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

Wednesday 10 January 2024

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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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 The first ionisation energies of four successive elements in the Periodic Table are shown.

Element	P	Q	R	S
First ionisation energy / kJ mol^{-1}	1251	1521	419	590

- (a) Which element has atoms with a full outer shell of electrons?

- ☐ A element P
☐ B element Q
☐ C element R
☐ D element S

- (b) Which element could be X in a gaseous covalent compound with the formula HX?

- ☐ A element P
☐ B element Q
☐ C element R
☐ D element S

- (c) Which element could be Y in an ionic compound with the formula YF_2 ?

- ☐ A element P
☐ B element Q
☐ C element R
☐ D element S

- (d) Which element has atoms with the largest atomic radius?

- ☐ A element P
☐ B element Q
☐ C element R
☐ D element S

(Total for Question 1 = 4 marks)



2 Which diagram represents the electronic structure of a nitrogen atom?

	1s	2s	2p		
<input type="checkbox"/> A	$\uparrow\downarrow$	\uparrow	$\uparrow\downarrow$	\uparrow	\uparrow
<input type="checkbox"/> B	$\uparrow\downarrow$	\uparrow	$\uparrow\downarrow$	$\uparrow\downarrow$	
<input type="checkbox"/> C	$\uparrow\downarrow$	$\uparrow\downarrow$	\uparrow	\uparrow	\uparrow
<input type="checkbox"/> D	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow$	\uparrow	

(Total for Question 2 = 1 mark)

3 Which species does **not** contain a total of 16 neutrons?

- ☐ A a molecule of ethene, $^{12}\text{C}_2^1\text{H}_4$
- ☐ B a molecule of oxygen, $^{16}\text{O}_2$
- ☐ C an atom of silicon, ^{30}Si
- ☐ D an ion of sulfur, $^{32}\text{S}^{2-}$

(Total for Question 3 = 1 mark)

4 Each response gives the atomic numbers of two elements.
Which pair of atomic numbers are those of elements that are in different blocks of the Periodic Table?

- ☐ A 5, 9
- ☐ B 10, 16
- ☐ C 13, 18
- ☐ D 16, 20

(Total for Question 4 = 1 mark)

5 Which molecule is polar?

- ☐ A $\text{CO}_2(\text{g})$
- ☐ B $\text{CCl}_4(\text{g})$
- ☐ C $\text{BeCl}_2(\text{g})$
- ☐ D $\text{NH}_3(\text{g})$

(Total for Question 5 = 1 mark)



6 Which oxide of nitrogen contains 30% nitrogen by mass?

[A_r values: N = 14.0 O = 16.0]

- ☐ A NO
- ☐ B NO₂
- ☐ C N₂O
- ☐ D N₂O₃

(Total for Question 6 = 1 mark)

7 Calculate the mass of sodium carbonate (Na₂CO₃) required to make up 250 cm³ of a 0.100 mol dm⁻³ solution.

[A_r values: C = 12.0 O = 16.0 Na = 23.0]

- ☐ A 1.30 g
- ☐ B 2.65 g
- ☐ C 5.30 g
- ☐ D 10.6 g

(Total for Question 7 = 1 mark)

8 A block of lead measuring 10 cm × 10 cm × 10 cm contains 3.295×10^{25} atoms.

Calculate the density of lead.

[A_r value: Pb = 207.2 Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$]

- ☐ A 3.79 g cm⁻³
- ☐ B 4.49 g cm⁻³
- ☐ C 11.34 g cm⁻³
- ☐ D 54.73 g cm⁻³

(Total for Question 8 = 1 mark)

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



9 Which are the correct bonding and structure for one of the substances listed?

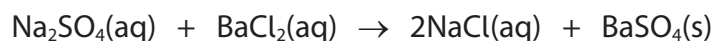
	Substance	Bonding	Structure
<input type="checkbox"/> A	copper(II) sulfate	covalent	giant
<input type="checkbox"/> B	graphene	covalent	simple molecular
<input type="checkbox"/> C	iodine	metallic	simple molecular
<input type="checkbox"/> D	sodium	metallic	giant

(Total for Question 9 = 1 mark)

10 An excess of sodium sulfate solution is added to 50 cm³ of a 0.100 mol dm⁻³ solution of barium chloride.

What is the mass of barium sulfate formed?

[*M_r* value: BaSO₄ = 233.4]



- ☐ A 1.167 g
- ☐ B 2.334 g
- ☐ C 11.67 g
- ☐ D 23.34 g

(Total for Question 10 = 1 mark)

11 Which compound shows the greatest degree of polarisation?

- ☐ A sodium chloride
- ☐ B sodium iodide
- ☐ C magnesium chloride
- ☐ D magnesium iodide

(Total for Question 11 = 1 mark)

12 A sample of seaweed contains 30.0 mg of iodine per kg.

What is the number of iodine **atoms** in 10 kg of this seaweed?

[A_r value: I = 126.9 Avogadro constant $L = 6.02 \times 10^{23} \text{ mol}^{-1}$]

- ☐ **A** 7.12×10^{19}
- ☐ **B** 1.42×10^{20}
- ☐ **C** 7.12×10^{20}
- ☐ **D** 1.42×10^{21}

(Total for Question 12 = 1 mark)

13 The concentration of sulfur dioxide in a sample of polluted air is 0.4 ppm.

What is the percentage of sulfur dioxide molecules in this polluted air?

- ☐ **A** 0.4%
- ☐ **B** 0.004%
- ☐ **C** 0.00004%
- ☐ **D** 0.0000004%

(Total for Question 13 = 1 mark)

14 How many structural isomers have the formula C_6H_{14} ?

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

(Total for Question 14 = 1 mark)

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



15 Which statement about poly(ethene) is **not** correct?

- ☐ A it is an addition polymer
- ☐ B it decolourises bromine water
- ☐ C it is non-biodegradable
- ☐ D it has the empirical formula CH_2

(Total for Question 15 = 1 mark)

16 Which mixture could be formed when a **single** molecule of $\text{C}_{12}\text{H}_{26}$ is cracked?

- ☐ A butene, pentane and propene
- ☐ B hexane, butene and ethane
- ☐ C nonane and ethene
- ☐ D propene and decane

(Total for Question 16 = 1 mark)

17 The substances formed from the combustion of petrol in car engines include

- ☐ A water, carbon dioxide and hydrogen
- ☐ B water, carbon monoxide and hydrogen chloride
- ☐ C water, carbon dioxide and sulfur dioxide
- ☐ D water, carbon particulates and hydrogen

(Total for Question 17 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS



SECTION B

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

18 Compounds **A**, **B**, **C** and **D** all have the molecular formula C_4H_8 .

A, **B** and **C** each contain one double bond, but **D** does not.

A and **B** are geometric isomers of each other.

(a) Deduce a possible structure and name for each compound.

(4)

Possible structure of **A**

Name

.....

Possible structure of **B**

Name

.....

Possible structure of **C**

Name

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Possible structure of **D**

Name

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DO NOT WRITE IN THIS AREA

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- (b) The carbon–carbon double bond consists of a σ bond and a π bond.

Describe the difference between the σ bond and the π bond.
Include a labelled diagram in your answer.

(4)

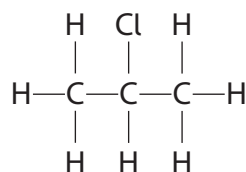
- (c) Give **two** reasons why compounds **A** and **B** exist as geometric isomers.

(2)

(Total for Question 18 = 10 marks)



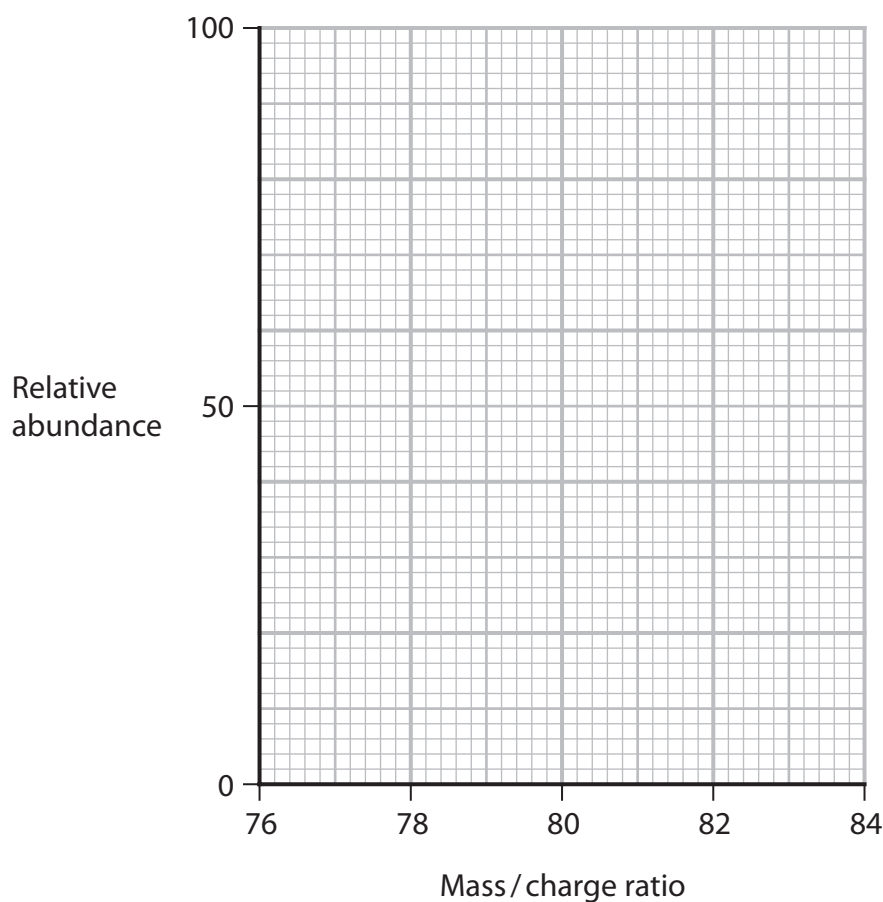
19 This question is about 2-Chloropropane.



- (a) 2-Chloropropane has a relative molecular mass of 78.5 g mol^{-1} .
Chlorine has two common isotopes, ^{35}Cl and ^{37}Cl .
There are three times more ^{35}Cl atoms than ^{37}Cl atoms.
The main isotope of hydrogen is ^1H and that of carbon is ^{12}C .
The diagram shows a mass spectrum grid.

Draw the peaks for the molecular ions of 2-Chloropropane resulting from these isotopes.

(2)



- (b) 2-Chloropropane can be produced by reacting propane with chlorine in a homolytic free radical reaction.



- (i) Show the initiation step of this reaction.
Include appropriate arrows and the conditions necessary for this step.

(2)

- (ii) Using your answer to (b)(i), state what is meant by the terms homolytic and free radical.

(2)

homolytic

free radical

- (iii) Suggest why this method has limited use in the synthesis of organic compounds.

(1)

(c) 2-Chloropropane can also be produced from the reaction of propene with hydrogen chloride.

- (i) Give the mechanism for this reaction.
Include curly arrows and relevant dipoles and lone pairs.

(4)

- (ii) Explain why only a small amount of 1-chloropropane is produced in this reaction.

(2)

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(Total for Question 19 = 13 marks)



20 This question is about magnesium, magnesium oxide and magnesium sulfate.

- (a) A sample of magnesium contains three isotopes and has a relative atomic mass of 24.32.

The table gives the relative abundances of two of these isotopes.

Mass number	24	25
Relative abundance / %	78.99	10.00

- (i) Calculate the relative abundance and hence the mass number of the third isotope.

Give your answer to the appropriate number of significant figures.

You must show all your working.

(4)

- (ii) State **one** similarity and **one** difference between these isotopes.

(1)

- (iii) State which of these isotopes would be deflected most in a mass spectrometer. Justify your answer.

(1)



(b) Magnesium oxide and magnesium sulfate are ionic compounds.

- (i) Draw a dot-and-cross diagram to show the bonding in magnesium oxide, MgO .
Show outer electrons only.

(2)

- (ii) The melting temperatures of magnesium oxide and magnesium sulfate are 2852°C and 1124°C respectively.

Explain why the melting temperature of magnesium oxide is significantly higher than that of magnesium sulfate.

(2)

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- (c) The table gives some data about the electrical conductivity of magnesium and magnesium oxide.

State	Electrical conductivity	
	Magnesium	Magnesium oxide
solid	high	low
liquid	high	high

Explain the similarities and differences in the electrical conductivity of the two substances.

(2)

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- (d) Magnesium sulfate can be made by reacting magnesium with dilute sulfuric acid.

- (i) Write an equation for the reaction that occurs.
Include state symbols in your answer.

(2)

- (ii) Give **two** observations you would make when the reaction is taking place.

(2)

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- (e) Hydrated crystals of magnesium sulfate, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, can be made by reacting magnesium with sulfuric acid.

In an experiment, magnesium was added to 30.0 cm^3 of $0.500 \text{ mol dm}^{-3}$ sulfuric acid.

[M_r value: $\text{MgSO}_4 \cdot 7\text{H}_2\text{O} = 246.4$ A_r value: $\text{Mg} = 24.3$]

- (i) Calculate the number of moles of sulfuric acid used in this experiment. (1)

- (ii) Calculate the mass of magnesium needed to react with the sulfuric acid. (1)

- (iii) Give a reason why slightly more than this mass of magnesium was used. (1)

- (iv) State how the magnesium sulfate solution could be separated from the mixture produced in this experiment. (1)

- (v) The magnesium sulfate solution was allowed to crystallise.
The crystals were dried and weighed.
The mass of the hydrated crystals, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, was 2.78 g .
Calculate the percentage yield in this experiment. (2)

(Total for Question 20 = 22 marks)



21 Boric acid is a white solid often used as an antiseptic.

- (a) Boric acid contains 17.48% by mass of boron, 77.67% of oxygen and the remainder is hydrogen. The molar mass of boric acid is 61.8 g mol^{-1} .

[A_r values: H = 1 B = 10.8 O = 16]

Show that the molecular formula of boric acid is H_3BO_3 .

You must show all your working.

(4)

- (b) The formula of boric acid can also be written as $\text{B}(\text{OH})_3$.

- (i) Draw a dot-and-cross diagram for this molecule.
Show outer electrons only.

(3)

- (ii) Suggest a value for the O—B—O bond angle. Justify your answer.

(2)

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(Total for Question 21 = 9 marks)



22 The density of an unknown gas is 0.656 g dm^{-3} at 20°C and $101\,000 \text{ Pa}$.

$$[pV = nRT \quad R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}]$$

(a) Calculate the molar mass of the unknown gas.

(5)

(b) The unknown gas is a hydrocarbon.

Give the name or formula for the unknown gas using your answer to (a).

(1)

(Total for Question 22 = 6 marks)

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

