Name and draw the structural formulae of the esters which can be made from unbranched alcohols and carboxylic acids, each containing up to four carbon atoms.

---

**PAPER 4 Topic 14 (Organic) (pre2016 called Paper 3)**

Percentage of all marks awarded for each subtopic from s2001 to w2015 green triangle)

<table>
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<th>SUBTOPIC</th>
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</tr>
</thead>
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<td>16.8</td>
</tr>
<tr>
<td>14.4 5 Alkanes and alkenes</td>
<td>21.0</td>
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<tr>
<td>14.6 Alcohols</td>
<td>6.4</td>
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<tr>
<td>14.7 Carboxylic acids &amp; esters</td>
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<td>14.82 Synthetic polymers</td>
<td>22.9</td>
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<tr>
<td>14.83 Natural polymers</td>
<td>14.3</td>
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**Percentage of all marks awarded for each subtopic from s2001 to w2015 green triangle**

- **P3 2001-15**: 16.8, 21.0, 6.4, 18.5, 22.9, 14.3
### 14.4 Alkanes

**Core**
- Describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning
- Describe the bonding in alkanes

**Supplement**
- Describe substitution reactions of alkanes with chlorine

### 14.5 Alkenes

**Core**
- Describe the manufacture of alkenes and of hydrogen by cracking
- Distinguish between saturated and unsaturated hydrocarbons:
  - from molecular structures
  - by reaction with aqueous bromine
- Describe the formation of poly(ethene) as an example of addition polymerisation of monomer units

**Supplement**
- Describe the properties of alkenes in terms of addition reactions with bromine, hydrogen and steam

### 14.6 Alcohols

**Core**
- Describe the manufacture of ethanol by fermentation and by the catalytic addition of steam to ethene
- Describe the properties of ethanol in terms of burning
- Name the uses of ethanol as a solvent and as a fuel

**Supplement**
- Outline the advantages and disadvantages of these two methods of manufacturing ethanol

### 14.7 Carboxylic acids

**Core**
- Describe the properties of aqueous ethanoic acid

**Supplement**
- Describe the formation of ethanoic acid by the oxidation of ethanol by fermentation and with acidified potassium manganate(VII)
- Describe ethanoic acid as a typical weak acid
- Describe the reaction of a carboxylic acid with an alcohol in the presence of a catalyst to give an ester
14.8 Polymers

14.8.1 Polymers

Core
- Define polymers as large molecules built up from small units (monomers)

Supplement
- Understand that different polymers have different units and/or different linkages

14.8.2 Synthetic polymers

Core
- Name some typical uses of plastics and of man-made fibres such as nylon and Terylene
- Describe the pollution problems caused by non-biodegradable plastics

Supplement
- Explain the differences between condensation and addition polymerisation
- Deduce the structure of the polymer product from a given alkene and vice versa
- Describe the formation of nylon (a polyamide) and Terylene (a polyester) by condensation polymerisation, the structure of nylon being represented as:

```
   \( \text{H} - \text{C} - \text{N} - \text{H} - \text{C} - \text{N} - \text{H} - \text{C} - \text{N} - \text{H} \)
```

and the structure of Terylene as:

```
   \( \text{H} - \text{C} - \text{O} - \text{C} - \text{O} - \text{C} - \text{O} \)
```

(Details of manufacture and mechanisms of these polymerisations are not required.)
14.8.3 Natural polymers

Core

- Name proteins and carbohydrates as constituents of food
- Describe the structure of proteins as:
  \[
  \begin{align*}
  &\text{H} \quad \text{N} \quad \text{C} \quad \text{O} \\
  &\text{H} \quad \text{N} \quad \text{C} \quad \text{O}
  \end{align*}
  \]
- Describe the hydrolysis of proteins to amino acids. (Structures and names are not required.)
- Describe complex carbohydrates in terms of a large number of sugar units, considered as \(\text{HO}--\text{OH}\), joined together by condensation polymerisation, e.g.
  \[
  \begin{align*}
  &\text{O} \quad \text{O} \quad \text{O} \quad \text{O} \\
  &\text{O} \quad \text{O} \quad \text{O} \quad \text{O}
  \end{align*}
  \]
- Describe the hydrolysis of complex carbohydrates (e.g. starch), by acids or enzymes to give simple sugars
- Describe the fermentation of simple sugars to produce ethanol (and carbon dioxide). (Candidates will not be expected to give the molecular formulae of sugars.)
- Describe, in outline, the usefulness of chromatography in separating and identifying the products of hydrolysis of carbohydrates and proteins

Supplement

- Describe proteins as possessing the same (amide) linkages as nylon but with different units

**Topic Chem 14 SubTopic: Carboxylic acids & Esters Q# 1 iGCSE Chemistry/2009/w/Paper 3/Q7b**

(ii) Write a word equation for the preparation of the ester butyl methanoate.

................................................................................................................................. [2]

**Topic Chem 14 SubTopic: Carboxylic acids & Esters Q# 2 iGCSE Chemistry/2010/s/Paper 31/**

4 Hydrolysis is used in chemistry to break down complex molecules into simpler ones.

(a) Compounds containing the group \(\text{C}--\text{O}\) or \(\text{--COO}\) are esters.
(i) Give the names and formulae of the two compounds formed when the ester ethyl propanoate is hydrolysed.

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{C} & \text{O} \\
\text{O} & \text{CH}_2\text{CH}_3
\end{align*}
\]

name .......................................................... name ..........................................................

formula .......................................................... formula ..........................................................

[4]

(iii) Name a synthetic polyester.

................................................................................................................................................ [1]

Topic Chem 14 SubTopic: Carboxylic acids & Esters Q# 3/ iGCSE Chemistry/2010/s/Paper 31/ 8 Methanoic acid is the first member of the homologous series of carboxylic acids.

(b) In some areas when water is boiled, the inside of kettles become coated with a layer of calcium carbonate. This can be removed by adding methanoic acid.

(i) Complete the equation.

.......... HCOOH + CaCO\(_3\) \rightarrow Ca(HCOO)\(_2\) + .......... + ............

[2]

(ii) Methanoic acid reacts with most metals above hydrogen in the reactivity series. Complete the word equation.

Zinc + methanoic acid \rightarrow .............................................. + ..............................................

[2]

Topic Chem 14 SubTopic: Carboxylic acids & Esters Q# 4/ iGCSE Chemistry/2011/s/Paper 31/ Q6 (a)

(ii) Explain, in general terms, what is meant by fermentation.

................................................................................................................................................

................................................................................................................................................

................................................................................................................................................

................................................................................................................................................

................................................................................................................................................

................................................................................................................................................ [3]
(b) Butanol can be oxidised to a carboxylic acid by heating with acidified potassium manganate(VII). Give the name and structural formula of the carboxylic acid.

name ............................................................................................................................................... [1]

structural formula

[1]

(c) Butanol reacts with ethanoic acid to form a liquid, X, which has the sweet smell of bananas. Its empirical formula is C₃H₆O and its Mᵣ is 116.

(i) What type of compound is liquid X?

............................................................................................................................................... [1]

(ii) Give the molecular formula of liquid X.

............................................................................................................................................... [1]

(iii) Draw the structural formula of X. Show all the individual bonds.

[2]

Topic Chem 14 SubTopic: Carboxylic acids & Esters Q# 5/ iGCSE Chemistry/2012/s/Paper 31/

6 Butane is an alkane. It has the following structural formula.

```
H   H   H   H
\ H---C---C---C---H
\ H   H   H
```

H     H     H     H
(c) One of the chlorobutanes reacts with sodium hydroxide to form butan-1-ol. Butan-1-ol can be oxidised to a carboxylic acid.

(i) State a reagent, other than oxygen, which will oxidise butan-1-ol to a carboxylic acid.  

.............................................................................................................................................. [1]

(ii) Name the carboxylic acid formed. 

.............................................................................................................................................. [1]

(iii) Butan-1-ol reacts with ethanoic acid to form an ester. Name this ester and give its structural formula showing all the individual bonds.

name .............................................................................................................................................. [1]

structural formula


Topic Chem 14 SubTopic: Carboxylic acids & Esters Q# 6/ IGCSE Chemistry/2014/w/Paper 31/ 

6 Esters, polyesters and fats all contain the ester linkage.

(a) Esters can be made from alcohols and carboxylic acids. For example, the ester ethyl ethanoate can be made by the following reaction.

\[ \text{CH}_3\text{COOH} + \text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O} \]

(i) Name the carboxylic acid and the alcohol from which the following ester could be made.

\[
\begin{array}{c}
\text{CH}_3\text{CH} = \text{CH} - \text{CH}_2 - \text{C}^\\text{O} \\
\text{O} \text{--CH}_3 \\
\end{array}
\]

name of carboxylic acid ........................................................................................................................ [2]

name of alcohol ................................................................................................................................. [2]
(ii) 6.0 g of ethanoic acid, \( M_r = 60 \), was reacted with 5.5 g of ethanol, \( M_r = 46 \). Determine which is the limiting reagent and the maximum yield of ethyl ethanoate, \( M_r = 88 \).

number of moles of ethanoic acid = .......................................................... [1]

number of moles of ethanol = ................................................................. [1]

the limiting reagent is ................................................................. [1]

number of moles of ethyl ethanoate formed = ........................................... [1]

maximum yield of ethyl ethanoate = .................................................. [1]

(c) This question is based on typical reactions of butan-1-ol.

(ii) Suggest the name of the ester formed from butanol and ethanoic acid.

................................................................................................................. [1]

(iii) Butan-1-ol is oxidised by acidified potassium manganate(VII).

Deduce the name and the structural formula of the organic product in this reaction.

name ...........................................................

structural formula

Q5 Compound X has/ the molecular formula of \( C_4H_6O_2 \)

(b) (i) Bromine water changes from brown to colourless when added to X.

What does this tell you about the structure of X?

.................................................................................................................. [1]

(ii) Magnesium powder reacts with an aqueous solution of X. Hydrogen is evolved.

What does this tell you about the structure of X?

.................................................................................................................. [1]

(iii) X contains two different functional groups.

Draw a structural formula of X.
(c) When lactic acid is heated, acrylic acid is formed.

\[
\begin{align*}
\text{lactic acid} & \quad \text{acrylic acid} \\
\text{H} & \quad \text{H} \\
\text{C} & \quad \text{C} \\
\text{C} & \quad \text{COOH} \\
\text{H} & \quad \text{H} \\
\text{OH} & \quad \text{COOH}
\end{align*}
\]

(i) Complete the word equation for the action of heat on lactic acid.

\[
\text{lactic acid} \rightarrow \text{........................................} + \text{........................................} \quad [1]
\]

(ii) Describe a test that would distinguish between lactic acid and acrylic acid.

\[
\begin{align*}
\text{test} & \\
\text{result for lactic acid} & \\
\text{result for acrylic acid} & \quad [3]
\end{align*}
\]

Butan-1-ol is used as a solvent for paints and varnishes, to make esters and as a fuel. Butan-1-ol can be manufactured from but-1-ene, which is made from petroleum.

Biobutanol is a fuel of the future. It can be made by the fermentation of almost any form of biomass - grain, straw, leaves etc.

(a) But-1-ene can be obtained from alkanes such as decane, C\textsubscript{10}H\textsubscript{22}, by cracking.

(i) Give the reaction conditions.

\[
\begin{align*}
\text{..........................................................} & \quad [2]
\end{align*}
\]

(ii) Complete an equation for the cracking of decane, C\textsubscript{10}H\textsubscript{22}, to give but-1-ene.

\[
\text{C}_{10}\text{H}_{22} \rightarrow \text{..........................................................} \quad [2]
\]

(iii) Name the reagent that reacts with but-1-ene to form butan-1-ol.

\[
\begin{align*}
\text{..........................................................} & \quad [1]
\end{align*}
\]

Ozone is a form of oxygen. Ozone is present in the upper atmosphere and it prevents dangerous solar radiation from reaching the Earth's surface. Some of the chemicals that diffuse into the upper atmosphere decompose ozone. Chemicals that have this effect are methane (CH\textsubscript{4}), chloromethane (CH\textsubscript{3}Cl) and an oxide of nitrogen (NO\textsubscript{2}).

(iii) How can chloromethane be made from methane?

\[
\begin{align*}
\text{reagent} & \\
\text{condition} & \quad [2]
\end{align*}
\]
(b) An important monomer is chloroethene which has the structural formula shown below.

\[
\begin{array}{c}
\text{H} \\
\text{C} = \text{C} \\
\text{H} \\
\text{Cl}
\end{array}
\]

It is made by the following method.

\[
\text{C}_2\text{H}_4 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4\text{Cl}_2 \quad \text{dichloroethane}
\]

This is heated to make chloroethene.

\[
\text{C}_2\text{H}_4\text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl}
\]

(i) Ethene is made by cracking alkanes. Complete the equation for cracking dodecane.

\[
\text{C}_{12}\text{H}_{20} \rightarrow \text{...............} + 2\text{C}_2\text{H}_4
\]

[1]

Another method of making dichloroethene is from ethane.

\[
\text{C}_3\text{H}_8 + 2\text{Cl}_2 \rightarrow \text{C}_2\text{H}_4\text{Cl}_2 + 2\text{HCl}
\]

(ii) Suggest a reason why the method using ethene is preferred.

.........................................................................................................................
......................................................................................................................... [1]

6 The structural formula of a butanol is given below.

\[
\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—CH}_2\text{—OH}
\]

(a) Butanol can be made from petroleum and also by fermentation.

(i) Describe the chemistry of making butanol from petroleum by the following route.

\[\text{petroleum} \rightarrow \text{butene} \rightarrow \text{butanol}\]

.........................................................................................................................
......................................................................................................................... [3]
6 Butane is an alkane. It has the following structural formula.

\[
\begin{align*}
&H \quad H \quad H \quad H \\
&H \quad C \quad C \quad C \quad H \\
&H \quad H \quad H \quad H
\end{align*}
\]

(b) Butane reacts with chlorine to form two isomers of chlorobutane.

(i) What type of reaction is this? 

.......................................................................................................................... [1]

(ii) Explain the term *isomer*.

.......................................................................................................................... [2]

(iii) Draw the structural formulae of these two chlorobutanes.

(c) Butter contains mainly saturated fats. Fats based on vegetable oils, such as olive oil, contain mainly unsaturated fats.

A small amount of fat was dissolved in an organic solvent. Describe how you could determine if the fat was saturated or unsaturated.

..........................................................................................................................

.......................................................................................................................... [3]
Topic Chem 14 SubTopic: Alkanes and alkenes Q# 16/ iGCSE Chemistry/2013/s/Paper 31/Q3

(e) Describe a test which would distinguish between cyclohexane and the unsaturated hydrocarbon hexene.

result of test with cyclohexane .......................................................................................................................................................................................... [3]

result of test with hexene ........................................................................................................................................................................................................................................ [3]

Topic Chem 14 SubTopic: Alkanes and alkenes Q# 17/ iGCSE Chemistry/2013/w/Paper 31/

7 (a) The following are two examples of substitution reactions. Only the reaction involving chlorine is a photochemical reaction.

\[ \text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl} \]

\[ \text{CH}_4 + \text{Br}_2 \rightarrow \text{CH}_3\text{Br} + \text{HBr} \]

(i) Explain the phrase substitution reaction.

......................................................................................................................................................................................................................................................... [1]

(ii) How do photochemical reactions differ from other reactions?

......................................................................................................................................................................................................................................................... [1]

Topic Chem 14 SubTopic: Alkanes and alkenes Q# 18/ iGCSE Chemistry/2013/w/Paper 31/

5 The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have the same chemical properties. They undergo addition reactions and are easily oxidised.

(b) Give the structural formula and name of each of the products of the following addition reactions.

(i) ethene and bromine

structural formula of product

name of product ................................................................................................................................................................................................. [2]

(ii) propene and hydrogen

structural formula of product

name of product ................................................................................................................................................................................................. [2]
(iii) but-1-ene and water

structural formula of product

name of product ................................................................. [2]

(c) Alkenes can be oxidised to carboxylic acids.

(i) For example, propene, \( \text{CH}_3-\text{CH}=\text{CH}_2 \), would produce ethanoic acid, \( \text{CH}_3-\text{COOH} \), and methanoic acid, \( \text{H}-\text{COOH} \). Deduce the formulae of the alkenes which would form the following carboxylic acids when oxidised.

ethanoic acid and propanoic acid

only ethanoic acid

(ii) Describe the colour change you would observe when an alkene is oxidised with acidified potassium manganate(VII).

.............................................................................. [2]

(c) Fats and vegetable oils are esters. The formulae of two examples of natural esters are given below.

\[
\begin{align*}
\text{ester 1:} & \quad \text{CH}_2-\text{CO}_2-\text{C}_7\text{H}_{15} \\
\text{ester 2:} & \quad \text{CH}_2-\text{CO}_2-\text{C}_7\text{H}_{15}
\end{align*}
\]

(i) One ester is saturated, the other is unsaturated. Describe a test to distinguish between them.

test .............................................................................................

result with unsaturated ester .......................................................

result with saturated ester .........................................................

................................................................................................. [3]
(ii) Deduce which one of the above esters is unsaturated. Give a reason for your choice.

.................................................................................................................................................. [2]

Topic Chem 14 SubTopic: All up to & including homologous series Q# 20/ IGCSE Chemistry/2009/w/Paper 3/

5 The first three elements in Group IV are carbon, silicon and germanium.
The elements and their compounds have similar properties.

(c) Germanium forms a series of hydrides comparable to the alkanes.

(i) Draw the structural formula of the hydride which contains four germanium atoms per molecule.

.................................................................................................................................................. [1]

(ii) Predict the products of the complete combustion of this hydride.

.................................................................................................................................................. [2]

Topic Chem 14 SubTopic: All up to & including homologous series Q# 21/ IGCSE Chemistry/2009/w/Paper 3/ Q7

(c) The fermentation of biomass by bacteria produces a mixture of products which include biobutanol, propanol, hydrogen and propanoic acid.

(i) Draw the structural formula of propanol and of propanoic acid. Show all the bonds.

propanol

..................................................................................................................................................

propanoic acid
(ii) Why is it important to develop these fuels, such as biobutanol, as alternatives to petroleum?

(d) How could you show that butanol made from petroleum and biobutanol are the same chemical?

(b) (i) Balance the equation for the complete combustion of butan-1-ol.

\[ \text{C}_4\text{H}_9\text{OH} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

(a) Give two general characteristics of a homologous series.

(c) Give the name, molecular formula and empirical formula of the fourth acid in this series.

name .......................................................... [1]
molecular formula ........................................... [1]
empirical formula ........................................... [1]

6 Structural formulae are an essential part of Organic Chemistry.

(a) Draw the structural formula of each of the following. Show all the bonds in the structure.

(i) ethanoic acid

(ii) ethanol
1. Petroleum contains hydrocarbons which are separated by fractional distillation.

   (a) (i) Complete the following definition of a hydrocarbon.

   A hydrocarbon is a compound which ................................................................. [2]

   (ii) Explain what is meant by the term *fractional distillation*.

   .............................................................................................................................. [2]

   (b) Some of the fractions obtained from petroleum are given below. State a use for each fraction.

   bitumen .................................................................

   lubricating fraction ...................................................

   paraffin fraction ......................................................

   gasoline fraction .................................................... [4]

Topic Chem 14 SubTopic: All up to & including homologous series Q# 26/ IGCSE Chemistry/2013/s/Paper 31/

4. The structural formula of cyclohexane is drawn below.

   ![Cyclohexane Structure](image)

   (a) The name gives information about the structure of the compound.

   *Hex* because there are six carbon atoms and *cyclo* because they are joined in a ring. What information about the structure of this compound is given by the ending *ane*?

   .............................................................................................................................. [2]

   (b) What are the molecular and empirical formulae of cyclohexane?

   molecular formula ................................. [2]

   empirical formula .................................
(c) Draw the structural formula of cyclobutane.

(d) (i) Deduce the molecular formula of hexene.

(ii) Explain why cyclohexane and the alkene, hexene, are isomers.

5 The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have the same chemical properties. They undergo addition reactions and are easily oxidised.

(a) The following hydrocarbons are isomers.

\[\text{CH}_3\text{CH}==\text{CH}_2\quad \text{CH}_3\text{CH}_2\text{CH}==\text{CH}_2\]

(i) Explain why these two hydrocarbons are isomers.

(ii) Give the structural formula of another hydrocarbon which is isomeric with the above.
Topic Chem 14 SubTopic: All up to & including homologous series Q# 28/ IGCSE Chemistry/2014/s/Paper 31/ Q3

(c) Most helium is obtained from natural gas found in the USA. Natural gas contains methane and 7% helium. One possible way to obtain the helium would be to burn the methane.

(i) Write an equation for the complete combustion of methane.

........................................................................................................ [1]

(ii) Suggest why this would not be a suitable method to obtain the helium.

........................................................................................................ [1]

Topic Chem 14 SubTopic: All up to & including homologous series Q# 29/ IGCSE Chemistry/2015/s/Paper 31/

4 The alcohols form a homologous series.

(a) (i) Give three characteristics which all members of a homologous series share.

........................................................................................................ [3]

(ii) Give the name of the third member of this series.

name __________________________ [1]

(iii) Deduce the molecular formula of the alcohol whose $M_r = 158$. Show your working.

........................................................................................................ [2]

(b) Explain why the following two alcohols are isomers.

\[ \text{CH}_3 \text{C} - \text{OH} \quad \text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{OH} \]

........................................................................................................ [2]
(c) Two macromolecules have the same amide linkage. Nylon, a synthetic polymer, has the following structure.

\[
\begin{array}{c}
\text{C} \quad \text{N} \quad \text{O} \\
\text{H} \\
\text{C} \quad \text{N} \quad \text{O} \\
\text{H} \\
\end{array}
\]

Protein, a natural macromolecule, has the following structure.

\[
\begin{array}{c}
\text{N} \\
\text{C} \quad \text{N} \quad \text{O} \quad \text{H} \\
\text{C} \quad \text{N} \quad \text{O} \quad \text{H} \\
\end{array}
\]

How are they different?

(a) (i) These constituents of food can be hydrolysed by boiling with acid or alkali. Complete the table.

<table>
<thead>
<tr>
<th>constituent of food</th>
<th>product of hydrolysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>protein</td>
<td></td>
</tr>
<tr>
<td>complex carbohydrate</td>
<td></td>
</tr>
</tbody>
</table>

(ii) What type of synthetic polymer contains the same linkage as proteins? ...........................................
(b) An incomplete structural formula of a protein is given below. Complete this diagram by inserting the linkages.

[Diagram showing incomplete structural formula]

Topic Chem 14 SubTopic: Natural polymers Q# 32/ iGCSE Chemistry/2015/w/Paper 31/

2 Describe how to separate the following. In each example, give a description of the procedure used and explain why this method works.

(c) Glycine from a mixture of the two amino acids glycine and alanine. Glycine has the lower $R_t$ value.

procedure .................................................................................................................................

..............................................................................................................................................

explanation ............................................................................................................................... [2]

Topic Chem 14 SubTopic: Natural polymers Q# 33/ iGCSE Chemistry/2015/w/Paper 31/ Q7 (c)

(iii) The structural formula of glucose can be represented by $\text{H} - \text{O} - \text{O} - \text{H}$. Draw part of the structural formula of starch which contains two glucose units.

............................................................................................................................................... [2]

(iv) Living organisms need carbohydrates for respiration.

What is meant by respiration?

............................................................................................................................................... [1]
(c) This question is based on typical reactions of butan-1-ol.

(i) When butan-1-ol, CH₃–CH₂–CH₂–CH₂–OH, is passed over the catalyst silicon(IV) oxide, water is lost.

Deduce the name and the structural formula of the organic product in this reaction.

name

structural formula

8 Lactic acid can be made from corn starch.

\[
\text{CH}_3 - \text{CH} - \text{COOH} \\
\quad \text{OH}
\]

Lactic acid

It polymerises to form the polymer, polylactic acid (PLA) which is biodegradable.

(a) Suggest two advantages that PLA has compared with a polymer made from petroleum.

........................................................................................................................................................................

........................................................................................................................................................................

........................................................................................................................................................................

........................................................................................................................................................................ [2]

(b) The structure of PLA is given below.

\[
\text{O} - \text{CH} - \text{C} - \text{O} - \text{CH} - \text{CH}_3
\]

(i) What type of compound contains the group that is circled?

........................................................................................................................................................................ [1]
(ii) Complete the following sentence.

Lactic acid molecules can form this group because they contain both an ____________________________ group and an ____________________________ group. [2]

(iii) Is the formation of PLA, an addition or condensation polymerisation? Give a reason for your choice.

.................................................................................................................................................................................... [2]

Topic Chem 14 SubTopic: Synthetic polymers Q# 36/ iGCSE Chemistry/2010/s/Paper 31/Q4

(b) The structure of a typical protein is drawn below.

(i) What is the name of the polymer linkage?

.................................................................................................................................................................................... [1]

(ii) Draw the structural formula of a man-made polymer with the same linkage.

.................................................................................................................................................................................... [3]

Topic Chem 14 SubTopic: Synthetic polymers Q# 37/ iGCSE Chemistry/2010/w/Paper 31/

5 Monomers polymerise to form polymers or macromolecules.

(a) (i) Explain the term polymerise.

.................................................................................................................................................................................... [1]

(ii) There are two types of polymerisation - addition and condensation. What is the difference between them?

.................................................................................................................................................................................... [2]
5 Monomers polymerise to form polymers or macromolecules.

(b) An important monomer is chloroethene which has the structural formula shown below.

\[
\begin{array}{c}
\text{H} \\
\text{C} \equiv \text{C} \\
\text{H} \quad \text{Cl}
\end{array}
\]

(iv) Draw the structural formula of poly(chloroethene).
Include three monomer units.

8 There are two types of polymerisation - addition and condensation.

(a) Explain the difference between them.

(b) Poly(dichloroethene) is used to package food. Draw its structure. The structural formula of dichloroethene is shown below.

\[
\begin{array}{c}
\text{H} \\
\text{C} \equiv \text{C} \\
\text{Cl} \quad \text{Cl}
\end{array}
\]
(c) The polymer known as PVA is used in paints and adhesives. Its structural formula is shown below.

\[ \text{CH}_2 - \text{CH} - \text{CH}_2 - \text{CH} - \]
\[ \text{OOCCH}_3 \quad \text{OOCCH}_3 \]

Deduce the structural formula of its monomer.

(d) A condensation polymer can be made from the following monomers.

\[ \text{HOOC(CH}_2\text{)}_4\text{COOH} \quad \text{and} \quad \text{H}_2\text{N(CH}_2\text{)}_6\text{NH}_2 \]

Draw the structural formula of this polymer.

(b) (i) Ethanoic acid and ethanol react to form an ester.
What is the name of this ester?

........................................................................................................................................................................ [1]
(ii) The same linkage is found in polyesters. Draw the structure of the polyester which can be formed from the monomers shown below.

\[ \text{HOOC} - \text{C}_6\text{H}_4 - \text{COOH} \quad \text{and} \quad \text{HO} - \text{CH}_2 - \text{CH}_2 - \text{OH} \]

[3]

(iii) Describe the pollution problems caused by non-biodegradable polymers.

[2]

7 Plastics are polymers. They are formed from their monomers by polymerisation.

(a) Two methods for the disposal of waste plastics are

- burning
- recycling.

Describe one advantage and one disadvantage of each method.

burning .................................................................

recycling .............................................................

........................................................................... [4]

(b) (i) There are two types of polymerisation reaction. Give their names and explain the differences between them.

........................................................................... [4]
(ii) Give the structural formula of a polymer which is formed from two different monomers.

---

5 The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have the same chemical properties. They undergo addition reactions and are easily oxidised.

(d) Alkenes polymerise to form addition polymers. Draw the structural formula of poly(cyanoethene), include at least two monomer units. The structural formula of the monomer, cyanoethene, is given below.

\[
\begin{align*}
\text{H} & \quad \text{C} = \text{C} & \quad \text{H} \\
\text{H} & \quad \text{C} & \quad \text{CN}
\end{align*}
\]

---

8 Polymers are made by the polymerisation of simple molecules called monomers.

(a) (i) The structural formula of a polymer is given below.

\[
\begin{align*}
\left[ \text{CH} - \text{CH} \right]_n \\
\left[ \text{CH}_3 - \text{CH}_3 \right]_n
\end{align*}
\]

This polymer is made by addition polymerisation. Draw the structural formula of its monomer.
(ii) The two monomers shown below form a nylon which is a condensation polymer.

\[
\begin{align*}
\text{H}_2\text{N} & \quad \text{NH}_2 \\
\text{HOOC} & \quad \text{COOH}
\end{align*}
\]

Draw its structural formula showing one repeat unit of the polymer.

(iii) Name the natural macromolecule which contains the same linkage as nylon.

(iv) Explain the difference between addition polymerisation and condensation polymerisation.

(b) Many polymers are non-biodegradable.

(i) Explain the term *non-biodegradable*.

(ii) State three problems caused by the disposal of non-biodegradable polymers.

(c) Storage tanks for cold water are now made from polymers because they are cheaper than metal tanks. Suggest two other advantages of making cold water tanks from polymers.
(b) The following two monomers can form a polyester.

\[
\text{HOOC} \quad \text{COOH} \quad \text{HO} \quad \text{OH}
\]

Draw the structural formula of this polyester. Include two ester linkages.

---

(b) State two uses of synthetic polymers.

(i) Describe two problems caused by the disposal of synthetic polymers in landfill sites.

(ii) Describe one problem caused by burning synthetic polymers.

(c) The structural formulae of two synthetic polymers are given below.

\[
\text{polymer A}
\]

\[
\text{polymer B}
\]

(i) Draw the structural formula of the monomer of polymer A.
(ii) Identify the functional group circled in polymer B.

(iii) Deduce the two types of organic compound which have reacted to form polymer B.

(d) Explain the difference between addition and condensation polymers. Classify A and B as either addition or condensation polymers.

Mark Scheme iG Chem 14 EQ P3 Organic Chemistry

Q# 1/ iGCSE Chemistry/2009/w/Paper 3/

(ii) butanol + methanoic acid → butyl methanoate + water
    correct products or reactants ONLY

Q# 2/ iGCSE Chemistry/2010/s/Paper 31/

4 (a) (i) ethanol
    CH₃CH₂OH

    propanoic acid
    CH₃CH₂COOH
    independent marking, no ecf
    accept C₂H₅
    not – HO

(iii) terylene / PET / Dacron / diolen / mylar / crimplene

Q# 3/ iGCSE Chemistry/2010/s/Paper 31/

8 (a) same general formula
    same chemical properties
    same functional group
    physical properties vary in predictable way
    common methods of preparation
    consecutive members differ by CH₂
    any two
    mark first two
    ignore others unless it contradicts a point which has been awarded a mark

(b) (i) 2HCOOH + CaCO₃ → Ca(HCOO)₂ + CO₂ + H₂O
    not balanced = [1]

    (ii) zinc + methanoic acid → zinc methanoate + hydrogen
        [1] for each product

    (iii) protected by oxide layer

[1]
(c) butanoic acid
CH₃CH₂CH₂-COOH / C₆H₅O₂ / C₃H₇COOH / C₄H₇OOH
C₆H₄O
mark ecf to molecular formula

Q# 4/ IGCSE Chemistry/2011/s/Paper 31/ Q6 (a)

(ii) glucose / sugar changed to alcohol / ethanol
accept an unbalanced equation
(catalysed by) enzymes / yeast

(b) butanoic acid
CH₃CH₂CH₂-COOH
hydrogen atoms omitted from ends of bonds, penalise once

(c) (i) ester

(ii) C₆H₅O₂
ignore CH₃COOC₄H₉

(iii) correct structural formula of butyl ethanoate showing all bonds

Q# 5/ IGCSE Chemistry/2012/s/Paper 31/

(c) (i) potassium manganate(VII) / potassium dichromate(VI) / copper(II) oxide;
note: do not insist on oxidation numbers but if given must be correct

(ii) butanoic acid;

(iii) butyl ethanoate;

correct formula all bonds shown = [2]
if alkyl groups incorrect then correct ester linkage showing bonds = [1]

Q# 6/ IGCSE Chemistry/2014/w/Paper 31/

6 (a) (i) butanoic acid methanol

(ii) number of moles of ethanoic acid = 0.1
number of moles of ethanol = 0.12(0)
the limiting reagent is ethanoic acid
number of moles of ethyl ethanoate formed = 0.1
maximum yield of ethyl ethanoate is 8.8 g

Q# 7/ IGCSE Chemistry/2015/s/Paper 31/

<table>
<thead>
<tr>
<th>4(c)(i) butyl ethanoate;</th>
<th>1 A butyl ester and ethanoic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>4(c)(ii) butanoic acid, structural formula of butanoic acid;</td>
<td>2 A butyric acid, minimum acceptable structure is CH₃CH₂CH₂COOH with C-HO connectivity in acid group</td>
</tr>
</tbody>
</table>

Q# 8/ IGCSE Chemistry/2015/w/Paper 31/

5(b)(i) unsaturated C=C double bond/alkene; 1
5(b)(ii) (organic/carboxylic) add/contains or releases H⁺ ions; 1
5(b)(iii) CH₂CH=CHCOOH / CH₃=CHCH₂COOH / CH₂=CH(CH₂)COOH; 1
Q# 9/ iGCSE Chemistry/2009/s/Paper 31/Q

(c) (i) lactic acid → acrylic acid + water

(ii) add bromine (water) or bromine in an organic solvent remains brown/orange/yellow
goes colourless NOT clear
If mark 1 near miss e.g. bromide allow marks 2 and 3
Colour of reagent must be shown somewhere for [3] otherwise max [2]

OR acidified potassium manganate(VII)
purple/pink to colourless

OR alkaline potassium manganate(VII)
purple/pink to green
or purple/pink to brown precipitate

Q# 10/ iGCSE Chemistry/2009/w/Paper 3/

7  (a) (i) heat catalyst

(ii) an equation that gives:
alene + alkane
or alkene + alkene + hydrogen

a correct and balanced equation for the cracking of decane, C_{10}H_{22} but not but-1-ene

(iii) water or steam

Q# 11/ iGCSE Chemistry/2010/s/Paper 31/

(iii) chlorine
not chlorinated water
cond light / UV / heat / high temperature if numerical value given about 200°C / lead tetraethyl
not warm

Q# 12/ iGCSE Chemistry/2010/w/Paper 31/

(b) (i) C_{12}H_{26} → C_8H_18 + 2C_2H_4

/ any other correct version

(ii) ethane and chlorine give range of products
/ ethene more readily available than ethene
/ waste half chlorine as hydrogen chloride
/ ethene more reactive than ethane

Q# 13/ iGCSE Chemistry/2011/s/Paper 31/

6  (a) (i) cracking / heat with catalyst
to make butane
butene reacts with steam/water / hydrated
accept heat and catalyst for cracking but if specified: 450 to 800°C zeolites /
aluminosilicates / silica / aluminium oxide/alumina / china / broken pot / porcelain /
chromium oxide

Q# 14/ iGCSE Chemistry/2012/s/Paper 31/

(b) (i) chlorination / substitution / photochemical / exothermic / halogenation / free radical;

(ii) (compounds) same molecular formula; different structural formulae;

(iii) CH₃–CH₂–CH₂–CH₂–Cl
CH₃–CH₂–CH(CH₃)–CH₃
Q# 15/ iGCSE Chemistry/2012/w/Paper 31/

(c) bromine/bromine water/aqueous bromine;
   unsaturated - brown / orange to colourless not: clear [1]
saturated - stays brown / orange [1]

or: alkaline potassium manganate(VII);
   from purple/pink to green / brown;
   stays purple;

or: acidic potassium manganate(VII)
   from purple/pink to colourless; not: clear
   stays purple;

Q# 16/ iGCSE Chemistry/2013/s/Paper 31/Q3

(e) add bromine (water) or (i)

cond: (remains) brown or orange or red or yellow [1]

cond: changes from brown, etc. to colourless or decolourises
not: clear [1]

OR

potassium manganate(VII) [1]
note: oxidation state not essential but if given must be correct or [0]
accept: potassium permanganate

cond: remains pink / purple [1]

cond: changes from pink to colourless (acidic)
not: clear [1]

cond: change from pink to green / brown (alkaline) [1]

Q# 17/ iGCSE Chemistry/2013/w/Paper 31/

7 (a) (i) hydrogen (atoms) replaced by (atoms) of a different element e.g. chlorine
NOT: substitute [1]

(ii) light required [1]

Q# 18/ iGCSE Chemistry/2013/w/Paper 31/

5 (a) (i) have same molecular formula / both are C₂H₁₂ [1]
   they have different structural formulae / different structures [1]

(ii) CH₃-CH₂-CH=CH-CH₃ / any other correct isomer [1]

(b) (i) CH₂(Br)-CH₂Br
NOT: C₂H₄Br₂
   dibromoethane [1]
   NOTE: numbers not required but if given must be 1, 2

(ii) CH₃-CH₂-CH₃
NOT: C₃H₈
   propane [1]

(iii) CH₃-CH₂-CH₂-CH₂-OH / CH₃-CH₂-CH(OH)-CH₃ [1]
   butanol
   numbers not required but if given must be correct and match formula

(c) (i) CH₃-CH=CH-CH₂-CH₃
CH₃-CH=CH-CH₃ [1]

(ii) pink / purple
   colourless
   NOT: clear [1]
Q# 19/ iGCSE Chemistry/2014/w/Paper 3/ Q6

(c) (i) add bromine water/bromine
    turns colourless
    remains brown/orange/reddish brown/yellow

    ALLOW: potassium manganate(VII) (acidic or alkaline)
    correct colour colourless/green or brown ppt
    stays pink/purple

(ii) ester 1
    COND alkyl group is CₗH₂ₙ₋₁ which is NOT C₁₉H₃₃
    or C₁₇H₃₅ is C₊₆H₂₁₋₁ or less hydrogen

(iii) soap or (sodium) salt (of a carboxylic acid) or carboxylate
    alcohol

Q# 20/ iGCSE Chemistry/2009/w/Paper 3/

(c) (i) structural formula of Ge₄H₁₀ all bonds shown

(ii) germanium(IV) oxide
    water

Q# 21/ iGCSE Chemistry/2009/w/Paper 3/ Q7

(c) (i) correct structural formulae [1] each
    accept either propanol and –OH in alcohol and acid
    penalise once for CH₃ type diagrams
    For either C₃H₇O or C₃H₆O₂ [0]

(ii) to conserve petroleum or reduce greenhouse effect

(d) have same boiling point

Q# 22/ iGCSE Chemistry/2009/w/Paper 3/

(b) (i) C₄H₉OH + 6O₂ → 4CO₂ + 5H₂O
    If only error is balancing the oxygen atoms

Q# 23/ iGCSE Chemistry/2010/s/Paper 31/

8 (a) same general formula
    same chemical properties
    same functional group
    physical properties vary in predictable way
    common methods of preparation
    consecutive members differ by CH₂
    any two
    mark first two
    ignore others unless it contradicts a point which has been awarded a mark

(c) butanoic acid
    CH₃CH₂CH₂CH₂COOH / C₄H₈O₂ / C₄H₇COOH / C₄H₈OCH
    C₄H₈O
    mark ecf to molecular formula

Q# 24/ iGCSE Chemistry/2011/w/Paper 31/

6 (a) (i) correct structural formula of ethanoic acid
    allow: –OH not: –COOH

(ii) correct structural formula of ethanol
    allow: –OH
Q# 25/ iGCSE Chemistry/2013/s/Paper 31/

1 (a) (i) contains carbon and hydrogen
cond: only / just

(ii) (different) boiling points
cond: separate

(b) bitumen-making roads / roofs / water-proofing, etc.

lubricating fraction – waxes / vaseline / grease, etc. or machinery example, e.g. (oil a) bike / hinges / reducing friction

paraffin fraction – jet fuel / (home) heating or tractors or cooking or lighting

gasoline fraction – petrol or fuel for cars / vans / trucks

Q# 26/ iGCSE Chemistry/2013/s/Paper 31/

3 (a) (i) pieces have (same) surface area
same amount / mass / quantity / volume / number of moles of carbonate

(ii) no more bubbles / carbon dioxide or piece disappears / dissolves

(b) experiment 1 \( \text{Ca}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \)

(c) (i) more concentrated or higher concentration (of acid) (in experiment 1)
accept: arguments based on collision theory

(ii) ethanoic acid is a weak acid or hydrochloric acid is a strong acid
accept: stronger or weaker

ethanoic acid less ionised / dissociated / lower / smaller concentration of hydrogen ions
accept: less hydrogen ions and vice versa argument but not dissociation of ions

(iii) lower temperature (particles) have less energy
moving more slowly
fewer collisions / lower collision rate

or

lower temperature (particles) have less energy
fewer particles collide

with the necessary energy to react

note: less energy fewer successful collisions gains all 3 marks

(d) (i) \( \text{C}_2\text{H}_4 \)
accept: a correct structural formula

(ii) same molecular formula not: chemical formula
different structural formulae / structures

Q# 27/ iGCSE Chemistry/2013/w/Paper 31/

5 (a) (i) have same molecular formula / both are \( \text{C}_6\text{H}_{12} \)

they have different structural formulae / different structures

(ii) \( \text{CH}_3\text{CH}_2\text{CH} = \text{CH} - \text{CH}_3 \) / any other correct isomer

Q# 28/ iGCSE Chemistry/2014/s/Paper 31/ Q3

(c) (i) \( \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \) (1)

(ii) would get a mixture of helium and carbon dioxide

or would get a mixture of gases

or waste of methane / natural gas / fossil fuel (1)
Q# 29/ iGCSE Chemistry/2015/s/Paper 31/

4(a)(i) Any three from:
- same general formula;
- contain the same functional group;
- consecutive members differ by CH₂;
- common methods of preparation;
- same or similar chemical properties;
- physical properties vary in a predictable manner / show trends / show a gradual change / an example of a physical variation e.g. mpt, bpt, volatility, viscosity;

3

4(a)(ii) propanol / propan-1-ol / propan-2-ol;

1

4(a)(iii) if molecular formula is given as C₆H₁₂O₂ award 2 marks

2

A C₆H₁₂O₂ for two marks

A (10 × 12) + (22 × 1) + 16 = 158 for one (working) mark

Q# 30/ iGCSE Chemistry/2011/w/Paper 31/ Q6

(c) synthetic – only two monomers
protein – many different monomers
or:
protein has 1 C=O and 1N–H
nylon has 2 C=O / 2N–H
or:
synthetic – one monomer is a dicarboxylic acid and the other is a diamine
protein all monomers are amino acids

A same number of each type of atom
A same number of atoms

Q# 31/ iGCSE Chemistry/2012/w/Paper 31/

6 (a) (i) amino acid / peptides;
salt / carboxylate or soap / fatty acid or glycerine / alcohol;
sugars or glucose;
accept: named sugar

(ii) polyester;
allow: named polyester
polyamide;
allow: nylon

(b) one correct amide linkage;
second amide linkage correctly orientated
– NHCO – followed by – NHCO –;
note: monomers are amino acids not diamines or dicarboxylic acid

Q# 32/ iGCSE Chemistry/2015/w/Paper 31/

2(c) chromatography;
use a locating agent / the two acids move at different rates / alanine travels faster / alanine higher up paper / travels further;

Q# 33/ iGCSE Chemistry/2015/w/Paper 31/ Q7 (c)

7(c)(iii) one correct –O– link between rectangles;
two correct glucose units with continuation bonds;

7(c)(iv) the reaction of glucose with oxygen to release (carbon dioxide and water and) energy;
or the reaction of glucose in a biological system to release energy;
Q# 34/ iGCSE Chemistry/2015/s/Paper 31/

<table>
<thead>
<tr>
<th>4(c)(i)</th>
<th>M1 butane or but-1-ene;</th>
<th>M1 and M2 are independent A but-1-ene for M1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M2 structural formula of but-1-ene;</td>
<td>Minimum acceptable structure is CH₃CH₂CH=CH₂ Double bond must be shown R structure of but-2-ene for M2</td>
</tr>
</tbody>
</table>

Q# 35/ iGCSE Chemistry/2009/s/Paper 31/

8 (a) biodegradable or breaks down naturally made from a renewable source or does not use up petroleum reduce visual pollution or reduces need for landfill sites or less danger to wildlife any TWO ignore mention of toxic gases

(b) (i) ester accept polyester or fat or lipid or vegetable oil or carboxylic acid

(ii) acid or carboxylic acid or alkanoic acid alcohol or hydroxyl or alkano NOT formulae NOT hydroxide

(iii) condensation COND because water is formed in reaction or monomer does not have C=C bond

Q# 36/ iGCSE Chemistry/2010/s/Paper 31/

(b) (i) polyamide / amide / peptide / polypeptide

(ii) correct amide linkage NHCO then CONH cond to mark 1, 2 monomers (different shading in box) cond continuation (to ONE correct linkage) OR nylon 6 only one linkage – NHCO cond only one monomer cond continuation (to correct linkage)

Q# 37/ iGCSE Chemistry/2010/w/Paper 31/

5 (a) (i) many (simple) molecules form one (large) molecule / monomer molecules form one polymer molecule

(ii) addition - polymer is the only product accept - nX → Xn condensation polymer and simpler molecules formed accept nX → Xn + nHCl / H₂O

Q# 38/ iGCSE Chemistry/2010/w/Paper 31/ Q5 (b)

(iv) must have three correct units cond continuation accept –(CH₂–CH(Cl))ₙ–

Q# 39/ iGCSE Chemistry/2011/s/Paper 31/
8 (a) addition – polymer only product / only one product
accept monomer has C=C
accept monomer and polymer have same empirical formula
accept no loss of material in polymerisation
not only one monomer

condensation – polymer and water / small molecule formed

(b) \(-CH_2 - \text{CCl}_3\)
repeat unit correct
COND continuation

(c) \(\text{CH}_2=\text{C}OOC\text{CH}_3\)

Q# 40/ iGCSE Chemistry/2011/s/Paper 31/ Q8

(d) \(-\text{OC}(\text{CH}_2)_4\text{CONH(CH}_2)_6\text{NH-}\)
COND amide correct linkage
correct repeat units
continuation
not NH_2 or COOH endings

Q# 41/ iGCSE Chemistry/2011/w/Paper 31/ 
(b) (i) ethyl ethanoate

(ii) \(-\text{OC}_2\text{H}_4\text{COOCH}_2\text{CH}_2\text{O-}\)
correct ester linkage
correct repeat units
continuation
accept: boxes if it is clear what the box represents

(iii) any two from:
long time to decay
landfill sites
visual pollution / litter
danger to animals
poisonous gases when burnt
accept: any correct suggestion

Q# 42/ iGCSE Chemistry/2012/s/Paper 31/ 

7 (a) burning
produces toxic gases / harmful to health
increases greenhouse gases / global warming
reduces visual pollution / litter
reduces risks to wildlife
shortage of landfill sites / reduces space needed in landfill sites / saves space
non-biodegradable / long time to rot / decompose / accumulates waste
burning source of energy / used to generate electricity

recycling
conserves petroleum / natural resources
difficult to recycle / expensive / takes much energy
problems over sorting
reduces need for landfill
quality of plastic is reduced each time it is recycled
four DIFFERENT valid points which are advantages or disadvantages of burning and/or recycling
(b) (i) addition (polymerisation);

(polymer) only product / no by-products;

condensation (polymerisation);

(polymer and) simple molecule / water / hydrogen chloride / one other product forms;

(ii) a correct linkage (for a polyamide / polyester);

two different monomers;

Q# 43/ iGCSE Chemistry/2013/w/Paper 31/

(d) -CH₂-CH(CN)-CH₂-CH(CN)-
correct repeat unit CH₂-CH(CN)

COND: at least 2 units in diagram

8 (a) (i) CH₃-CH=CH–CH₃ (1)

(ii) one correct amide linkage between two rectangles (1)

correct sequencing of a second amide link and monomers (1)

two correct amide links and rest of structure correct (including additional monomers if seen) and correct continuation bonds (1)

(iii) protein or polypeptide or named protein (1)

(iv) addition: only the polymer or one product is formed (1)

condensation: the polymer and a small molecule / water / HCl is formed (1)

(b) (i) does not break down or rot or decompose (1)

by microbes or fungi or bacteria or by living organisms (1)

(ii) Any three from:

visual pollution (1)

(shortage of) landfill sites (1)

danger to wildlife / animals (including at sea) (1)

toxic gases when burnt or greenhouse gases produced when burned (1)

(c) Any two from:
(c) Any two from:
- resistant to corrosion
- unreactive to water
- more durable
- lighter
- less dense
- easier to manufacture
- can be moulded
- good insulator
- keeps the water cold

[Total: 14]

Q# 45/ iGCSE Chemistry/2014/w/Paper 31/Q6

(b) correct ester linkage [1]
- two ester linkages (COND on M1)
- continuation (COND on M2)

Q# 46/ iGCSE Chemistry/2015/w/Paper 31/

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
</table>
| 4(a)(i)  | any two from:  
- shortage of sites
- landfill sites fill up  
- visual pollution
- filter  
- danger to wild life | 2 |
| 4(a)(ii) | (produce) toxic gases or CO or HCl or HF/carbon dioxide/greenhouse gases; | 1 |
| 4(b)     | any two from:  
- bags/clothing or specified clothing/packaging/bowls/cups/plates/flooring/carpet/pipes/insulation/non-stick coatings/ropes; | 1 |

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
</table>
| 4(c)(i)  | CH₃CH=CHOH  
double bond is shown; rest of structure correct | 2 |
| 4(c)(ii) | ester; | 1 |
| 4(c)(iii) | (carboxylic) acid;  
- alcohol | 1 |
| 4(d)     | addition – polymer only product/only one product  
condensation – (polymer and) simple molecule/water/hydrogen chloride made  
polymer A is an addition polymer and polymer B is a condensation polymer; | 1 |