iG Chem 5 EQ P3 13w to 01s 81marks

PAPERS 1, 3 and 6
Percentage of all WEIGHTED marks awarded for each topic from w2001 to w2015 (green) and % of Paper 3 marks (red)

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PAPER 3
Percentage of all marks awarded for each topic from w2001 to w2015 (red cross) and for 2013s to 2015w (green triangle)

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5. Electricity and chemistry

Core
- Define electrolysis as the breakdown of an ionic compound, molten or in aqueous solution, by the passage of electricity
- Describe the electrode products and the observations made during the electrolysis of:
  - molten lead(II) bromide
  - concentrated hydrochloric acid
  - concentrated aqueous sodium chloride
  - dilute sulfuric acid
  - between inert electrodes (platinum or carbon)
- State the general principle that metals or hydrogen are formed at the negative electrode (cathode), and that non-metals (other than hydrogen) are formed at the positive electrode (anode)
- Predict the products of the electrolysis of a specified binary compound in the molten state
- Describe the electroplating of metals
- Outline the uses of electroplating
- Describe the reasons for the use of copper and (steel-coated) aluminium in cables, and why plastics and ceramics are used as insulators

Supplement
- Relate the products of electrolysis to the electrolyte and electrodes used, exemplified by the specific examples in the Core together with aqueous copper(II) sulfate using carbon electrodes and using copper electrodes (as used in the refining of copper)
- Describe electrolysis in terms of the ions present and reactions at the electrodes in the examples given
- Predict the products of electrolysis of a specified halide in dilute or concentrated aqueous solution
- Construct ionic half-equations for reactions at the cathode
- Describe the transfer of charge during electrolysis to include:
  - the movement of electrons in the metallic conductor
  - the removal or addition of electrons from the external circuit at the electrodes
  - the movement of ions in the electrolyte
8. Iron and steel rust when exposed to water and oxygen. Rust is hydrated iron(III) oxide.

(a) The following cell can be used to investigate rusting.

![Electrolysis cell diagram]

(i) What is a cell?

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

(ii) Which electrode will be oxidised and become smaller? Explain your choice.

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

(iii) What measurements would you need make to find the rate of rusting of the electrode you have chosen in (ii)?

.................................................................................................................................................. [2]
(iv) Suggest an explanation why the addition of salt to the water increases the rate of rusting.

Q# 3/ iGCSE Chemistry/2011/s/Paper 31/ Q2 (a)
(ii) Name a device which can change chemical energy into electrical energy.

Q# 4/ iGCSE Chemistry/2010/w/Paper 31/ Q5 (b)
(iii) Describe an industrial method of making chlorine.

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/
3 The diagram shows a cell. This is a device which produces electrical energy. The reaction in a cell is a redox reaction and involves electron transfer.

(i) Complete the sentence.
A cell will change ........................................ energy into electrical energy. [1]

(ii) Draw an arrow on the diagram to show the direction of the electron flow. [1]

(iii) In the left hand beaker, the colour changes from brown to colourless. Complete the equation for the reaction.

\[ \text{Br}_2 \text{ + } \text{Fe}^{2+} \text{ (aq)} \rightarrow \text{Fe}^{3+} \text{ (aq)} + \text{Br}^{-} \] [2]
Q# 6/ IGCSE Chemistry/2009/w/Paper 3/ Q3

(c) Zinc electrodes have been used in cells for many years, one of the first was the Daniel cell in 1831.

(i) Give an explanation for the following in terms of atoms and ions.

observation at zinc electrode – **the electrode becomes smaller**

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

observation at copper electrode – **the electrode becomes bigger**

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

(ii) When a current flows, charged particles move around the circuit.

What type of particle moves through the electrolytes?

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

Which particle moves through the wires and the voltmeter?

.......................................................................................................................................................... [1]
2 The results of experiments on electrolysis using inert electrodes are given in the table.

Complete the table; the first line has been completed as an example.

<table>
<thead>
<tr>
<th>electrolyte</th>
<th>change at negative electrode</th>
<th>change at positive electrode</th>
<th>change to electrolyte</th>
</tr>
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<tbody>
<tr>
<td>molten lead(II) bromide</td>
<td>lead formed</td>
<td>bromine formed</td>
<td>used up</td>
</tr>
<tr>
<td>potassium formed</td>
<td></td>
<td>iodine formed</td>
<td>used up</td>
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<tr>
<td>dilute aqueous sodium chloride</td>
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</tr>
<tr>
<td>aqueous copper(II) sulfate</td>
<td></td>
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<tr>
<td>hydrogen formed</td>
<td>bromine formed</td>
<td>potassium hydroxide formed</td>
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</table>

[Total: 8]

5 The electrolysis of concentrated aqueous sodium chloride produces three commercially important chemicals hydrogen, chlorine and sodium hydroxide.

(a) The ions present are Na⁺(aq), H⁺(aq), Cl⁻(aq) and OH⁻(aq).

(i) Complete the ionic equation for the reaction at the negative electrode (cathode).

\[ \underline{\text{..............}} + \underline{\text{..............}} \rightarrow H_2 \] [1]

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

\[ \underline{\text{..............}} - \underline{\text{..............}} \rightarrow Cl_2 \] [1]

(iii) Explain why the solution changes from sodium chloride to sodium hydroxide.

\[ \underline{\text{.................................................................}} \] [1]
Q# 9/ IGCSE Chemistry/2008/s/Paper 31/
3  Copper is purified by electrolysis.

(a) Complete the following.

The positive electrode (anode) is made from .................................................................

The negative electrode (cathode) is made from .................................................................

The electrolyte is aqueous ..................................................................................................... [3]

(b) Write an ionic equation for the reaction at the positive electrode (anode).
............................................................................................................................................... [2]

Q# 10/ IGCSE Chemistry/2006/w/Paper 3/ Q6

(b) Impure copper is extracted from the ore. This copper is refined by electrolysis.

(i) Name;
the material used for the positive electrode (anode),
..............................................................................................................................................

the material used for the negative electrode (cathode),
..............................................................................................................................................

a suitable electrolyte.
.............................................................................................................................................. [3]

(ii) Write an ionic equation for the reaction at the negative electrode.
............................................................................................................................................... [1]
(c) Cell reactions are both exothermic and redox. They produce electrical energy as well as heat energy.

(i) The diagram shows a simple cell.

Which substance in this cell is the reductant and which ion is the oxidant?

reductant .................................................................
oxidant ............................................................... [2]

(ii) How could the voltage of this cell be increased?

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

(d) Cells can be set up with inert electrodes and the electrolytes as oxidant and reductant.

The potassium manganate(VII) is the oxidant and the potassium iodide is the reductant.

(i) Describe the colour change that would be observed in the left hand beaker.

................................................................................................. [2]
(ii) Write an ionic equation for the reaction in the right hand beaker.

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

Q# 12/ 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.

(ii) The electrolysis of molten strontium chloride produces strontium metal and chlorine. Write ionic equations for the reactions at the electrodes.

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

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

(iii) One of the products of the electrolysis of concentrated aqueous strontium chloride is chlorine. Name the other two.

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

Q# 13/ iGCSE Chemistry/2004/s/Paper 3/ Q5

(b) Aqueous copper(II) sulphate solution can be electrolysed using carbon electrodes. The ions present in the solution are as follows.

\[ \text{Cu}^{2+}(aq), \quad \text{SO}_4^{2-}(aq), \quad \text{H}^+(aq), \quad \text{OH}^-(aq) \]

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

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

(ii) A colourless gas was given off at the positive electrode (anode) and the solution changes from blue to colourless.

Explain these observations.

.................................................................................................................................................. [2]
(c) Aqueous copper(II) sulphate can be electrolysed using copper electrodes. The reaction at the negative electrode is the same but the positive electrode becomes smaller and the solution remains blue.

(i) Write a word equation for the reaction at the positive electrode.

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

(ii) Explain why the colour of the solution does not change.

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

(iii) What is the large scale use of this electrolysis?

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

Q# 14/ iGCSE Chemistry/2003/s/Paper 3/

5 The first three elements in Period 6 of the Periodic Table of the Elements are caesium, barium and lanthanum.

(b) All three metals can be obtained by the electrolysis of a molten halide. The electrolysis of the aqueous halides does not produce the metal.

(i) Complete the equation for the reduction of lanthanum ions at the negative electrode (cathode).

\[ \text{La}^{3+} + \text{..} \rightarrow \text{..} \]

(ii) Name the three products formed by the electrolysis of aqueous caesium bromide.

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

Q# 15/ iGCSE Chemistry/2003/s/Paper 3/

1 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

(e) One of the methods used to prevent iron or steel from rusting is to electroplate it with another metal, such as tin. Complete the following.

The anode is made of ...........................................

The cathode is made of ...........................................

The electrolyte is a solution of .................................. [3]
Q# 16/ iGCSE Chemistry/2002/w/Paper 3/ Q4

(b) Copper is refined by the electrolysis of aqueous copper(II) sulphate using copper electrodes. Describe the change that occurs at the electrodes.

(i) cathode (pure copper) .................................................................................................................. [1]

(ii) anode (impure copper) ..................................................................................................................[1]

(iii) Write an ionic equation for the reaction at the cathode.

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

(iv) If carbon electrodes are used, a colourless gas is given off at the anode and the electrolyte changes from a blue to a colourless solution.

The colourless gas is ............................................

The solution changes into ....................................... [2]

(c) Electrolysis and cells both involve chemical reactions and electricity.

What is the essential difference between them?

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

Q# 17/ iGCSE Chemistry/2002/s/Paper 3/

3 A major food retailer in the UK is going to distribute sandwiches using hydrogen-powered vehicles.

(c) Outline how hydrogen is manufactured from water.

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

.................................................................................................................................................. [2]
Q# 18/ iGCSE Chemistry/2001/w/Paper 3/ Q4

(e) The diagram below represents a simple cell.

(i) Write an ionic equation for the reaction that occurs at the zinc electrode.

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

(ii) How could the voltage of the cell be increased?

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

(f) A different type of cell is drawn below.

(i) The pH of the solution increases. Give the name of the ion formed.

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

(ii) Complete the equation that represents the formation of this ion.

\[ O_2 + \text{.........} \; H_2O + \text{.........} \rightarrow \text{.........} \].............. [2]
Mark Scheme

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/

8 (a) (i) device which changes chemical energy;  
into electrical energy;  
OR  
produces a voltage / potential difference / electricity;  
due to difference in reactivity of two metals;  
OR  
produces a voltage / potential difference / electricity;  
by redox reactions;  
[1]

(ii) negative / electrode B / right electrode;  
accept: anode because it is the electrode which supplies electrons to 
external circuit  
loses ions / iron ions / Fe²⁺ or Fe³⁺;  
electrons move from this electrode;  
[1]

(iii) change of mass of electrode / mass of rust formed;  
time / mention of stop watch / regular intervals;  
[1]

(iv) to make it a better conductor;  
[1]

Q# 3/ iGCSE Chemistry/2011/s/Paper 31/ Q2 (a)

(ii) cell  
accept battery  
not generator  
[1]

Q# 4/ iGCSE Chemistry/2010/w/Paper 31/ Q5 (b)

(iii) electrolysis  
aqueous sodium chloride  
[1]

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/

3 (i) chemical  
[1]

(ii) from right to left  
not through salt bridge  
[1]

(iii) Br₂ + 2e → 2Br⁻  
for Br⁻ as product [1]  
[2]

Q# 6/ iGCSE Chemistry/2009/w/Paper 3/ Q3

(c) (i) zinc atoms change into ions, (the zinc dissolves)  
copper(II) ions change into atoms, (becomes plated with copper)  
[1]

(ii) ions  
electrons  
[1]

Q# 7/ iGCSE Chemistry/2009/s/Paper 31/
2 molten potassium iodide NOT aqueous
hydrogen [1]
oxxygen [1]
water used up or solution becomes more concentrated or sodium chloride remains NOT no change [1]
If products are given as hydrogen, chlorine and sodium hydroxide then 2/3

copper [1]
oxxygen (and water) [1]
sulfuric acid accept hydrogen sulfate [1]

a) aqueous or dilute or concentrated potassium bromide accept correct formulae [1]

[Total: 8]

Q# 8/ iGCSE Chemistry/2008/w/Paper 31/
5 (a) (i) $2H^+ + 2e \rightarrow H_2$ [1]
(ii) $2Cl^- - 2e \rightarrow Cl_2$ or $2Cl^- \rightarrow Cl_2 + 2e$ [1]
(iii) $Na^+$ and $OH^-$ are left OR $Cl^-$ removed $OH^-$ left
NB ions by name or formula essential NOT any reaction of $Na$ or $Na^+$ NOT $Na^+$ and $OH^-$ combine

Q# 9/ iGCSE Chemistry/2008/s/Paper 31/
3 (a) impure copper
(pure) copper
ACCEPT any (soluble) copper salt or $Cu^{2+}$ if both name and formulae given, both have to be correct [1]

(b) $Cu + 2e \rightarrow Cu^{2+}$ or $Cu \rightarrow Cu^{2+} + 2e$ [2]
for having $Cu \rightarrow Cu^{2+}$ [1] ONLY

Q# 10/ iGCSE Chemistry/2006/w/Paper 3/ Q6
(b) (i) impure copper/blister copper/boulder copper etc
(pure) copper
 copper sulphate or nitrate or chloride or contains $Cu^{2+} aq$ [1]

(ii) $Cu^{2+} + 2e = Cu$ [1]

Q# 11/ iGCSE Chemistry/2006/s/Paper 3/ Q6
(c) (i) reductant zinc
oxidant hydrogen (ions) [1]

(ii) magnesium instead of zinc or increase concentration of acid or copper instead of iron [1]
(iii) sacrificial protection or stop iron/steel rusting or galvanising [1]

(d) (i) pink or purple to colourless or decolourised NOT red NOT clear [1]

(ii) $2\Gamma^- - 2e = I_2$
unbalanced ONLY [1]

Q# 12/ iGCSE Chemistry/2005/w/Paper 3/ Q5(c)

(ii) $Sr^{2+} + 2e = Sr$ [1]
$2Cl^- - 2e = Cl_2$ [1]
or $2Cl^- = Cl_2 + 2e$

(iii) hydrogen [1] and strontium hydroxide [1] [2]

Q# 13/ iGCSE Chemistry/2004/s/Paper 3/ Q5

(b) (i) $Cu^{2+} + 2e = Cu$ [1]

(ii) gas is oxygen [1]

(copper(II) sulphate) changes to sulphuric acid, or copper ions removed from solution [1]

(iii) copper atoms - electrons = copper ions accept correct symbol equation [1]

(ii) concentration of copper ions does not change or amount or number of copper ions does not change [1]
copper ions are removed and then replaced or copper is transferred from anode to cathode [1]

(iii) refining copper or plating (core) or extraction of boulder copper [1]

Q# 14/ iGCSE Chemistry/2003/s/Paper 3/ Q5

(b) (i) $La^{3+} + 3e^- = La$ [1]

(ii) hydrogen [1]
bromine NOT Bromide [1]
caesium hydroxide [1]
ignore any comments about electrodes [1]

Q# 15/ iGCSE Chemistry/2003/s/Paper 3/ Q/IGCSE Chemistry/201

(e) anode tin NOT impure time cathode iron or steel [1]
tin salt or tin ions as electrolyte NOT oxide or hydroxide or carbonate [1]
Q# 16/ iGCSE Chemistry/2002/w/Paper 3/ Q4

(b) 
(i) copper deposited or mass increases 
(ii) copper goes into solution or mass decreases 
(iii) \( \text{Cu}^{2+} + 2e^- \rightarrow \text{Cu} \) 
(iv) oxygen

\text{sulphuric acid accept hydrogen sulphate} 

(c) 
(ii) cells produce electricity or exothermic or change chemical energy into electrical energy 

\text{electrolysis uses it or endothermic or change electrical energy into chemical energy} 

Q# 17/ iGCSE Chemistry/2002/s/Paper 3/ Q3

(c) 
(steam) and alkane 
heat or catalyst or details of chemistry – forms carbon monoxide/dioxide and (hydrogen) 

OR electrolysis 

brine or acidified water 
or hydrogen forms at cathode 

OR carbon/coke 
heat or details of chemistry – forms carbon monoxide/dioxide and (hydrogen) 

Q# 18/ iGCSE Chemistry/2001/w/Paper 3/ Q4

(e) 
(i) \( \text{Zn} \rightarrow 2e \rightarrow \text{Zn}^{2+} \) 

(ii) Higher reactivity metal instead of Zn 
or lower instead of iron or bigger difference in reactivity or increase concentration of acid 

(f) 
(i) hydroxide 

(ii) \( \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^- \) 

unbalanced only [1] 
\( \text{O}_2 + 2\text{H}_2\text{O} + 2\text{Fe} \rightarrow 2\text{Fe(OH)}_2 \) [2]