Pearson Edexcel International Advanced Level

Thursday 9 October 2025

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WCH11/01A**

Chemistry

International Advanced Subsidiary/Advanced Level

UNIT 1: Structure, Bonding and Introduction to Organic Chemistry

Question paper

You must have:
Scientific calculator, ruler, HB pencil and Answer Book (sent separately)

Turn over ▶

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P 8 7 4 1 8 A

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 element is in the d-block of the Periodic Table?

A argon

B chlorine

C iron

D sodium

(Total for Question 1 = 1 mark)

---

2 Some ionic radii are shown.

Ion	Ionic radius / nm
Na^+	0.102
K^+	0.138
F^-	0.133
Cl^-	0.180

Which compound has the strongest ionic bonding?

(1)

A sodium fluoride

B sodium chloride

C potassium fluoride

D potassium chloride

(Total for Question 2 = 1 mark)

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

3 In which pair are the ions isoelectronic?

A Ca^{2+} and S^{2-}

B K^{+} and Br^{-}

C Li^{+} and F^{-}

D Mg^{2+} and Cl^{-}

(Total for Question 3 = 1 mark)

4 A 2 kg sample of water contains 40 parts per million (ppm) by mass of nitrate ions.

What is the mass, in g, of nitrate ions in this sample?

A 8×10^{-2}

B 5×10^{-5}

C 8×10^{-5}

D 5×10^{-8}

(Total for Question 4 = 1 mark)

5 What is the atom economy, by mass, for the formation of iron in this reaction?

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

[Data: A_r C = 12.0 O = 16.0 Fe = 55.8]

A 29.7%

B 45.8%

C 55.9%

D 71.7%

(Total for Question 5 = 1 mark)

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

6 A sample of hydrated calcium sulfate, $CaSO_4 \cdot xH_2O$, was heated to constant mass.

3.405 g of anhydrous calcium sulfate and 0.900 g of water were formed.

What is the value of **x**?

[Data: Molar mass of $CaSO_4$ = 136.2 g mol^{-1}]

A 0.5

B 2

C 3

D 4

(Total for Question 6 = 1 mark)

7 How many orbitals are there, in total, in the first three quantum shells of an atom?

A 3

B 6

C 9

D 14

(Total for Question 7 = 1 mark)

8 Which of these forms of carbon does **not** contain delocalised electrons?

A graphite

B graphene

C C_{60} fullerene

D diamond

(Total for Question 8 = 1 mark)

9 Which molecule is polar?

A BF_3

B CF_4

C OF_2

D PF_5

(Total for Question 9 = 1 mark)

10 A pure alkane fuel is burned in air.

Which substance is **not** a possible combustion product?

A H_2

B H_2O

C CO

D CO_2

(Total for Question 10 = 1 mark)

11 Which of these compounds has the greatest covalent character?

A MgF_2

B MgI_2

C BaF_2

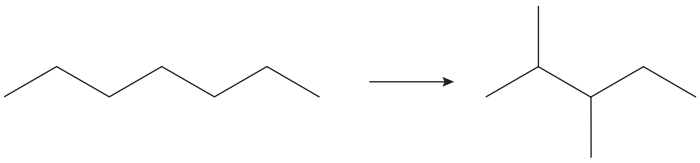
D BaI_2

(Total for Question 11 = 1 mark)

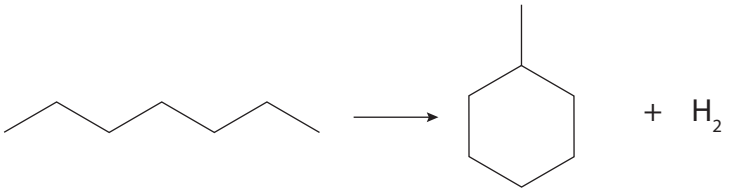
12 Some equations for reactions used in reforming crude oil fractions are shown.

Which equation is **not** balanced?

A



B



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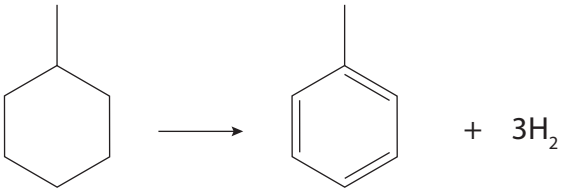

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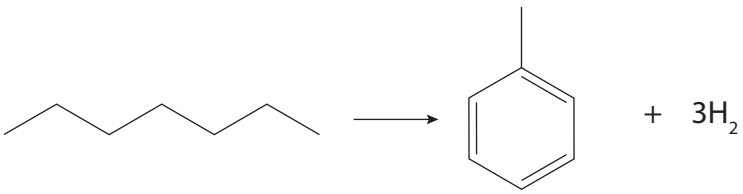
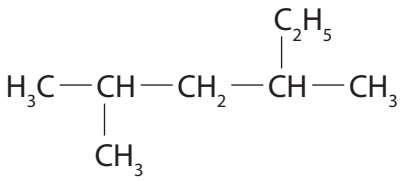


(Total for Question 12 = 1 mark)

13 What is the IUPAC name for the compound with the structure shown?



A 2-methyl-4-ethylpentane

B 2-ethyl-4-methylpentane

C 2,4-dimethylhexane

D 3,5-dimethylhexane

(Total for Question 13 = 1 mark)

14 What is the percentage by mass of nitrogen in ammonium nitrate, NH_4NO_3?

[Data: A_r H = 1.0 N = 14.0 O = 16.0]

A 14.0%

B 17.5%

C 28.0%

D 35.0%

(Total for Question 14 = 1 mark)

15 The chemical properties of an element are determined by its

A electronic configuration

B number of neutrons

C number of protons plus neutrons

D relative atomic mass

(Total for Question 15 = 1 mark)

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

16 What is the empirical formula of the oxide formed when 2.6 g of chromium reacts with pure oxygen to produce 3.8 g of chromium oxide?

[Data: A_r O = 16.0 Cr = 52.0]

A CrO

B CrO_2

C Cr_2O_3

D Cr_3O_4

(Total for Question 16 = 1 mark)

17 Identify the atom with two unpaired electrons in its lowest energy state (ground state).

A Be

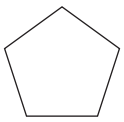
B C

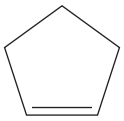
C Cl

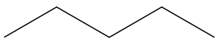
D Ca

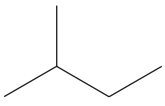
(Total for Question 17 = 1 mark)

18 Which compound has an empirical formula **different** from its molecular formula?

A 

B 

C 

D 

(Total for Question 18 = 1 mark)

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

19 Chlorine can be prepared by the reaction between concentrated hydrochloric acid and concentrated sodium chlorate(I).

Chlorine is a hazardous substance and the risk due to the chlorine is best lowered by

A working in groups

B wearing gloves

C wearing goggles

D using a fume cupboard

(Total for Question 19 = 1 mark)

20 Metallic bonding is best described as the electrostatic attraction between

A cations and anions

B cations and delocalised electrons

C nuclei and shared pairs of electrons

D nuclei and two electrons from one atom

(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

21 This question is about atomic structure and gases.

(a) Chlorine exists as two isotopes with mass numbers 35 and 37.

(i) State the number and type of each of the particles in the **nucleus** of a chlorine-37 atom.

(2)

(ii) Complete the electronic configuration of a chloride **ion**, Cl^-, using the s, p, d notation.

(1)

(iii) A sample of chlorine contains 24.48% of chlorine-37 atoms.

Calculate the relative atomic mass of this sample of chlorine.
Give your answer to **two** decimal places.

(2)

(b) Fluorine has one naturally occurring isotope with mass number 19.

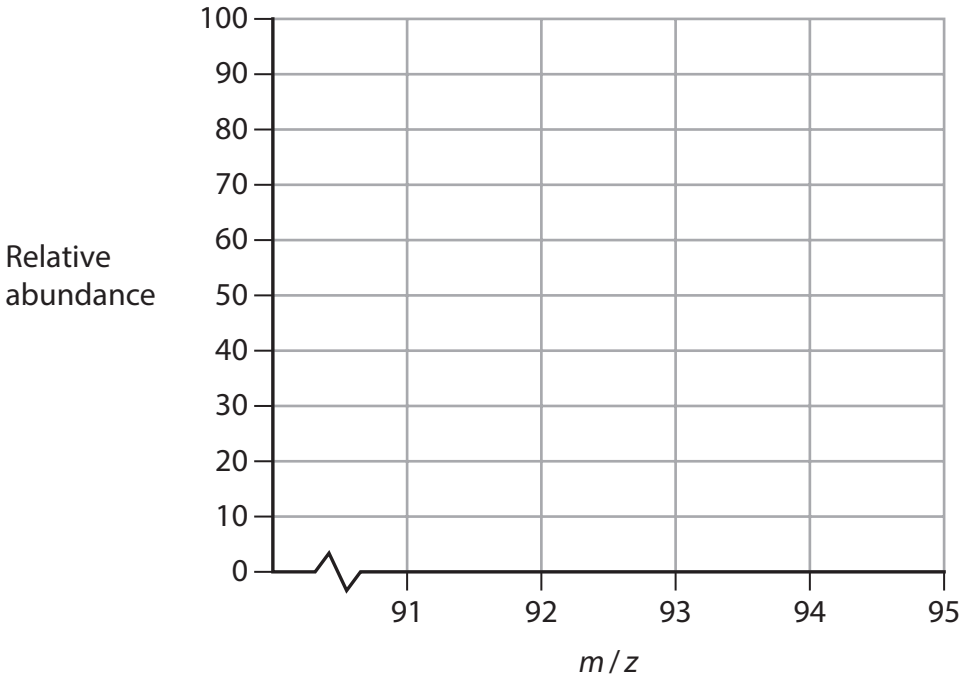
Chlorine and fluorine react to form chlorine trifluoride, ClF_3.

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of chlorine trifluoride.
Use dots(●) for the chlorine electrons and crosses (✖) for the fluorine electrons.
Show outer shell electrons only.

(2)

(ii) Complete the mass spectrum to show the peaks that you would expect for the molecular ion, ClF_3^+.

(3)



(c) Pentane is used as a fuel and produces carbon dioxide gas when burnt.
The equation for the complete combustion of pentane is shown.

$$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$$

Calculate the volume of carbon dioxide, in **cm^3**, produced at room temperature and pressure (r.t.p.) from the complete combustion of 15.0 cm^3 of liquid pentane.

[Data: Density of liquid pentane = 0.626 g cm^{-3}

One mole of any gas occupies 24.0 dm^3 at r.t.p.]

(4)

(Total for Question 21 = 14 marks)

22 This is a question about ionisation energies.

(a) State, **in words**, the meaning of the term 'first ionisation energy'.

(3)

(b) Write the equation for the **second** ionisation energy of lithium.

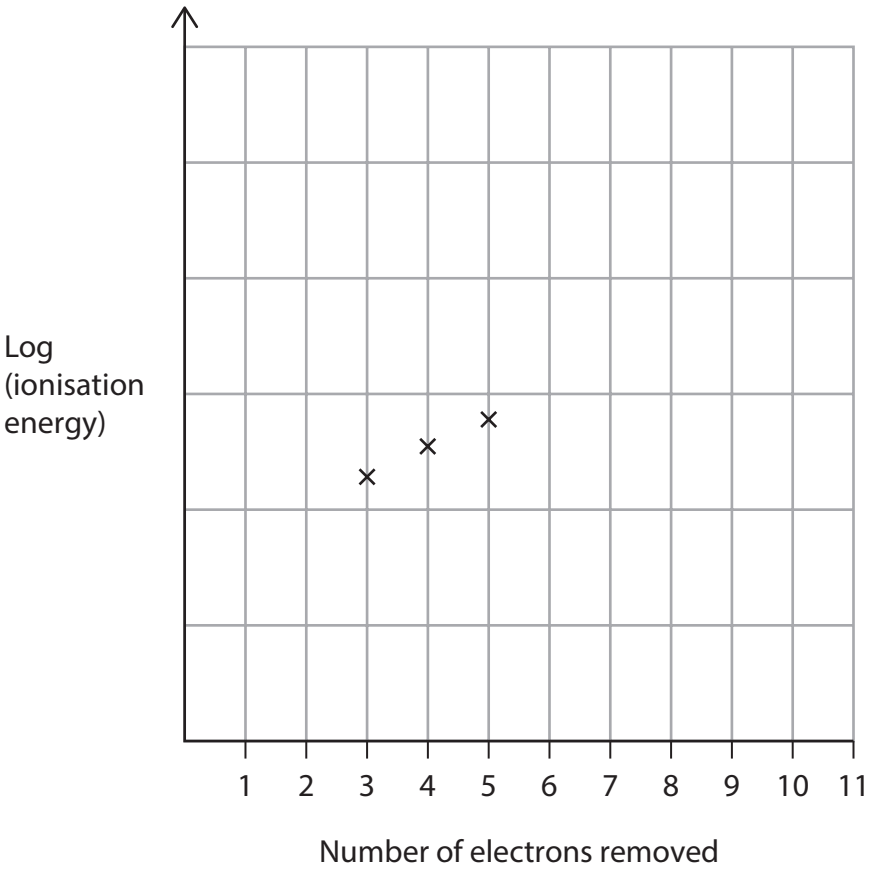
(1)

(c) State why it is not possible to determine the **third** ionisation energy for helium.

(1)

(d) Complete the sketch of the log (ionisation energy) of sodium.

(4)



(e) Explain why there is a general decrease in the values of the first ionisation energy on descending a group in the Periodic Table.

(3)

(f) Explain why the first ionisation energy of sulfur is less than that of phosphorus.

(2)

(g) The first ionisation energy for sodium is +496 kJ mol^{-1} and for magnesium is +738 kJ mol^{-1}.

Suggest a value for the first ionisation energy of aluminium and justify your answer.

(3)

Ionisation energy value:

Justification

(Total for Question 22 = 17 marks)

23 This is a question about alkenes.

(a) Calculate the volume, in **cm³**, of 0.0200 mol of ethene gas at a temperature of 108 °C and a pressure of 1.28×10^5 Pa.
Give your answer to an appropriate number of significant figures.

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

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

(4)

(b) The carbon-carbon double bond consists of both a sigma (σ) and a pi (π) bond.

(i) Describe **two** differences between the orbital overlap of a sigma bond and the orbital overlap of the pi bond in ethene.

(2)

(ii) State the feature of a pi bond which can result in *E*–*Z* isomers.

(1)

(iii) Not all alkenes with the molecular formula, $\mathbf{C_4H_8}$, exhibit *E*–*Z* isomerism.

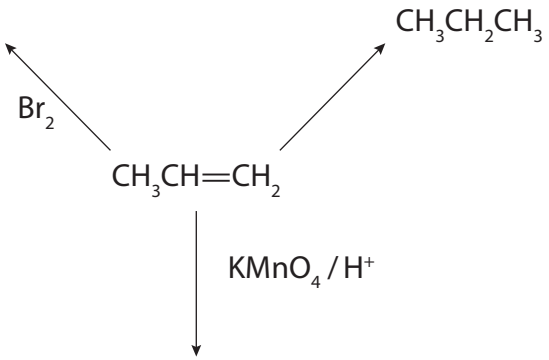
Complete the table in the Answer Book with

- the displayed formula of the *E* isomer and of the *Z* isomer
- the displayed formula of one alkene that does not exhibit *E*–*Z* isomerism and include its name.

(3)

(c) (i) Write, on the dotted lines in the answer book, the **structural formulae** for the organic products of the reaction scheme for propene shown.

(3)



(ii) Draw a section of poly(propene) with **two** repeat units.

(1)

(d) Draw the mechanism for the reaction between hydrogen bromide and propene to form the major product.
Include curly arrows, and relevant dipoles and lone pairs.

(4)

(Total for Question 23 = 18 marks)

24 Mohr's salt, $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$, and copper(II) chromate(VI) are both ionically-bonded solids.

(a) Mohr's salt is usually made by dissolving equimolar amounts of iron(II) sulfate and ammonium sulfate in dilute sulfuric acid and then crystallising.
The reaction equation is shown.

$$FeSO_4 \cdot 7H_2O + (NH_4)_2SO_4 \rightarrow (NH_4)_2Fe(SO_4)_2 \cdot 6H_2O + H_2O$$

(i) Calculate the mass of Mohr's salt produced from 6.95 g of iron(II) sulfate with excess ammonium sulfate and a 78.2% yield.

[Data: Molar mass $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O = 392$]

(4)

(ii) Calculate the number of **cations** in **two** moles of Mohr's salt.

[Data: Avogadro constant, $L = 6.02 \times 10^{23}$ mol^{-1}]

(2)

(b) State what is meant by the term 'ionic bond'.

(1)

(c) Electrolysis is an experiment which can be carried out in a school or college laboratory on an aqueous **green** solution of copper(II) chromate(VI) to provide evidence for the presence of ionic bonding.

Draw a labelled diagram in the Answer Book of the apparatus that you would use for this experiment.
Indicate observations which show that the bonding in copper(II) chromate(VI) is ionic.

(4)

(Total for Question 24 = 11 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)											(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											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							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Thursday 9 October 2025

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WCH11/01A**

Chemistry

International Advanced Subsidiary/Advanced Level

UNIT 1: Structure, Bonding and Introduction to Organic Chemistry

Answer Book

You must have:
Question Paper
Scientific calculator, ruler, HB pencil

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.*

Advice

- 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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P 8 7 4 7 3 A 0 1 2 0

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

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 1 = 1 mark)

2

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 2 = 1 mark)

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

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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)

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

7

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 7 = 1 mark)

8

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 8 = 1 mark)

9

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 9 = 1 mark)

10

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 10 = 1 mark)

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

11

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 11 = 1 mark)

12

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 12 = 1 mark)

13

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 13 = 1 mark)

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

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)

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

18

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 18 = 1 mark)

19

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 19 = 1 mark)

20

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

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SECTION B

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

21

(a)

(i)

(2)

.....

.....

(ii)

(1)

.....

(iii)

(2)

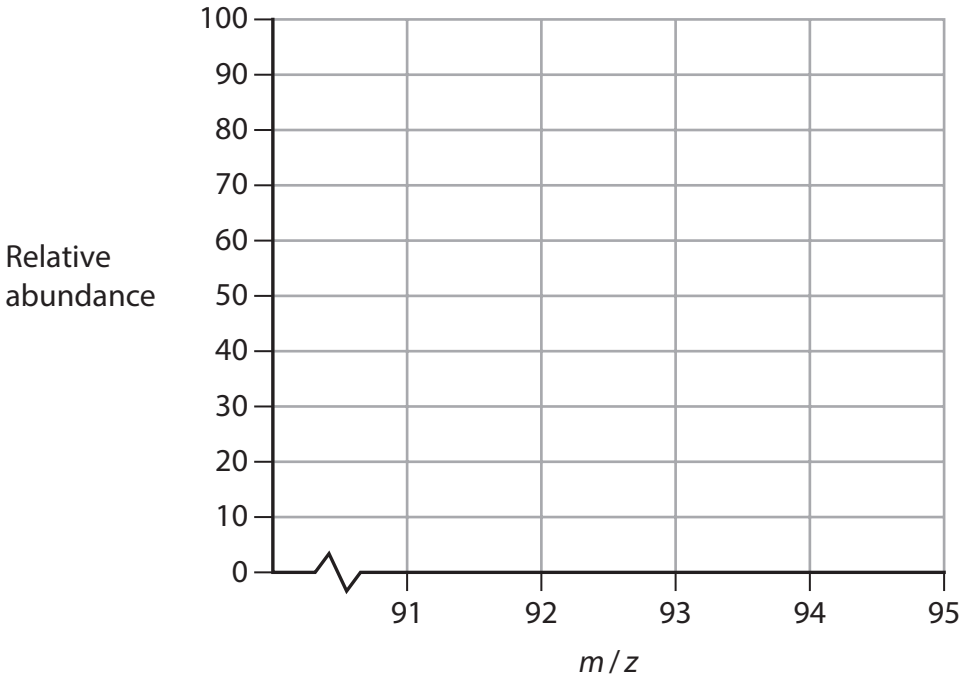
(b)

(i)

(2)

(ii)

(3)



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(c)

(4)

(Total for Question 21 = 14 marks)

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22

(a)

(3)

(b)

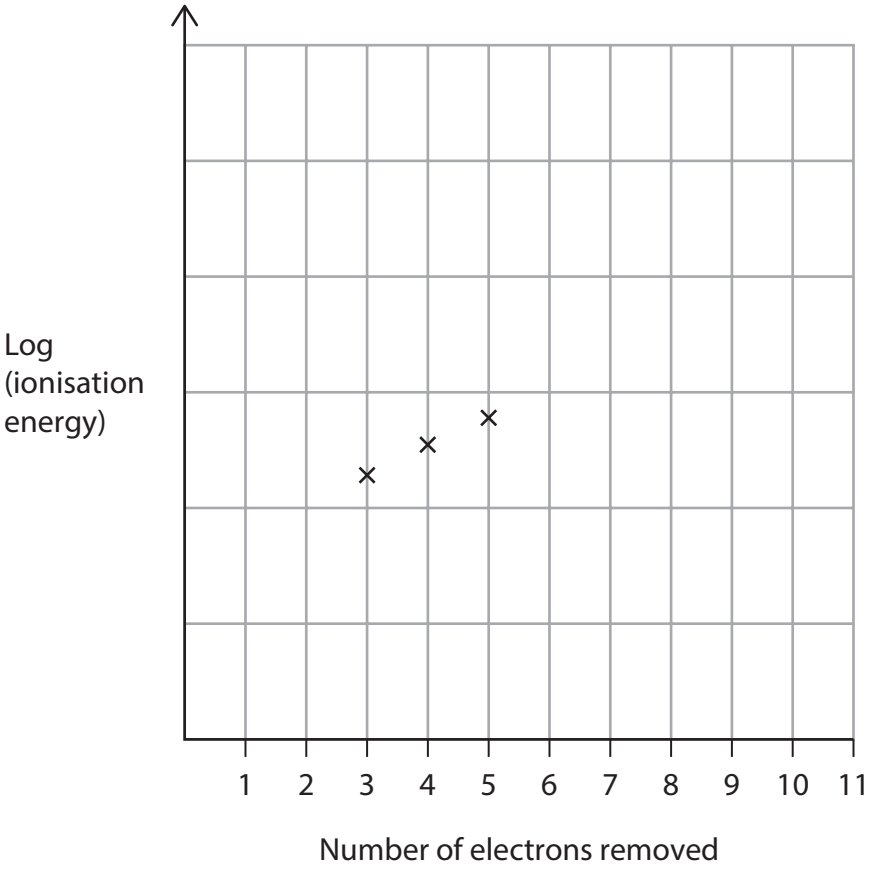
(1)

(c)

(1)

(d)

(4)



(e)

(3)

(f)

(2)

(g)

(3)

Ionisation energy value:.....

Justification.....

(Total for Question 22 = 17 marks)

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DO NOT WRITE IN THIS AREA

23

(a)

(4)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b)

(i)

(2)

(ii)

(1)

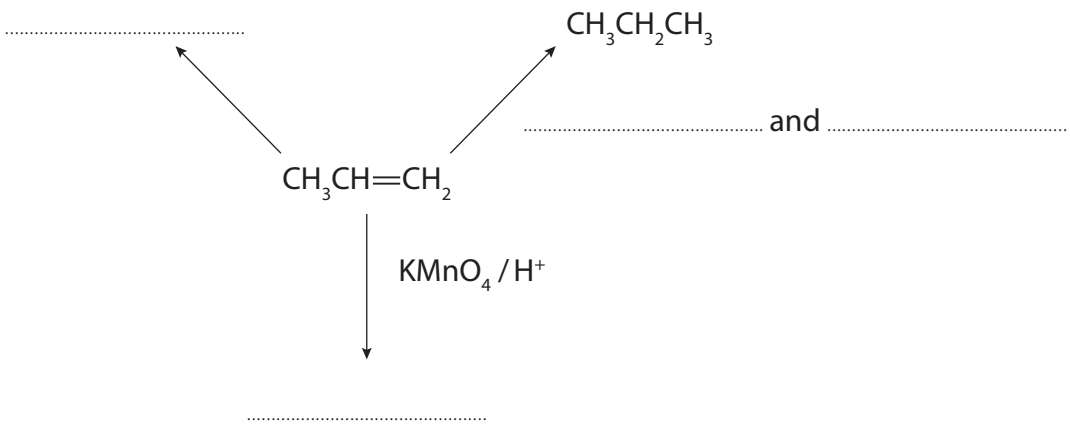
(iii)

(3)

E isomer	*Z* isomer
Alkene with no *E-Z* isomerism	
Name:	

(c) (i)

(3)



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(ii)

(1)

(d)

(4)

(Total for Question 23 = 18 marks)

24

(a)

(i)

(4)

(ii)

(2)

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(b)

(1)

.....

.....

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(c)

(4)

(Total for Question 24 = 11 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