

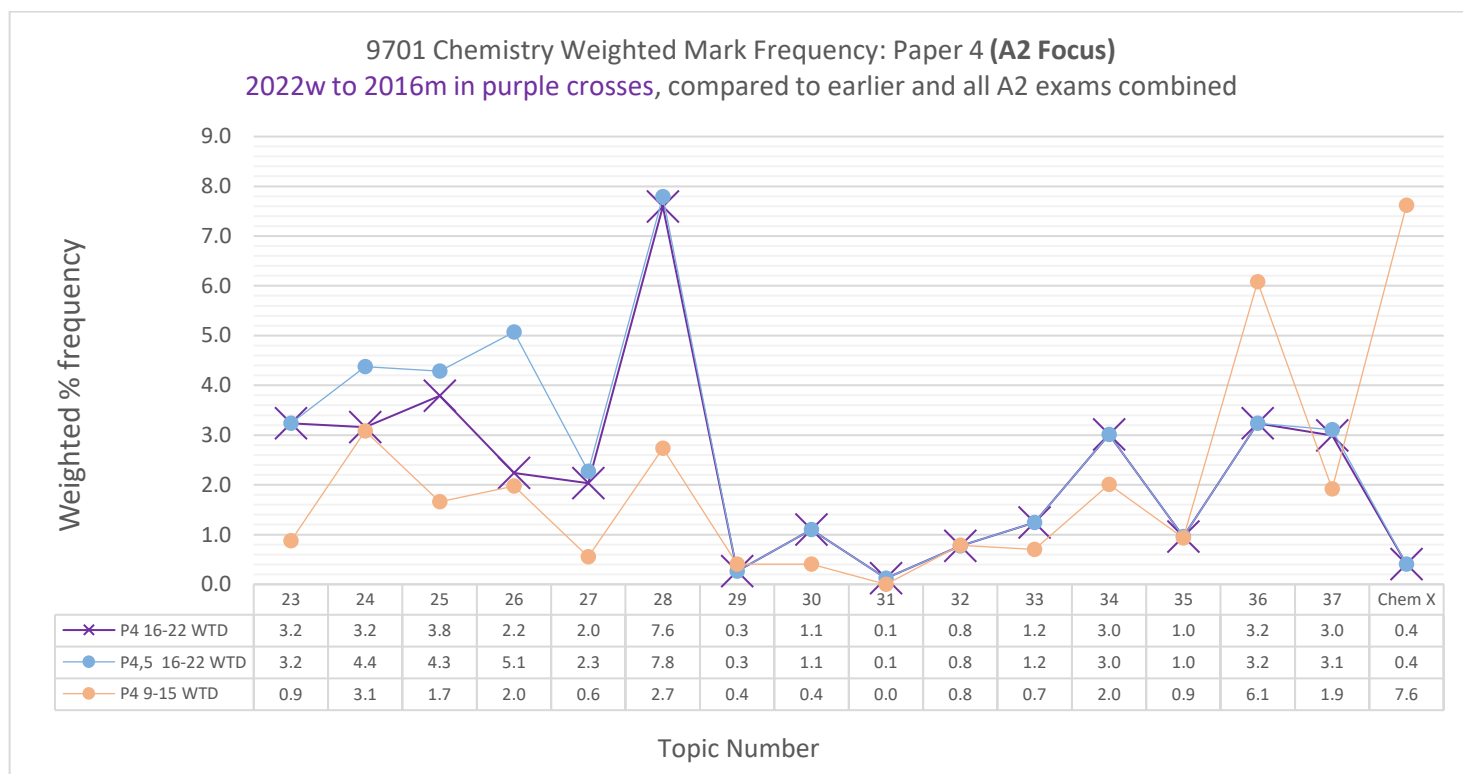
ALvl Chem 29 EQ 22m to 09w Paper 4 An introduction to A Level organic chemistry 27marks

As you start and work through this worksheet you can tick off your progress to show yourself how much you have done, and what you need to do next. The first task is just to read the first question and should take you less than 3 minutes to complete.

Paper 4 Topic Checklist

Tick each task off as you go along

	RANK:	P4 Noob	P4 Novice	P4 Bronze	P4 Silver	P4 Gold	P4 ¹ Winner	P4 Hero	P4 Legend
		1 Q Started	1 Q done	10% of marks	25% of marks	40% of marks	50% of marks	75% of marks	100% of marks
Topic 29 (marks)	27		2	3	7	11	14	20	27
Time - 72 seconds per mark (minutes)	33		3	3	8	13	16	25	33



What the most thoughtful students will get out of their extensive studying will be a capacity to do meaningful brain-based work even under stressful conditions, which is a part of the self-mastery skillset that will continue to deliver value for the whole of their lives. Outstanding grades will also happen, but the most important outcome from skillful action in study is being better at any important tasks even if circumstances are do not feel ideal.

Learning how to manage oneself so we can more reliably get ambitious and successful outcomes out of our challenges in a productive and positive way is one aspect of life's most valuable pursuit summarised and inscribed on the Temple of Apollo at Delphi: "know thyself".

1. To complete these questions, as important as your answer, is checking your answer against the mark scheme.
2. For each question, or page, convert your mark score into a percentage. This will allow you to see (and feel) your progress as you get more experience and understanding with each topic.
3. If you find you get a higher percentage answering short answer questions than multiple choice questions that often means you are using the marking scheme correctly; your correct answer might not be fully complete. The marks easiest to miss rely on providing more details fully described.

¹ DO NOT work on these higher levels of completion unless you have also achieved at least a "Silver" (25%) in the same topic in Paper 5, if it exists.

Organic chemistry

29 An introduction to A Level organic chemistry

Class of compound	Name of functional group	Structural formula of functional group	Displayed formula	Skeletal formula	Name
arene	arene		*n/a		benzene
halogenoarene	halogen		*n/a		chlorobenzene (when X = Cl)
phenol	phenol		*n/a		phenol
acyl chloride	acyl chloride				propanoyl chloride
amines (secondary and tertiary)	amine				(naming of secondary and tertiary amines is not required)
amide (primary, secondary and tertiary)	amide				propanamide
amino acid	amine and carboxyl				2-aminoethanoic acid

*where a benzene ring is part of the molecule, a displayed formula would not be expected to be drawn.

29.1 Formulae, functional groups and the naming of organic compounds

Learning outcomes

Candidates should be able to:

- 1 understand that the compounds in the table on page 42 contain a functional group which dictates their physical and chemical properties
- 2 interpret and use the general, structural, displayed and skeletal formulae of the classes of compound stated in the table on page 42
- 3 understand and use systematic nomenclature of simple aliphatic organic molecules (including cyclic compounds containing a single ring of up to six carbon atoms) with functional groups detailed in the table on page 42, up to six carbon atoms (six plus six for esters and amides, straight chains only for esters and nitriles)
- 4 understand and use systematic nomenclature of simple aromatic molecules with one benzene ring and one or more simple substituents, for example 3-nitrobenzoic acid or 2,4,6-tribromophenol

29.2 Characteristic organic reactions

Learning outcomes

Candidates should be able to:

- 1 understand and use the following terminology associated with types of organic mechanisms:
 - (a) electrophilic substitution
 - (b) addition-elimination

29.3 Shapes of aromatic organic molecules; σ and π bonds

Learning outcomes

Candidates should be able to:

- 1 describe and explain the shape of benzene and other aromatic molecules, including sp^2 hybridisation, in terms of σ bonds and a delocalised π system

29.4 Isomerism: optical

Learning outcomes

Candidates should be able to:

- 1 understand that enantiomers have identical physical and chemical properties apart from their ability to rotate plane polarised light and their potential biological activity
- 2 understand and use the terms optically active and racemic mixture
- 3 describe the effect on plane polarised light of the two optical isomers of a single substance
- 4 explain the relevance of chirality to the synthetic preparation of drug molecules including:
 - (a) the potential different biological activity of the two enantiomers
 - (b) the need to separate a racemic mixture into two pure enantiomers
 - (c) the use of chiral catalysts to produce a single pure optical isomer(Candidates should appreciate that compounds can contain more than one chiral centre, but knowledge of meso compounds and nomenclature such as diastereoisomers is **not** required.)



Q# 1/ ALVl Chemistry/2022/m/TZ 1/Paper 4/Q# 4 /www.SmashingScience.org :o)

4 Compounds **F** and **J** are shown in Fig. 4.1.

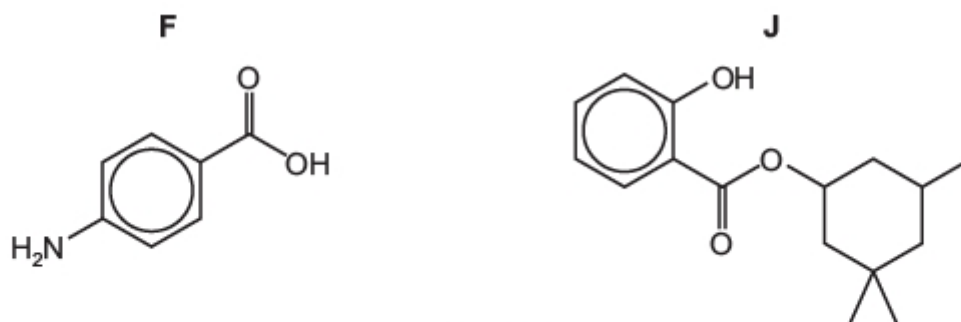


Fig. 4.1

(a) **F** and **J** both contain the arene functional group.

(i) Identify the other functional groups in **F** and **J**.

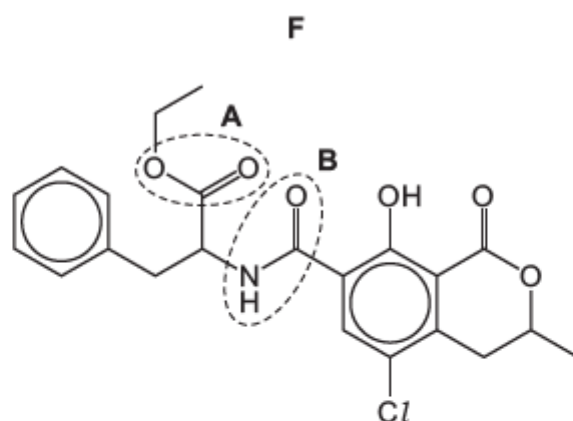
F:

J:

[2]

Q# 2/ ALVl Chemistry/2020/m/TZ 2/Paper 4/Q# 4 /www.SmashingScience.org :o)

4 Compound **F** has been found in small quantities in some cereals and dried fruit.



(a) (i) Give the name of the functional groups labelled **A** and **B**.

A

B

[2]

(ii) State the number of chiral carbon atoms in one molecule of **F**.

..... [1]

Q# 3/ ALVl Chemistry/2019/s/TZ 1/Paper 4/Q# 7 /www.SmashingScience.org :o)

7 (a) Benzene can be converted into cyclohexane.



(ii) State the bond angles in benzene and cyclohexane.

bond angle in benzene bond angle in cyclohexane

Explain your answers.

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

[2]

Q# 4/ ALvl Chemistry/2019/m/TZ 2/Paper 4/Q# 6 /www.SmashingScience.org :o)

6 The names of many drugs used in medicine often include parts of the names of the functional groups their molecules contain.

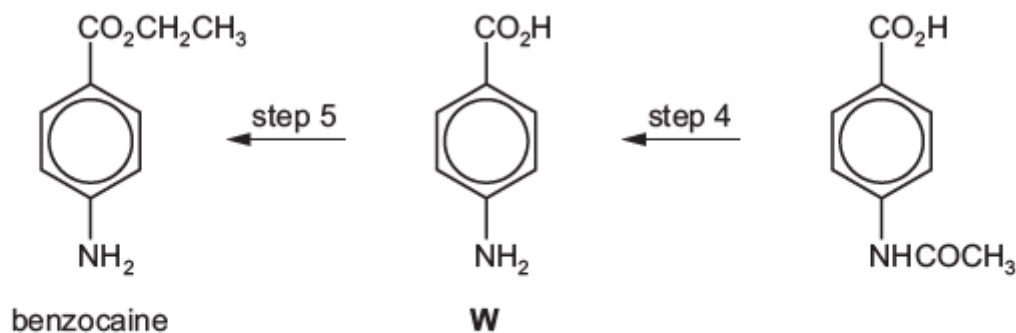
(a) Suggest **two** functional groups present in a molecule of the drug named chloramphenicol.

1

2

[1]

Q# 5/ ALvl Chemistry/2017/w/TZ 1/Paper 4/Q# 6(b) /www.SmashingScience.org :o)

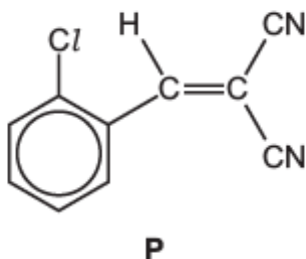


(i) Give the systematic name of compound W.

..... [1]

Q# 6/ ALvl Chemistry/2017/w/TZ 1/Paper 4/Q# 5 /www.SmashingScience.org :o)

5 Compound P contains several functional groups.



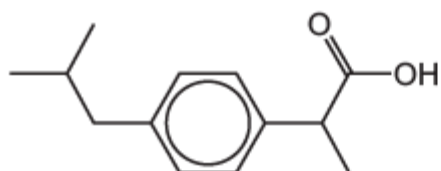
(a) Name the functional groups present in P.

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

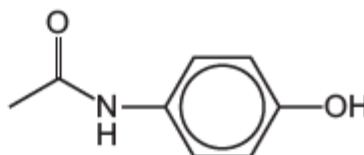


Q# 7/ ALvl Chemistry/2016/w/TZ 1/Paper 4/Q# 6 /www.SmashingScience.org :o)

6 Ibuprofen and paracetamol are pain-relief drugs.



ibuprofen



paracetamol

(a) Ibuprofen and paracetamol both contain the aryl (benzene) functional group.

Name the **other** functional groups present in each molecule.

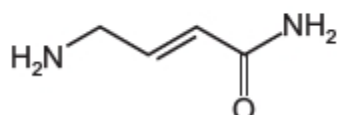
ibuprofen

paracetamol

[2]

Q# 8/ ALvl Chemistry/2015/w/TZ 1/Paper 4/Q# 7 /www.SmashingScience.org :o)

(b) Compound **W** has the following structure.



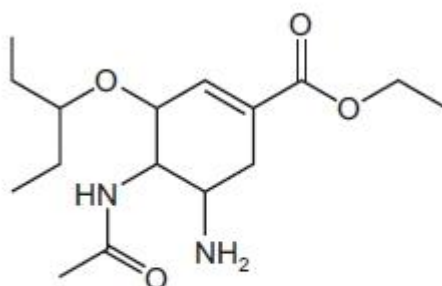
(i) How many σ and π bonds are present in a molecule of **W**?

σ bonds π bonds

[2]

Q# 9/ ALvl Chemistry/2014/w/TZ 1/Paper 4/Q# 7 /www.SmashingScience.org :o)

7 (a) Oseltamivir is an antiviral drug that slows the spread of the influenza (flu) virus.



oseltamivir

Circle **two** bonds, each in a different functional group, that could be easily hydrolysed in the body. [2]

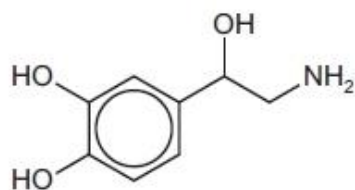
(b) Oseltamivir is a chiral drug. This drug is usually taken as a single optical isomer rather than as a mixture of isomers.

Suggest **one** benefit of taking a drug in this way.

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

Q# 10/ ALvl Chemistry/2014/s/TZ 1/Paper 4/Q# 4 /www.SmashingScience.org :o)

- 4 Noradrenaline is a hormone and neurotransmitter, which is released during stress to stimulate the heart and increase blood pressure.



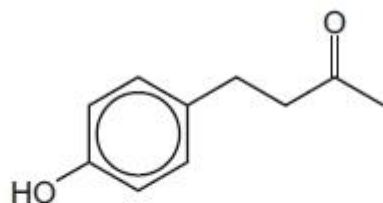
noradrenaline

- (a) State the **names** of **three** functional groups in the noradrenaline molecule.

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

Q# 11/ ALvl Chemistry/2012/w/TZ 1/Paper 4/Q# 5 /www.SmashingScience.org :o)

- 5 Compound G is a naturally occurring aromatic compound that is present in raspberries.



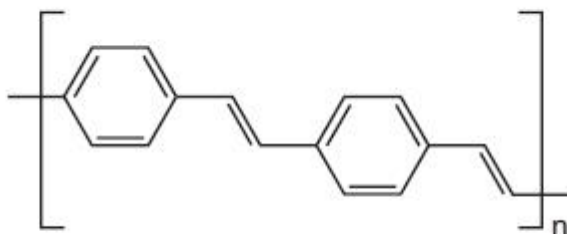
compound G

- (a) Identify the functional groups present in compound G.

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

Q# 12/ ALvl Chemistry/2012/s/TZ 1/Paper 4/Q# 8 /www.SmashingScience.org :o)

- (d) There has been a great deal of commercial interest in the development of polymers that can conduct electricity and/or emit light. A length of one such polymer is shown.



- (i) Suggest how this polymer conducts electricity.

.....

(ii) Suggest the molecular geometry required for this molecule to conduct.

Explain your answer.

.....

.....

(iii) What is the empirical formula of this polymer?

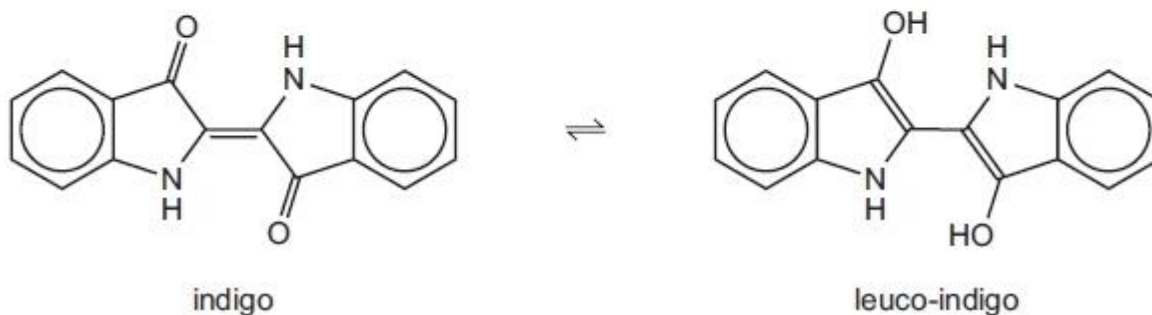
.....

[4]

Q# 13/ ALVl Chemistry/2012/s/TZ 1/Paper 4/Q# 3 /www.SmashingScience.org :o)

3 Indigo is the dye used in blue jeans. Although originally extracted from plants of the type *indigofera*, it is now almost entirely made artificially.

Indigo is insoluble in water but this disadvantage can be overcome by converting it into the water-soluble colourless leuco-indigo. If cloth soaked in a solution of leuco-indigo is left to dry in the air, the leuco-indigo is converted into the insoluble blue indigo, which is precipitated out onto the fibres of the cloth.



(ii) Name **three** functional groups in indigo.

..... [2]

Mark Scheme

Q# 1/ ALVl Chemistry/2022/m/TZ 1/Paper 4/Q# 4 /www.SmashingScience.org :o)

4(a)(i)	In F: (phenyl)amine AND carboxylic acid In J: phenol AND ester Any two for one mark All four for two marks	2
---------	---	---

Q# 2/ ALVl Chemistry/2020/m/TZ 2/Paper 4/Q# 4 /www.SmashingScience.org :o)

4(a)(i)	A = ester B = (2°) amide	2
4(a)(ii)	2	1

Q# 3/ ALVl Chemistry/2019/s/TZ 1/Paper 4/Q# 7 /www.SmashingScience.org :o)

7(a)(ii)	M1: benzene (120°) and cyclohexane (109.5°) M2: as π -bonds are transformed into σ -bonds	2
----------	---	---

Q# 4/ ALVl Chemistry/2019/m/TZ 2/Paper 4/Q# 6 /www.SmashingScience.org :o)

6(a)	Any two of: chloro amine / amino alcohol / hydroxyl / phenol benzene / phenyl ring / aryl / arene	1
------	---	---

Q# 5/ ALvl Chemistry/2017/w/TZ 1/Paper 4/Q# 6 /www.SmashingScience.org :o)

6(b)(i)	4-aminobenzoic acid	1
---------	---------------------	---

Q# 6/ ALvl Chemistry/2017/w/TZ 1/Paper 4/Q# 5 /www.SmashingScience.org :o)

5(a)	nitrile; alkene; chloro; benzene/arene	2
------	--	---

Q# 7/ ALvl Chemistry/2016/w/TZ 1/Paper 4/Q# 6 /www.SmashingScience.org :o)

6(a)	ibuprofen: carboxylic acid / carboxyl paracetamol: phenol and amide any two = 1 mark all three = 2 marks	
------	---	--

Q# 8/ ALvl Chemistry/2015/w/TZ 1/Paper 4/Q# 7 /www.SmashingScience.org :o)

(b) (i)	σ -bonds = 14 π -bonds = 2	2
---------	--	---

Q# 9/ ALvl Chemistry/2014/w/TZ 1/Paper 4/Q# 7 /www.SmashingScience.org :o)

(b)	lower doses of the drug required OR improved activity of the drug OR reduced side effects	1	[1]
(c)	decreases enzyme activity OR decreases rate at which product is formed binds with the enzyme's active site OR has a complementary shape to active site OR similar shape to substrate (competitive inhibition can be overcome by) increasing [substrate] OR increasing substrate concentration	1 1 1	[3]
(d)	energy source/carrier OR releases energy when hydrolysed	1	[1]

Q# 10/ ALvl Chemistry/2014/s/TZ 1/Paper 4/Q# 4 /www.SmashingScience.org :o)

4 (a) three from phenol
(secondary) alcohol
(primary) amine
arene/aryl/benzene 3 × [1]

Q# 11/ ALvl Chemistry/2012/w/TZ 1/Paper 4/Q# 5 /www.SmashingScience.org :o)

5 (a) phenol [1]
ketone [1]
[2]

Q# 12/ ALvl Chemistry/2012/s/TZ 1/Paper 4/Q# 8 /www.SmashingScience.org :o)

(d) (i) (through its long chain of) delocalised electrons/mobile electrons
free electrons is not sufficient [1]

(ii) planar [1]

the π bonds/p-orbitals overlap (with each other) [1]

(iii) C_8H_6
 C_4H_3 [2]

[5 max 4]

[Total: 10]

Q# 13/ ALvl Chemistry/2012/s/TZ 1/Paper 4/Q# 3 /www.SmashingScience.org :o)

(ii) ketone, alkene, amine, aryl (benzene/arene/phenyl) (any 3) [2]

