



**SECTION A**

**Answer ALL the questions in this section in the Answer Book.**

**You should aim to spend no more than 20 minutes on this section.**

**For each question, select one answer from A to D and put a cross  $\boxtimes$  in the Answer Book. If you change your mind, put a line through the box  $\boxtimes$  and then mark your new answer with a cross  $\boxtimes$ .**

**1** What is the empirical formula of butane?

- A**  $C_4H_{10}$
- B**  $C_2H_5$
- C**  $CH_{2.5}$
- D**  $C_nH_{2n+2}$

**(Total for Question 1 = 1 mark)**

**2** When zinc is added to copper(II) sulfate solution, copper is formed.

(a) What is a possible name for this type of reaction?

(1)

- A** addition
- B** displacement
- C** neutralisation
- D** substitution

(b) Which is the ionic half-equation for a process that takes place during this reaction?

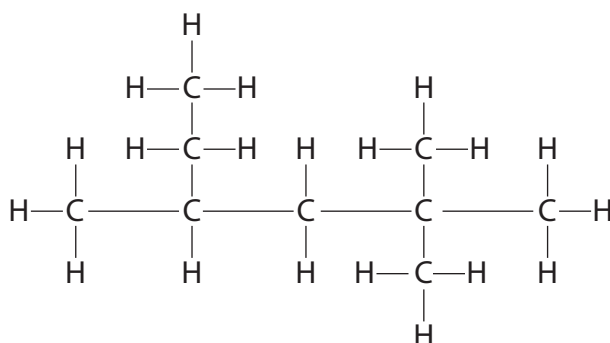
(1)

- A**  $Cu^{2+} + e^{-} \rightarrow Cu^{+}$
- B**  $Cu^{+} + e^{-} \rightarrow Cu$
- C**  $Zn \rightarrow Zn^{+} + e^{-}$
- D**  $Zn \rightarrow Zn^{2+} + 2e^{-}$

**(Total for Question 2 = 2 marks)**



3 What is the name of the hydrocarbon shown using IUPAC rules?



- A 2,2-dimethyl-4-ethylpentane
- B 2-ethyl-4,4-dimethylpentane
- C 3,5,5-trimethylhexane
- D 2,2,4-trimethylhexane

(Total for Question 3 = 1 mark)

4 Which element is in the **p-block** and has atoms containing **two** unpaired electrons in the ground state?

- A carbon
- B fluorine
- C lithium
- D titanium

(Total for Question 4 = 1 mark)

5 Sea water contains 2.7 mg of sulfate ions per kilogram.  
What is the concentration of sulfate ions in parts per million by mass?

- A  $2.7 \times 10^{-6}$
- B  $2.7 \times 10^{-3}$
- C 2.7
- D  $2.7 \times 10^3$

(Total for Question 5 = 1 mark)



6 How many ions are in 284 g of sodium sulfate,  $\text{Na}_2\text{SO}_4$ ?

Data: Avogadro constant =  $6.0 \times 10^{23} \text{ mol}^{-1}$   
Molar mass of sodium sulfate =  $142 \text{ g mol}^{-1}$

- A  $1.2 \times 10^{24}$
- B  $2.4 \times 10^{24}$
- C  $3.6 \times 10^{24}$
- D  $8.4 \times 10^{24}$

(Total for Question 6 = 1 mark)

7  $100 \text{ cm}^3$  of methane,  $\text{CH}_4$ , is completely burned in  $400 \text{ cm}^3$  of oxygen.

What is the final volume of the gas mixture, in  $\text{cm}^3$ , when all volumes are measured at room temperature and pressure?

- A 100
- B 200
- C 300
- D 500

(Total for Question 7 = 1 mark)

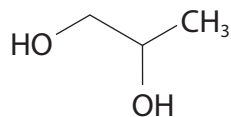
8 Which ion has the **largest** ionic radius?

- A  $\text{Ca}^{2+}$
- B  $\text{Cl}^-$
- C  $\text{K}^+$
- D  $\text{S}^{2-}$

(Total for Question 8 = 1 mark)



9 Which reagent reacts with propene to form the compound shown?



- A oxygen and water
- B hydrogen peroxide solution
- C aqueous sodium hydroxide
- D acidified potassium manganate(VII)

(Total for Question 9 = 1 mark)

10 How many straight chain (non-cyclic) isomers have the molecular formula  $C_3H_5Cl$ ?

- A 3
- B 4
- C 5
- D 6

(Total for Question 10 = 1 mark)

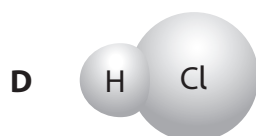
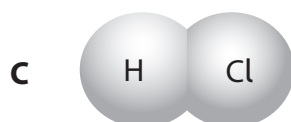
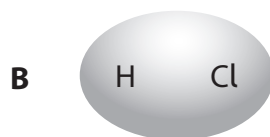
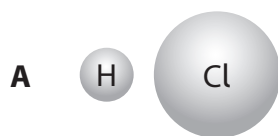
11 When ethane reacts with chlorine, a mixture of products forms.

Which of the products gives the **best** evidence for a free radical mechanism?

- A HCl
- B  $C_4H_{10}$
- C  $C_2H_5Cl$
- D  $C_2H_4Cl_2$

(Total for Question 11 = 1 mark)

12 Which diagram **best** represents the electron density in a molecule of hydrogen chloride?



(Total for Question 12 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

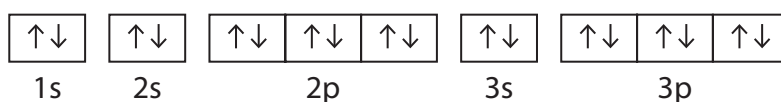


**13** Which pair of ions will form the compound with the most covalent character?

- A  $\text{Li}^+$  and  $\text{I}^-$
- B  $\text{Na}^+$  and  $\text{Br}^-$
- C  $\text{K}^+$  and  $\text{Cl}^-$
- D  $\text{Rb}^+$  and  $\text{F}^-$

(Total for Question 13 = 1 mark)

**14** Which ion does **not** have the electronic configuration shown?



- A  $\text{K}^+$
- B  $\text{Ca}^{2+}$
- C  $\text{Ti}^{2+}$
- D  $\text{Sc}^{3+}$

(Total for Question 14 = 1 mark)

**15** What is the electronic configuration of the nitride ion,  $\text{N}^{3-}$ ?

- A  $1s^2 2s^2$
- B  $1s^2 2s^2 2p^3$
- C  $1s^2 2s^2 2p^4$
- D  $1s^2 2s^2 2p^6$

(Total for Question 15 = 1 mark)

**16** The first five ionisation energies of an element, in  $\text{kJ mol}^{-1}$ , are

578	1817	2745	11 578	14 831
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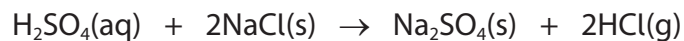
Which element could this be?

- A sodium
- B magnesium
- C aluminium
- D silicon

(Total for Question 16 = 1 mark)



- 17** Sodium sulfate is formed when concentrated sulfuric acid reacts with excess sodium chloride at very high temperatures.



Data:  $M_r$       98.1              58.5              142.1              36.5

What is the atom economy by mass for the formation of sodium sulfate?

- A** 64%
- B** 66%
- C** 80%
- D** 91%

**(Total for Question 17 = 1 mark)**

- 18** Which hazard symbol must be displayed on a bottle containing hexane?



**(Total for Question 18 = 1 mark)**

**Use this space for any rough working. Anything you write in this space will gain no credit.**

**19** Which is a free radical?

- A** OH
- B** OH<sup>-</sup>
- C** OH<sub>2</sub>
- D** OH<sub>3</sub><sup>+</sup>

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**(Total for Question 19 = 1 mark)**

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**TOTAL FOR SECTION A = 20 MARKS**



**SECTION B**

**Answer ALL the questions. Write your answers in the spaces provided in the Answer Book.**

**20** This question is about the bonding, structure and properties of the elements in Period 3 of the Periodic Table and their compounds.

(a) The melting temperatures of the elements across Period 3 are shown.

element	Na	Mg	Al	Si	P	S	Cl	Ar
melting temperature / K	371	922	933	1683	317	386	172	84

(i) Plot a graph of melting temperatures against elements in Period 3 on the grid in the Answer Book.

(3)

(ii) Explain, with reference to structure and bonding, why silicon has a very high melting temperature.

(3)

(b) Sodium has the lowest electrical conductivity of the Period 3 elements.

(i) Describe how metals conduct electricity.

(2)

(ii) Give a possible reason why sodium has a lower electrical conductivity than aluminium.

(1)

(c) Aluminium is extracted by the electrolysis of molten aluminium oxide.

(i) Draw a dot-and-cross diagram to show the bonding in aluminium oxide. Use dots(●) for aluminium electrons and crosses(×) for oxygen electrons. Show outer shell electrons only.

(3)

(ii) Give a reason why aluminium oxide must be molten before electrolysis can occur.

(1)

**(Total for Question 20 = 13 marks)**



**21** This question is about a preparation of hydrated zinc sulfate crystals.

An excess of powdered zinc is added to  $25.0 \text{ cm}^3$  of  $1.25 \text{ mol dm}^{-3}$  sulfuric acid.

(a) (i) State **two** observations you would make during this reaction. (2)

(ii) Write the **ionic** equation for this reaction.  
Include state symbols. (2)

(b) (i) The formula of the hydrated zinc sulfate crystals is  $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ .  
Calculate the molar mass of  $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ . (1)

(ii) Calculate the number of moles of sulfuric acid in  $25.0 \text{ cm}^3$  of a  
 $1.25 \text{ mol dm}^{-3}$  solution. (1)

(iii)  $3.75 \text{ g}$  of hydrated zinc sulfate crystals form.  
Calculate the percentage yield of hydrated zinc sulfate.  
Give your answer to an appropriate number of significant figures. (2)

**(Total for Question 21 = 8 marks)**

**22** A sample of an element, **X**, was extracted from a meteorite.

The percentage abundances by mass of the isotopes of **X** in the mass spectrum of the sample are shown.

$m/z$	Percentage abundance
54	5.45
56	92.1
57	2.45

- (a) (i) Calculate the relative atomic mass of the **X** in this sample.  
Give your answer to **three** significant figures. (2)
- (ii) Identify **X** and hence give the numbers of particles present in the species at  $m/z = 56$  in the mass spectrum. (2)
- (iii) A peak at  $m/z = 28$  was also detected in the mass spectrum of **X**.  
Identify the species which produced this peak. (1)
- (b) Explain why the three isotopes of **X** will have the same chemical properties. (2)

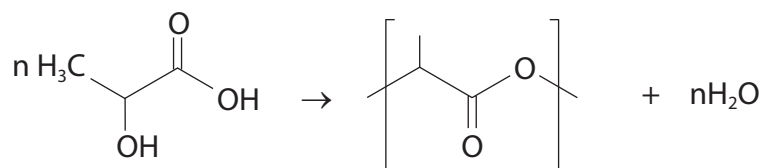
**(Total for Question 22 = 7 marks)**



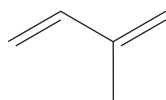
**23** This question is about polymers.

- (a) Plastic bags can be made from poly(lactic acid), PLA, which is biodegradable. PLA is obtained from corn.

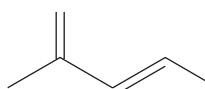
An equation for the polymerisation of lactic acid is shown.



- (i) Write a balanced equation for the polymerisation of propene using displayed formulae. (2)
- (ii) Give **two** differences between the polymerisation of propene and that of lactic acid. (2)
- (iii) Identify what in the environment breaks down biodegradable polymers. (1)
- (iv) Biodegradable polymers reduce waste going to landfill. Give **two other** advantages of biodegradable polymers. (2)
- (b) Isoprene is used to make synthetic rubber. A skeletal formula for isoprene is shown.



- (i) State why isoprene does **not** have geometric isomers. (1)
- (ii) A related molecule does show geometric isomerism.



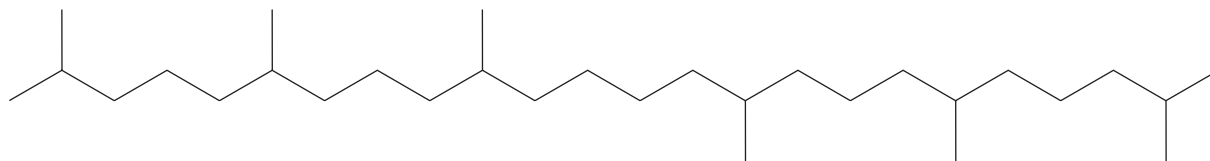
Draw the **skeletal** formula of the geometric isomer of this molecule. (1)

- (iii) Give the reason why a carbon-carbon double bond may result in geometric isomerism. (1)

**Total for Question 23 = 10 marks**



**24** This question is about the production of squalane, a liquid alkane which occurs naturally in human skin and is used in cosmetic products.



**squalane**

(a) Squalane is odourless and colourless.

Suggest **two other** properties that make squalane useful in cosmetics.

(2)

(b) Give the **molecular** formula of squalane.

(1)

(c) Squalane can be produced from squalene, an alkene present in various oils, by reaction with hydrogen gas in the presence of a suitable catalyst.

(i) Give the name of a suitable catalyst for the hydrogenation of squalene.

(1)

(ii) Squalane used in cosmetic products must contain no more than 0.2 ppm of catalyst.

Calculate the maximum permitted mass of catalyst in a cosmetic product containing 40 g of squalane.

Give your answer in **standard form**.

(1)

(iii) A reactor at 200°C contains 6800 mol of squalene, and hydrogen gas at a pressure of  $4.0 \times 10^5$  Pa.

Under these conditions, the complete hydrogenation of squalene requires 400 m<sup>3</sup> of hydrogen gas.

Calculate the number of C=C bonds in one molecule of squalene.

Use the ideal gas equation,  $pV = nRT$ .

[Data:  $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ ]

(4)

(iv) Write the equation, using molecular formulae, for the complete hydrogenation of squalene to squalane.

State symbols are **not** required.

(1)



(d) Globally, several million  $\text{dm}^3$  of squalene is consumed each year. Traditionally, squalene was obtained exclusively from shark liver oil. The liver of a typical shark yields 290 g squalene.

(i) Suggest the name of a suitable technique to obtain squalene from shark liver oil.

(1)

(ii) Calculate the minimum number of sharks that would be needed to produce 2.6 million  $\text{dm}^3$  of squalene.

[Data: Density of squalene =  $0.86 \text{ g cm}^{-3}$ ]

(2)

(iii) Many large corporations now use squalane obtained entirely from plants.

Squalane can be obtained sustainably from corn starch with a yield of 22.6% by mass.

The production of 1 tonne of corn starch requires 0.093 hectares of land.

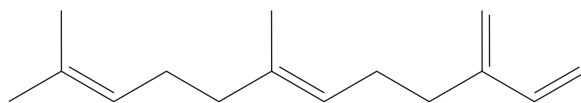
Calculate the area of land, **in  $\text{km}^2$** , required to produce 3500 tonnes of squalane from corn starch.

[Data: 1 tonne = 1000 kg; 1 hectare =  $0.01 \text{ km}^2$ ]

(3)

- (e) The alkene, **X**, with the molecular formula,  $C_{15}H_{24}$ , can also be obtained from corn starch.

**X** is the *E* geometric isomer and only has one geometric isomer.



**X**

- (i) State why **X** is the *E* isomer. (1)
- (ii) The structure of **X** can be simplified to  $R-CH=CH_2$ .  
 Draw the mechanism for the formation of the **major** product of the reaction between **X** and hydrogen bromide.  
 Use the simplified structure.  
 Include curly arrows, and relevant lone pairs and dipoles. (4)
- (iii) Complete the diagram in the Answer Book to show another structural isomer of  $C_{15}H_{24}$ . (1)

**(Total for Question 24 = 22 marks)**

**TOTAL FOR SECTION B = 60 MARKS**  
**TOTAL FOR PAPER = 80 MARKS**



Please check the examination details below before entering your candidate information

Candidate surname	Other names
Centre Number	Candidate Number
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Pearson Edexcel International Advanced Level

Monday 12 January 2026

Afternoon (Time: 1 hour 30 minutes)	<div style="border: 1px solid black; padding: 2px; display: inline-block;">Paper reference</div> <span style="font-size: 1.5em; font-weight: bold; margin-left: 10px;">WCH11/01A</span>
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Chemistry

International Advanced Subsidiary/Advanced Level

UNIT 1: Structure, Bonding and Introduction to Organic Chemistry

Answer Book

<p><b>You must have:</b></p> Scientific calculator, ruler, HB pencil and Question Paper (sent separately)	<div style="border: 1px solid black; padding: 5px; width: 80px; height: 40px; margin: 0 auto;">Total Marks</div>
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### Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

### Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- A Periodic Table is printed on the back cover of this paper.

### Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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**Pearson**

**SECTION A****Answer ALL the questions in this section.****You should aim to spend no more than 20 minutes on this section.****For each question, select one answer from A to D and put a cross in the box . If you change your mind, put a line through the box [X] and then mark your new answer with a cross .****1**

- A  
 B  
 C  
 D

**(Total for Question 1 = 1 mark)****2**

(a)

- A  
 B  
 C  
 D

(1)

(b)

- A  
 B  
 C  
 D

(1)

**(Total for Question 2 = 2 marks)**

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**3**

- A
- B
- C
- D

**(Total for Question 3 = 1 mark)****4**

- A
- B
- C
- D

**(Total for Question 4 = 1 mark)****5**

- A
- B
- C
- D

**(Total for Question 5 = 1 mark)**

6

- A
- B
- C
- D

(Total for Question 6 = 1 mark)

7

- A
- B
- C
- D

(Total for Question 7 = 1 mark)

8

- A
- B
- C
- D

(Total for Question 8 = 1 mark)

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9

- A
- B
- C
- D

(Total for Question 9 = 1 mark)

10

- A
- B
- C
- D

(Total for Question 10 = 1 mark)

11

- A
- B
- C
- D

(Total for Question 11 = 1 mark)



12

- A
- B
- C
- D

(Total for Question 12 = 1 mark)

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13

- A
- B
- C
- D

(Total for Question 13 = 1 mark)

14

- A
- B
- C
- D

(Total for Question 14 = 1 mark)

15

- A
- B
- C
- D

(Total for Question 15 = 1 mark)

16

- A
- B
- C
- D

(Total for Question 16 = 1 mark)



17

- A
- B
- C
- D

(Total for Question 17 = 1 mark)

18

- A
- B
- C
- D

(Total for Question 18 = 1 mark)

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19

- A
- B
- C
- D

(Total for Question 19 = 1 mark)

**TOTAL FOR SECTION A = 20 MARKS**

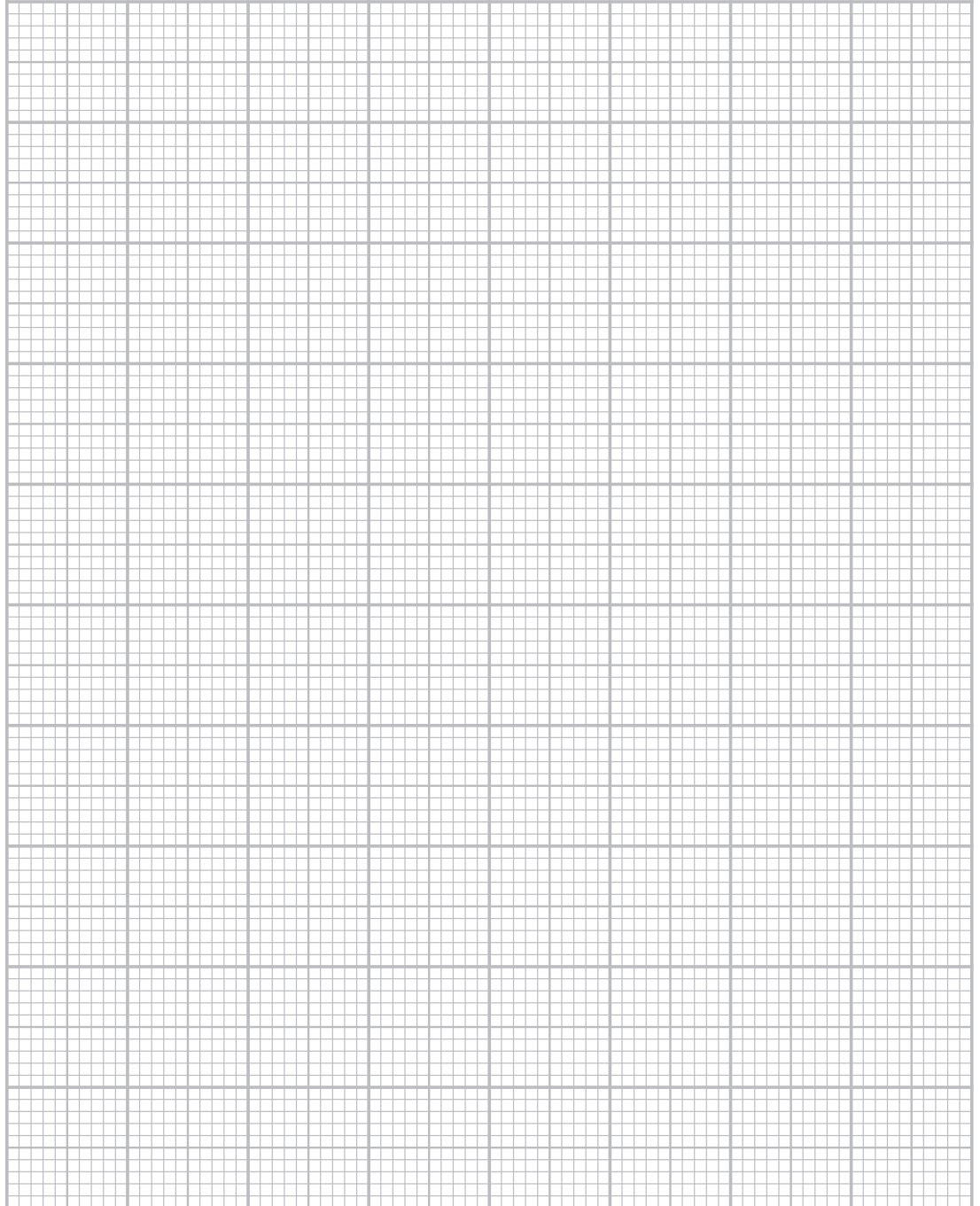


**SECTION B**

**Answer ALL the questions. Write your answers in the spaces provided.**

**20 (a) (i)**

**(3)**



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(ii)

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(b)

(i)

(2)

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(ii)

(1)

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(c)

(i)

(3)

(ii)

(1)

(Total for Question 20 = 13 marks)



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**21**

(a) (i) (2)

.....

.....

.....

(ii) (2)

(b) (i) (1)

(ii) (1)

(iii) (2)

**(Total for Question 21 = 8 marks)**



22

(a) (i) (2)

(ii) (2)

X .....

Number of particles present in the species at $m / e = 56$		
protons	electrons	neutrons

(iii) (1)

(b) (2)

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**(Total for Question 22 = 7 marks)**

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(b)

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(ii)

(1)

(iii)

(1)

**(Total for Question 23 = 10 marks)**



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24

(a)

(2)

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(b)

(1)

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(c)

(i)

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(ii)

(1)



(iii)

(4)

(iv)

(1)

(d)

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(iii)

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(e)

(i)

(1)

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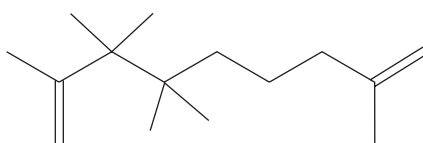


(ii)

(4)

(iii)

(1)



(Total for Question 24 = 22 marks)

**TOTAL FOR SECTION B = 60 MARKS**  
**TOTAL FOR PAPER = 80 MARKS**

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# The Periodic Table of Elements

1      2      3      4      5      6      7      0 (8)

1.0	<b>H</b>
	hydrogen
	1

**Key**

relative atomic mass
<b>atomic symbol</b>
name
atomic (proton) number

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	
6.9 <b>Li</b> lithium 3	9.0 <b>Be</b> beryllium 4	45.0 <b>Sc</b> scandium 21	47.9 <b>Ti</b> titanium 22	50.9 <b>V</b> vanadium 23	52.0 <b>Cr</b> chromium 24	54.9 <b>Mn</b> manganese 25	55.8 <b>Fe</b> iron 26	58.9 <b>Co</b> cobalt 27	58.7 <b>Ni</b> nickel 28	63.5 <b>Cu</b> copper 29	65.4 <b>Zn</b> zinc 30	10.8 <b>B</b> boron 5	12.0 <b>C</b> carbon 6	14.0 <b>N</b> nitrogen 7	16.0 <b>O</b> oxygen 8	19.0 <b>F</b> fluorine 9	4.0 <b>He</b> helium 2	
23.0 <b>Na</b> sodium 11	24.3 <b>Mg</b> magnesium 12	88.9 <b>Y</b> yttrium 39	91.2 <b>Zr</b> zirconium 40	92.9 <b>Nb</b> niobium 41	95.9 <b>Mo</b> molybdenum 42	[98] <b>Tc</b> technetium 43	101.1 <b>Ru</b> ruthenium 44	102.9 <b>Rh</b> rhodium 45	106.4 <b>Pd</b> palladium 46	107.9 <b>Ag</b> silver 47	112.4 <b>Cd</b> cadmium 48	27.0 <b>Al</b> aluminium 13	28.1 <b>Si</b> silicon 14	31.0 <b>P</b> phosphorus 15	32.1 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17	39.9 <b>Ar</b> argon 18	
39.1 <b>K</b> potassium 19	40.1 <b>Ca</b> calcium 20	87.6 <b>Sr</b> strontium 38	91.2 <b>Zr</b> zirconium 40	92.9 <b>Nb</b> niobium 41	95.9 <b>Mo</b> molybdenum 42	101.1 <b>Ru</b> ruthenium 44	102.9 <b>Rh</b> rhodium 45	106.4 <b>Pd</b> palladium 46	107.9 <b>Ag</b> silver 47	112.4 <b>Cd</b> cadmium 48	114.8 <b>In</b> indium 49	69.7 <b>Ga</b> gallium 31	72.6 <b>Ge</b> germanium 32	74.9 <b>As</b> arsenic 33	79.0 <b>Se</b> selenium 34	79.9 <b>Br</b> bromine 35	83.8 <b>Kr</b> krypton 36	
132.9 <b>Cs</b> caesium 55	137.3 <b>Ba</b> barium 56	138.9 <b>La*</b> lanthanum 57	178.5 <b>Hf</b> hafnium 72	180.9 <b>Ta</b> tantalum 73	183.8 <b>W</b> tungsten 74	186.2 <b>Re</b> rhenium 75	190.2 <b>Os</b> osmium 76	195.1 <b>Pt</b> platinum 78	197.0 <b>Au</b> gold 79	200.6 <b>Hg</b> mercury 80	204.4 <b>Tl</b> thallium 81	204.4 <b>Pb</b> lead 82	207.2 <b>Pb</b> lead 82	209.0 <b>Po</b> polonium 84	209.0 <b>Bi</b> bismuth 83	210.0 <b>Po</b> polonium 84	[222] <b>Rn</b> radon 86	
[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111									

140 <b>Ce</b> cerium 58	141 <b>Pr</b> praseodymium 59	144 <b>Nd</b> neodymium 60	150 <b>Sm</b> samarium 62	152 <b>Eu</b> europium 63	157 <b>Gd</b> gadolinium 64	163 <b>Dy</b> dysprosium 66	165 <b>Ho</b> holmium 67	167 <b>Er</b> erbium 68	169 <b>Tm</b> thulium 69	173 <b>Yb</b> ytterbium 70	175 <b>Lu</b> lutetium 71
232 <b>Th</b> thorium 90	[231] <b>Pa</b> protactinium 91	238 <b>U</b> uranium 92	[242] <b>Pu</b> plutonium 94	[243] <b>Am</b> americium 95	[247] <b>Cm</b> curium 96	[251] <b>Cf</b> californium 98	[254] <b>Es</b> einsteinium 99	[253] <b>Fm</b> fermium 100	[256] <b>Md</b> mendelevium 101	[254] <b>No</b> nobelium 102	[257] <b>Lr</b> lawrencium 103

\* Lanthanide series

\* Actinide series

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