Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Wednesday 07 May 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **WCH11/01**

Chemistry

International Advanced Subsidiary/Advanced Level
UNIT 1: Structure, Bonding and Introduction to Organic Chemistry

You must have:
Scientific calculator, ruler

Total Marks

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.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- 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 ☒ and then mark your new answer with a cross ☒.

1: Which row shows the numbers of neutrons and electrons in a bromide ion $^{79}Br^-$?

		Number of neutrons	Number of electrons
☒	**A**	44	35
☒	**B**	44	36
☒	**C**	46	35
☒	**D**	46	36

(Total for Question 1 = 1 mark)

2: What volume of sulfur dioxide gas reacts completely with 50 cm^3 of 0.12 mol dm^{-3} sodium hydroxide solution?

[molar volume of a gas = 24 dm^3 at room temperature and pressure]

$$SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O$$

☒ **A** 0.072 dm^3

☒ **B** 0.144 dm^3

☒ **C** 0.288 dm^3

☒ **D** 72 dm^3

(Total for Question 2 = 1 mark)

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

3: Which amount does **not** have a mass of approximately 6 g?

- ☒ **A** 0.33 mol water (H_2O; $M_r = 18$)
- ☒ **B** 0.25 mol magnesium (Mg; $A_r = 24.3$)
- ☒ **C** 0.033 mol glucose ($C_6H_{12}O_6$; $M_r = 180$)
- ☒ **D** 0.025 mol copper(II) sulfate ($CuSO_4$; $M_r = 159.6$)

(Total for Question 3 = 1 mark)

4: How many molecules of H_2O are present in 1 drop (0.050 cm^3) of water?

[$L = 6.02 \times 10^{23}$, density of water = 1 g cm^{-3}]

- ☒ **A** 2.17×10^{26}
- ☒ **B** 6.69×10^{23}
- ☒ **C** 1.67×10^{22}
- ☒ **D** 1.67×10^{21}

(Total for Question 4 = 1 mark)

5: Which mass of fertiliser contains 467 g of nitrogen?

- ☒ **A** 2 kg sodium nitrate ($NaNO_3$; $M_r = 85$)
- ☒ **B** 1 kg urea (NH_2CONH_2; $M_r = 60$)
- ☒ **C** 1 kg ammonium nitrate (NH_4NO_3; $M_r = 80$)
- ☒ **D** 1 kg ammonium sulfate ($(NH_4)_2SO_4$; $M_r = 132.1$)

(Total for Question 5 = 1 mark)

6: Which is the correct order for the processes in a mass spectrometer?

☒ **A**	deflection	detection	ionisation	vaporisation
☒ **B**	vaporisation	ionisation	deflection	detection
☒ **C**	ionisation	vaporisation	deflection	detection
☒ **D**	vaporisation	deflection	ionisation	detection

(Total for Question 6 = 1 mark)

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7: Which of these molecules are polar?

I hydrogen chloride, $HCl(g)$
II beryllium chloride, $BeCl_2(g)$
III boron trichloride, $BCl_3(g)$

☒ **A** I only

☒ **B** II and III

☒ **C** I and III

☒ **D** I, II and III

(Total for Question 7 = 1 mark)

8: Which substance does **not** exist as a giant lattice?

☒ **A** silver (Ag)

☒ **B** sodium chloride (NaCl)

☒ **C** graphite (C)

☒ **D** buckminsterfullerene (C_{60})

(Total for Question 8 = 1 mark)

9: Which method for the preparation of hydrogen has the highest atom economy by mass?

☒ **A** $2H_2O \rightarrow 2H_2 + O_2$

☒ **B** $CH_4 + H_2O \rightarrow 3H_2 + CO$

☒ **C** $CO + H_2O \rightarrow H_2 + CO_2$

☒ **D** $CH_3OH + H_2O \rightarrow 3H_2 + CO_2$

(Total for Question 9 = 1 mark)

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

10: Which reaction to produce copper(II) nitrate (M_r = 187.5) has an atom economy of 46.5% by mass?

- ☒ **A** $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
- ☒ **B** $2Cu + Pt(NO_3)_4 \rightarrow 2Cu(NO_3)_2 + Pt$
- ☒ **C** $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$
- ☒ **D** $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$

(Total for Question 10 = 1 mark)

11: What is the maximum volume of butane which will completely burn in 130 cm^3 of oxygen?

$$C_4H_{10} + 6.5O_2 \rightarrow 4CO_2 + 5H_2O$$

- ☒ **A** 10 cm^3
- ☒ **B** 15 cm^3
- ☒ **C** 20 cm^3
- ☒ **D** 40 cm^3

(Total for Question 11 = 1 mark)

12: A 3.50 g sample of an organic compound will completely burn forming 5.15 g of carbon dioxide and 2.11 g of water.

What is the empirical formula of the compound?

- ☒ **A** CH_2O
- ☒ **B** CH_3O
- ☒ **C** C_2HO
- ☒ **D** CH_2O_2

(Total for Question 12 = 1 mark)

13: Which type of reaction occurs when an alkane is cracked?

- ☒ **A** combustion
- ☒ **B** hydrolysis
- ☒ **C** neutralisation
- ☒ **D** thermal decomposition

(Total for Question 13 = 1 mark)

14: (a) Hairdressers use solutions of hydrogen peroxide that have these hazards:

- can cause serious eye damage
- is harmful if swallowed
- is an oxidising agent

Which hazard symbols should be on containers of this solution?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) When hydrogen peroxide is used in an experiment to measure rate of decomposition, how could the risk be reduced?

(I) using an alternative method that involves less hazardous materials
(II) by working on a smaller scale
(III) taking precautions specific to the hazard

(1)

☒ **A** (I) only

☒ **B** (III) only

☒ **C** (II) and (III)

☒ **D** (I), (II) and (III)

(Total for Question 14 = 2 marks)

15: One molecule of a hydrocarbon is cracked to form two molecules of ethene, two molecules of propene and one molecule of propane. What is the molecular formula of the hydrocarbon?

☒ **A** C_8H_{18}

☒ **B** $C_{10}H_{22}$

☒ **C** $C_{11}H_{24}$

☒ **D** $C_{13}H_{28}$

(Total for Question 15 = 1 mark)

16: How many hydrogen atoms are in 14 g of methane?

[$L = 6.02 \times 10^{23}$]

☒ **A** 5.268×10^{23}

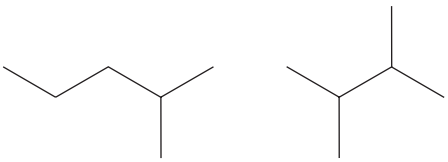
☒ **B** 6.880×10^{23}

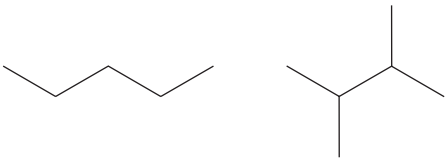
☒ **C** 2.107×10^{24}

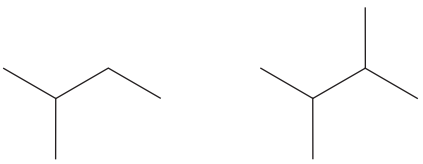
☒ **D** 2.752×10^{24}

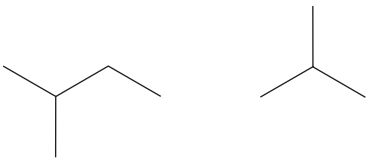
(Total for Question 16 = 1 mark)

17: Which structures represent a pair of isomers?

☒ **A** 

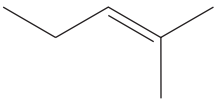
☒ **B** 

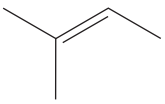
☒ **C** 

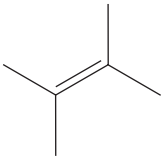
☒ **D** 

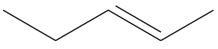
(Total for Question 17 = 1 mark)

18: Which molecule has a geometric isomer?

☒ **A** 

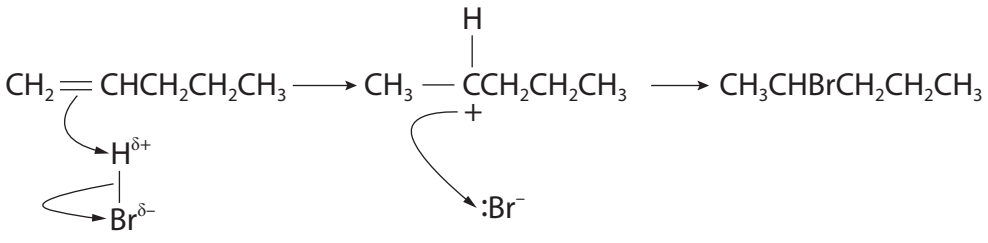
☒ **B** 

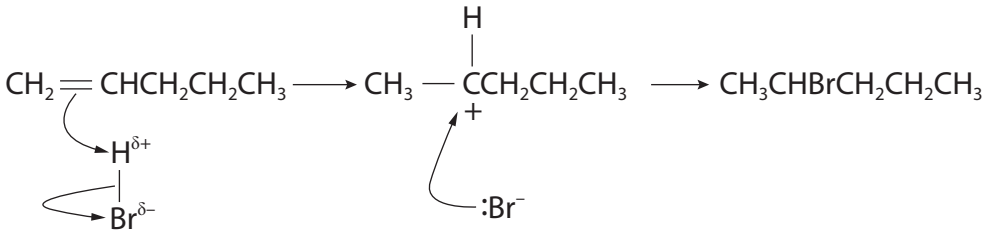
☒ **C** 

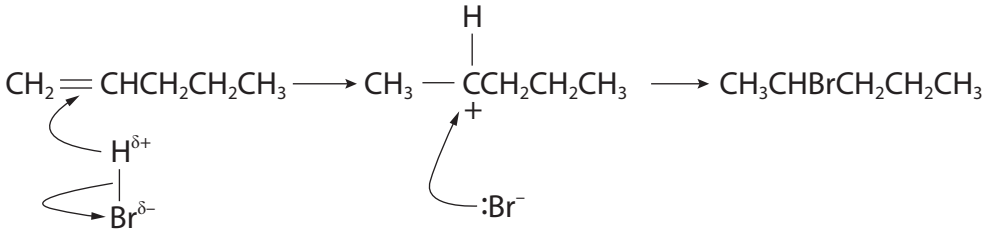
☒ **D** 

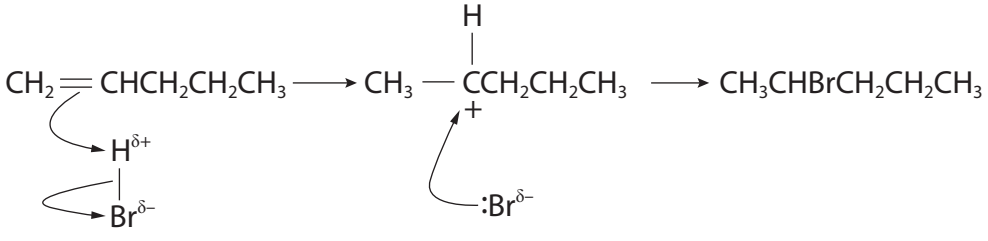
(Total for Question 18 = 1 mark)

19: Which is the correct mechanism for the electrophilic addition reaction between HBr and pent-1-ene to give the major product?

☒ **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: This question is about carbon dioxide.

(a) According to data from 2021, there are 415 ppm of carbon dioxide in the atmosphere by volume.

Calculate the moles of carbon dioxide present in 1.00 m^3 of air at 20.0 °C and 101 kPa.

[Ideal gas equation $pV = nRT$
$R = 8.31\ J\ mol^{-1}\ K^{-1}$]

(4)

(b) Dodecane $C_{12}H_{26}$, is found in kerosene and forms carbon dioxide during its complete combustion.

(i) State what is meant by complete combustion.

(1)

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.....

(ii) Write a balanced equation for the complete combustion of dodecane, $C_{12}H_{26}$.

Include state symbols.

(2)

(iii) Kerosene is used as aeroplane fuel. A jet plane can carry a maximum of 800 passengers and uses 11 400 dm^3 of fuel per hour.

Calculate the mass, in kg, of carbon dioxide emitted from the engine per passenger on a full flight from Sydney to Hong Kong, flight time 9 hours 15 minutes.

Give your answer to three significant figures.
[Assume kerosene consists solely of $C_{12}H_{26}$

Density of dodecane = 0.749 g cm^{-3}]

(6)

(iv) The formula $C_{12}H_{26}$ represents many isomers, including six diethyloctanes.
The names of four of these diethyloctanes are

3,3-diethyloctane, 3,4-diethyloctane, 3,5-diethyloctane,
3,6-diethyloctane.

Draw the **skeletal** formulae of the remaining two diethyloctanes.

(2)

(Total for Question 20 = 15 marks)

21: This question is about ionisation energy.

(a) Write the equation for the third ionisation energy of calcium.

Include state symbols.

(3)

(b) (i) The following data show the first seven ionisation energies for an element in Period 3. Deduce, with a reason, the identity of the element.

(2)

Ionisation number	1	2	3	4	5	6	7
Energy / kJ mol^{-1}	1000	2251	3361	4564	7012	8496	27107

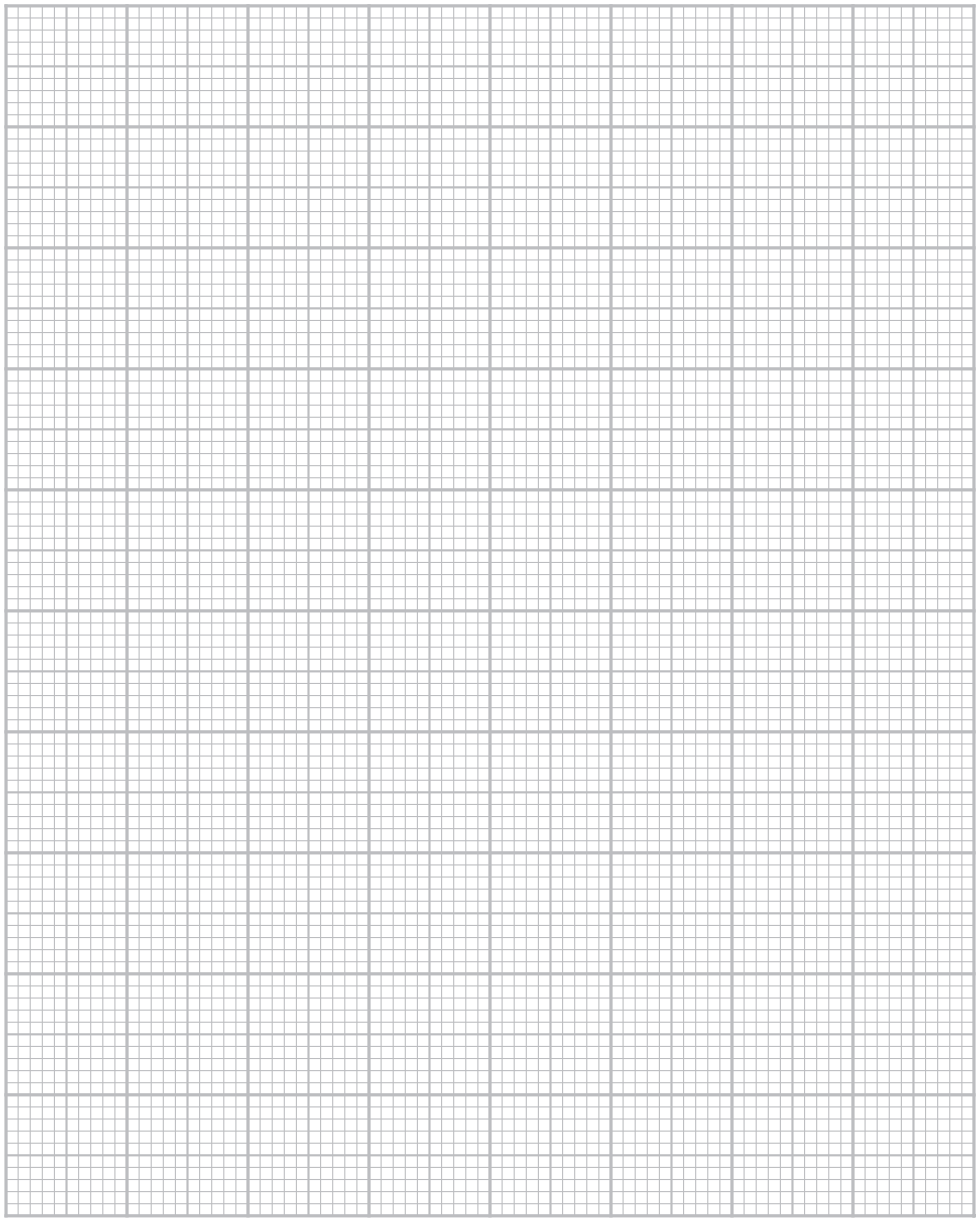
(ii) State the general trend in first ionisation energies across Period 3.

(1)

(c) (i) Plot the following first ionisation energies of the elements in Period 2 on the grid below.

(3)

Element	Li	Be	B	C	N	O	F	Ne
1st ionisation energy / kJ mol^{-1}	520	900	801	1086	1402	1314	1681	2081



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(ii) Explain the difference in first ionisation energies between beryllium and boron.

(2)

(iii) Explain the difference in first ionisation energies between carbon and nitrogen.

(2)

(Total for Question 21 = 13 marks)

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22: This question is about alkanes and halogens.

Alkanes can react with halogens to form halogenoalkanes.

(a) Name the type and mechanism for the reaction between halogens and alkanes.

(1)

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(b) Chlorine reacts with butane.

(i) Give the equation for the initiation step.

Include appropriate arrows and electrons.

(2)

(ii) Give an equation for each of the first two propagation steps.

(2)

First propagation step

.....

Second propagation step

.....

(iii) Give the equation for the termination step to form an alkane.

(1)

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(c) Calculate the percentage yield if 1.00 g of trichlorobutane is produced from 10.0 g butane using the overall equation shown.

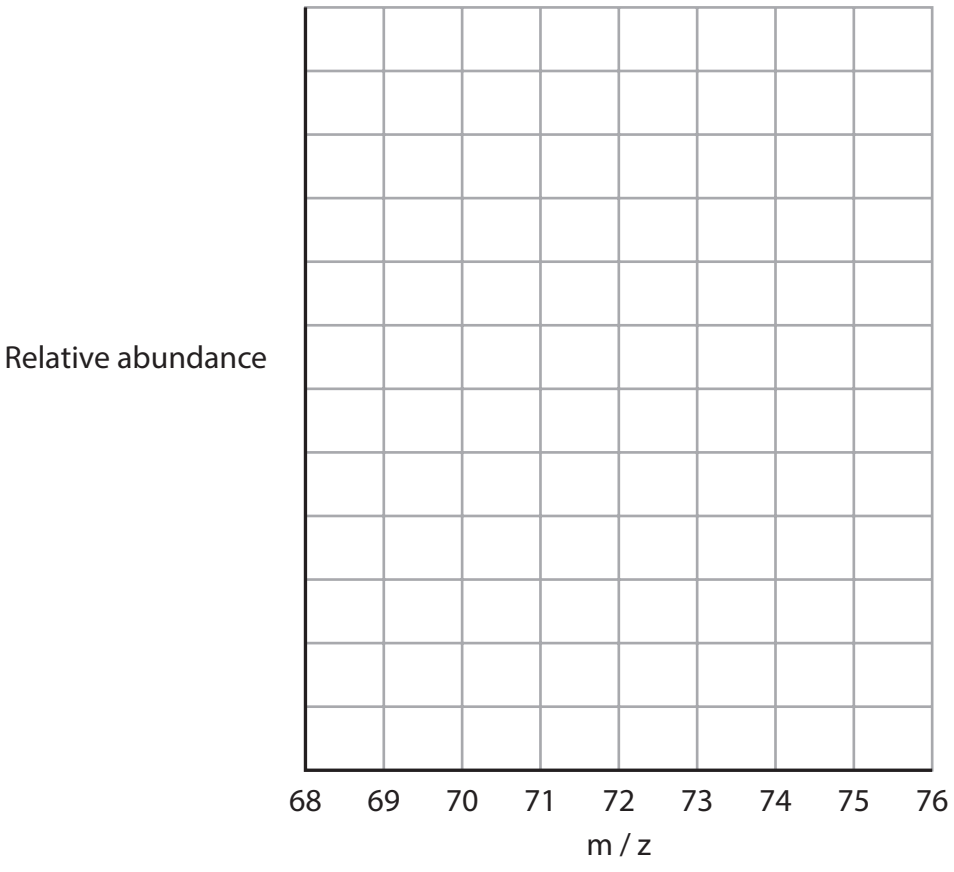
$$C_4H_{10} + 3Cl_2 \rightarrow C_4H_7Cl_3 + 3HCl$$

(3)

(d) Chlorine can be analysed in a mass spectrometer. On the grid shown, draw the spectrum you would expect to see for the molecular ion peaks for a chlorine molecule, Cl_2.

Isotopic abundances ^{35}Cl 75% ^{37}Cl 25%

(2)



(Total for Question 22 = 11 marks)

23: This question is about structure and bonding.

(a) Ionic bonding occurs between metals and non-metals.

(i) Describe ionic bonding.

(1)

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(ii) Explain why the ionic bonding in magnesium fluoride might be expected to be stronger than the ionic bonding in sodium fluoride.

(2)

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(iii) Sodium and oxygen react to form sodium oxide, which is also ionic.
Draw the dot-and-cross diagram showing the ions present in sodium oxide.

(2)

(iv) Draw the ionic lattice for sodium chloride.

You should show at least nine ions.

(2)

(b) Non-metal atoms join together using covalent bonds.

(i) Describe covalent bonding.

(1)

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(ii) Methane, ammonia and water are covalently bonded compounds.

Draw the dot-and-cross diagrams for the molecules of methane (CH_4), ammonia (NH_3) and water (H_2O).

(3)

methane

ammonia

water

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(iii) The three molecules (methane, ammonia and water) each have a different shape. Complete the table below.

(3)

molecule	shape	bond angle
methane		
ammonia		
water		

(iv) Explain the differences between the molecular shapes and bond angles for ammonia and water.

(2)

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(v) Ethene and poly(ethene) have different melting temperatures.

Molecule	Melting temperature (K)
ethene	104.1
poly(ethene)	400

Explain why their melting temperatures are different.

(2)

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.....

(c) Metals are held together by metallic bonding.

(i) Describe metallic bonding.

(1)

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(ii) Metals conduct electricity when solid.

Explain, with the aid of a diagram, why copper conducts electricity.

(2)

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(Total for Question 23 = 21 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)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
* Actinide series	232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103