Paper Reference(s) **WCH01/01**

Pearson Edexcel
International Advanced Level

Chemistry
Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Wednesday 9 January 2019 – Morning

Time: 1 hour 30 minutes plus your additional time allowance

INSTRUCTIONS TO CANDIDATES
Write your centre number, candidate number, surname, other names and your signature in the boxes below. Check that you have the correct question paper.

Centre No.								
Candidate No.								
Surname								
Other names								
Signature								
Paper Reference	W	C	H	0	1	/	0	1

Pearson

- **Use BLACK ink or BLACK ball-point pen.**
- **Answer ALL questions.**
- **Answer the questions in the spaces provided – there may be more space than you need.**

MATERIALS REQUIRED FOR EXAMINATION
Scientific calculator, ruler

ITEMS INCLUDED WITH QUESTION PAPERS
Periodic Table

INFORMATION FOR CANDIDATES
- **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.**
- **Questions labelled with an ASTERISK (*) are ones where the quality of your written communication will be assessed – you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.**
- **A Periodic Table is provided.**

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

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 European Union limit for nitrogen dioxide in the atmosphere is $0{\cdot}0209\,cm^3$ in $1\,m^3$.
In units of parts per million (ppm) this is

☐ **A** $2{\cdot}09 \times 10^{-5}$

☐ **B** $2{\cdot}09 \times 10^{-2}$

☐ **C** $20{\cdot}9$

☐ **D** $2{\cdot}09 \times 10^{4}$

(TOTAL FOR QUESTION 1 = 1 MARK)

(Questions continue on next page)

2 A sample of blood plasma contains 3·10 mg of sodium ions in 1 cm^3.
The concentration, in mol dm^{-3}, of sodium ions in the plasma is

☐ A $1{\cdot}35 \times 10^{-1}$

☐ B $2{\cdot}82 \times 10^{-1}$

☐ C $1{\cdot}35 \times 10^{-4}$

☐ D $2{\cdot}82 \times 10^{-4}$

(TOTAL FOR QUESTION 2 = 1 MARK)

3 Dilute sulfuric acid is mixed with a solution of barium chloride.
The reaction that occurs is

☐ A displacement.

☐ B neutralisation.

☐ C precipitation.

☐ D redox.

(TOTAL FOR QUESTION 3 = 1 MARK)

(Questions continue on next page)

4 How many ATOMS are there in 120 cm^3 of ammonia gas at room temperature and pressure (r.t.p.)?

[Molar volume of gas at r.t.p. = 24 000 $cm^3 mol^{-1}$
Avogadro constant = 6·0 × 10^{23} mol^{-1}]

☐ A 3·0 × 10^{21}

☐ B 1·2 × 10^{22}

☐ C 1·5 × 10^{22}

☐ D 1·2 × 10^{25}

(TOTAL FOR QUESTION 4 = 1 MARK)

(Questions continue on next page)

5 The reaction of magnesium chloride with silver nitrate gives a precipitate of silver chloride.

$$MgCl_2(aq) + 2AgNO_3(aq) \longrightarrow Mg(NO_3)_2(aq) + 2AgCl(s)$$

A solution containing 0·001 mol of magnesium chloride reacts with excess silver nitrate. What is the mass of the precipitate formed?

[Molar mass / g mol^{-1}: AgCl = 143·4]

☐ A 0·072 g

☐ B 0·143 g

☐ C 0·287 g

☐ D 0·574 g

(TOTAL FOR QUESTION 5 = 1 MARK)

(Questions continue on next page)

6 When 0·127 g of copper is added to excess silver nitrate solution, the following reaction occurs.

$$Cu(s) + 2AgNO_3(aq) \longrightarrow Cu(NO_3)_2(aq) + 2Ag(s)$$

What mass of silver is formed?

[Molar masses / g mol^{-1}: Cu = 63·5 Ag = 107·9]

☐ A 0·216 g

☐ B 0·254 g

☐ C 0·432 g

☐ D 0·863 g

(TOTAL FOR QUESTION 6 = 1 MARK)

(Questions continue on next page)

7 The molecular formula of phosphorus(V) oxide is P_4O_{10}.
What is the percentage by mass of phosphorus in this oxide?

[Molar masses / g mol^{-1}: O = 16·0 P = 31·0]

☐ A 28·6%

☐ B 42·9%

☐ C 43·7%

☐ D 56·3%

(TOTAL FOR QUESTION 7 = 1 MARK)

(Questions continue on next page)

8 Aluminium reacts with hydrochloric acid.

$2Al(s) + 6HCl(aq) \longrightarrow 2AlCl_3(aq) + 3H_2(g)$

What is the maximum volume of hydrogen at room temperature and pressure (r.t.p.) that can be formed from 0·135 g of aluminium?

[Molar volume of gas at r.t.p. = 24 000 $cm^3 mol^{-1}$
Molar mass Al = 27·0 $g mol^{-1}$]

☐ A 60 cm^3

☐ B 80 cm^3

☐ C 120 cm^3

☐ D 180 cm^3

(TOTAL FOR QUESTION 8 = 1 MARK)

(Questions continue on next page)

9 150 cm^3 of ethane is mixed with 700 cm^3 of oxygen.
The equation for the reaction is

$$C_2H_6(g) + 3\frac{1}{2}O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l)$$

What is the total volume of gas when the reaction is complete?

All gas volumes are measured at the same temperature and pressure.

☐ A 150 cm^3

☐ B 300 cm^3

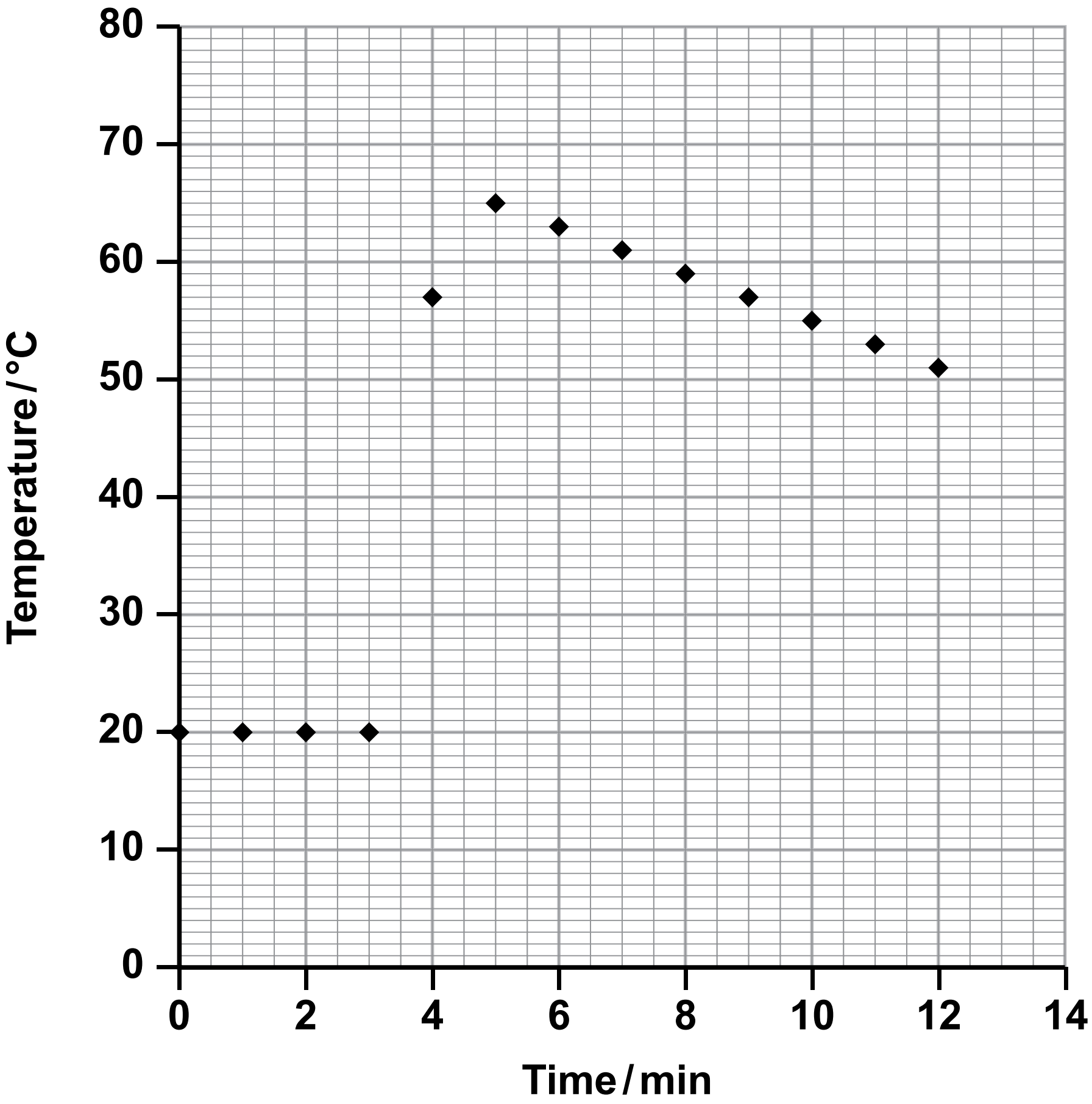
☐ C 325 cm^3

☐ D 475 cm^3

(TOTAL FOR QUESTION 9 = 1 MARK)

(Questions continue on next page)

10 In an experiment to determine the enthalpy change for the reaction between zinc and copper(II) sulfate, a cooling curve was used to estimate the temperature change. The zinc was added to the copper(II) sulfate solution at 3½ minutes and the results were plotted on a graph.



(Question continues on next page)

What is the temperature change?

- ☐ A 45°C
- ☐ B 48°C
- ☐ C 65°C
- ☐ D 68°C

(TOTAL FOR QUESTION 10 = 1 MARK)

(Questions continue on next page)

11 The enthalpy changes of two reactions are

$$2Fe(s) + 1\tfrac{1}{2}O_2(g) \longrightarrow Fe_2O_3(s) \quad \Delta H^{\ominus} = -824\,kJ\,mol^{-1}$$

$$C(s) + \tfrac{1}{2}O_2(g) \longrightarrow CO(g) \quad \Delta H^{\ominus} = -110\,kJ\,mol^{-1}$$

For the reaction

$$Fe_2O_3(s) + 3C(s) \longrightarrow 2Fe(s) + 3CO(g)$$

the enthalpy change is

- ☐ **A** $-494\,kJ\,mol^{-1}$
- ☐ **B** $+494\,kJ\,mol^{-1}$
- ☐ **C** $-714\,kJ\,mol^{-1}$
- ☐ **D** $+714\,kJ\,mol^{-1}$

(TOTAL FOR QUESTION 11 = 1 MARK)

(Questions continue on next page)

12 Which change would have a NEGATIVE ΔH value?

☐ **A** $Cl(g) + e^- \rightarrow Cl^-(g)$

☐ **B** $Cl_2(g) \rightarrow 2Cl(g)$

☐ **C** $Na(s) \rightarrow Na(l)$

☐ **D** $Na(g) \rightarrow Na^+(g) + e^-$

(TOTAL FOR QUESTION 12 = 1 MARK)

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13 The combustion of magnesium may be represented by two equations.

$$Mg(s) + \tfrac{1}{2}O_2(g) \rightarrow MgO(s) \quad (1)$$

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s) \quad (2)$$

The units of ΔH for equation (1) are $kJ\,mol^{-1}$. The units of ΔH for equation (2) are

☐ **A** $kJ\,mol^{-1}$

☐ **B** $(kJ\,mol^{-1}) \div 2$

☐ **C** $(kJ\,mol^{-1}) \times 2$

☐ **D** $(kJ\,mol^{-1})^2$

(TOTAL FOR QUESTION 13 = 1 MARK)

(Questions continue on next page)

14 Which of the species, Ne, F^- and Na^+, have the electronic structure $1s^2\ 2s^2\ 2p^6$?

☐ A Ne only

☐ B Ne and F^- only

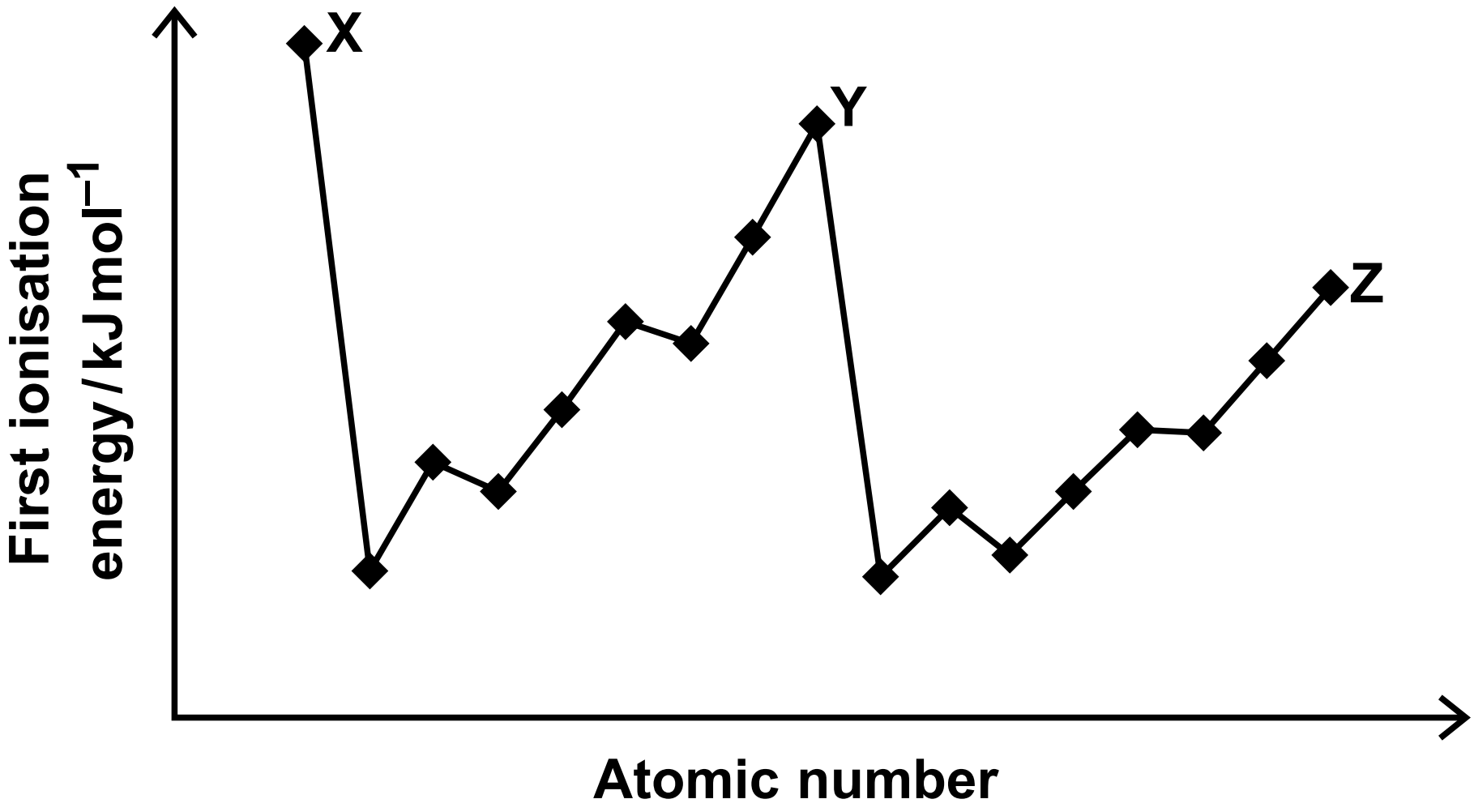
☐ C Ne and Na^+ only

☐ D Ne, F^- and Na^+

(TOTAL FOR QUESTION 14 = 1 MARK)

(Questions continue on next page)

15 The graph shows the variation of first ionisation energy with atomic number for successive elements in the Periodic Table.



The elements X, Y and Z are

☐ **A** alkali metals.

☐ **B** alkaline earth metals.

☐ **C** halogens.

☐ **D** noble gases.

(TOTAL FOR QUESTION 15 = 1 MARK)

(Questions continue on next page)

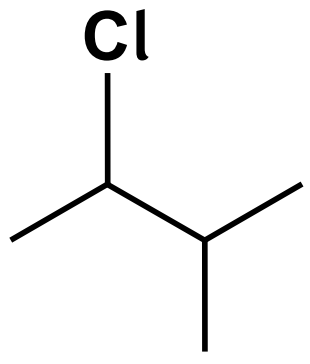
16 The electrostatic interactions involved in a covalent bond are electron-electron, nucleus-nucleus and electron-nucleus.
What types of interaction occur?

	electron-electron	nucleus-nucleus	electron-nucleus
☐ A	attraction	attraction	repulsion
☐ B	repulsion	repulsion	attraction
☐ C	attraction	repulsion	attraction
☐ D	repulsion	attraction	attraction

(TOTAL FOR QUESTION 16 = 1 MARK)

(Questions continue on next page)

17 What is the name of the organic compound with the structure shown?



☐ **A** 2-chloro-1,1-dimethylpropane

☐ **B** 2-chloro-3,3-dimethylpropane

☐ **C** 2-chloro-3-methylbutane

☐ **D** 1-chloro-2,3-dimethylbutane

(TOTAL FOR QUESTION 17 = 1 MARK)

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18 Methane is considered a better fossil fuel than coal because methane

☐ **A** is not a greenhouse gas.

☐ **B** is mainly obtained from renewable sources.

☐ **C** produces less carbon dioxide per kWh of power generated.

☐ **D** has no effect on the ozone layer.

(TOTAL FOR QUESTION 18 = 1 MARK)

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19 How many σ bonds are there in the organic compound with the skeletal structure shown?

- ☐ **A** 2
- ☐ **B** 3
- ☐ **C** 10
- ☐ **D** 11

(TOTAL FOR QUESTION 19 = 1 MARK)

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20 But-2-ene reacts with acidified potassium manganate(VII) at room temperature.
The organic product of this reaction is

- ☐ **A** butane-1,2-diol.
- ☐ **B** butane-1,3-diol.
- ☐ **C** butane-1,4-diol.
- ☐ **D** butane-2,3-diol.

(TOTAL FOR QUESTION 20 = 1 MARK)

TOTAL FOR SECTION A = 20 MARKS

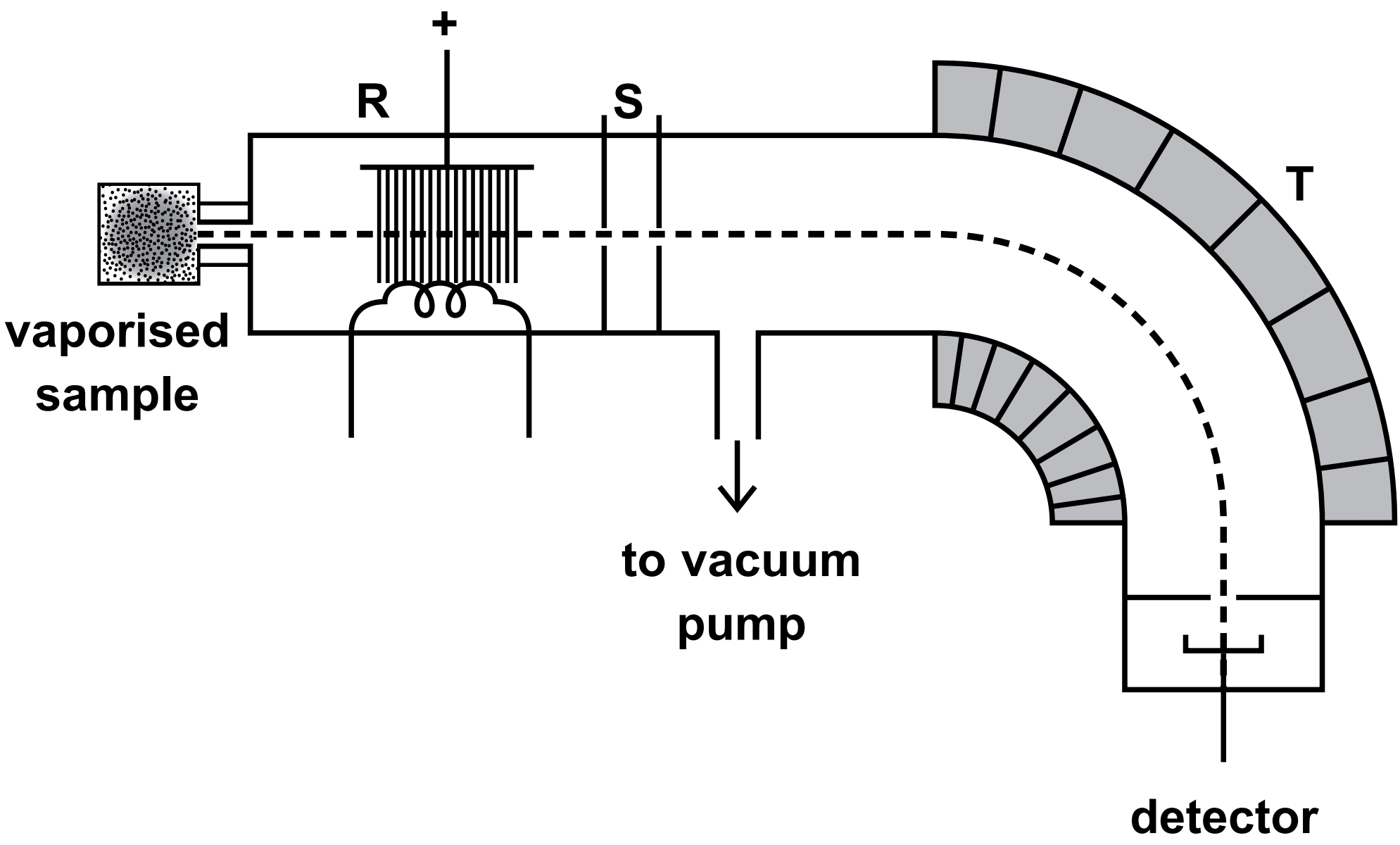
(Section B begins on next page)

SECTION B

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

21 Mass spectrometry is used to determine the relative atomic masses of elements.

The diagram shows the main features of a mass spectrometer.



(Question continues on next page)

(a) After vaporisation, the sample passes through three stages before reaching the detector.

(i) The first stage is ionisation, which occurs at R. Describe fully the ionisation process for the element nickel, Ni, writing an equation to illustrate it.
State symbols are not required. (2 marks)

(Question continues on next page)

(ii) Describe the processes occurring at S and T.

(2 marks)

S _____

_____

_____

T _____

_____

_____

(Question continues on next page)

(iii) Explain why the sample needs to be ionised.

(1 mark)

(b) The tallest peak in a mass spectrum (called the base peak) is given a height of 100 and the heights of all the other peaks are given relative to the base peak. A sample of the element nickel is analysed in a mass spectrometer and found to have two significant peaks.

m / e	Relative peak height
58	100
60	39·8

(Question continues on next page)

(i) Calculate the relative atomic mass of nickel in this sample.
Give your answer to one decimal place.

(2 marks)

(Question continues on next page)

(ii) Use the relative peak heights to calculate the percentage abundance of the two isotopes in the sample. (2 marks)

(Question continues on next page)

(iii) The mass spectrum of this sample of nickel had a very small peak at m / e = 29. Identify the species responsible for this peak.
Write an equation to show how it is formed.
State symbols are not required. (2 marks)

(Question continues on next page)

(c) **Mass spectrometry is also used to identify chemical compounds.**
State ONE application for this use of the technique. (1 mark)

(TOTAL FOR QUESTION 21 = 12 MARKS)

(Questions continue on next page)

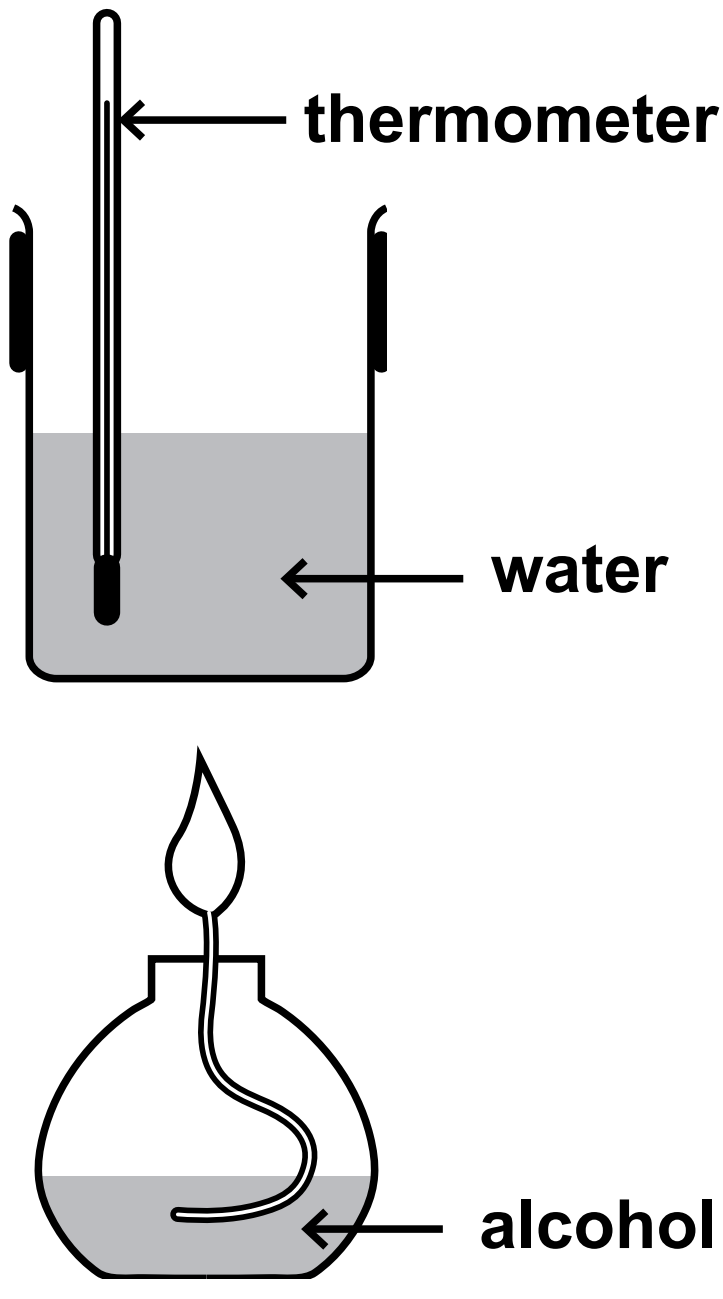
22 Enthalpy changes of combustion are very important in thermochemistry because they can be used to determine enthalpy changes that cannot be measured directly.

(a) Define standard enthalpy change of combustion.

(2 marks)

(Question continues on next page)

(b) A class of students used the apparatus below to determine the enthalpy change of combustion for some alcohols.



One student obtained the following results for ethanol.

Measurement	Value
Mass of water / g	250·00
Mass of ethanol used / g	0·55
Temperature rise / °C	9·5

(Question continues on next page)

(i) Calculate the energy transferred in the student's experiment. (1 mark)

Use the expression

$$\text{Energy transferred (J)} = \text{mass of water} \times 4{\cdot}18 \times \text{temperature change}$$

(ii) Calculate the enthalpy change of combustion of ethanol.
Give a sign and units with your answer.

(3 marks)

(c) Most of the students obtained similar results for the enthalpy change of combustion of ethanol. The class mean was $-840\,kJ\,mol^{-1}$ compared with the Data Book value of $-1367\,kJ\,mol^{-1}$.

(i) Calculate the percentage error in the mean value obtained by the class compared to the Data Book value. (1 mark)

(Question continues on next page)

*(ii) One student suggested that the difference between the students' values and the Data Book value was due to the uncertainties in measuring the masses and temperatures. Explain why this suggestion is incorrect.

No calculation is required. (2 marks)

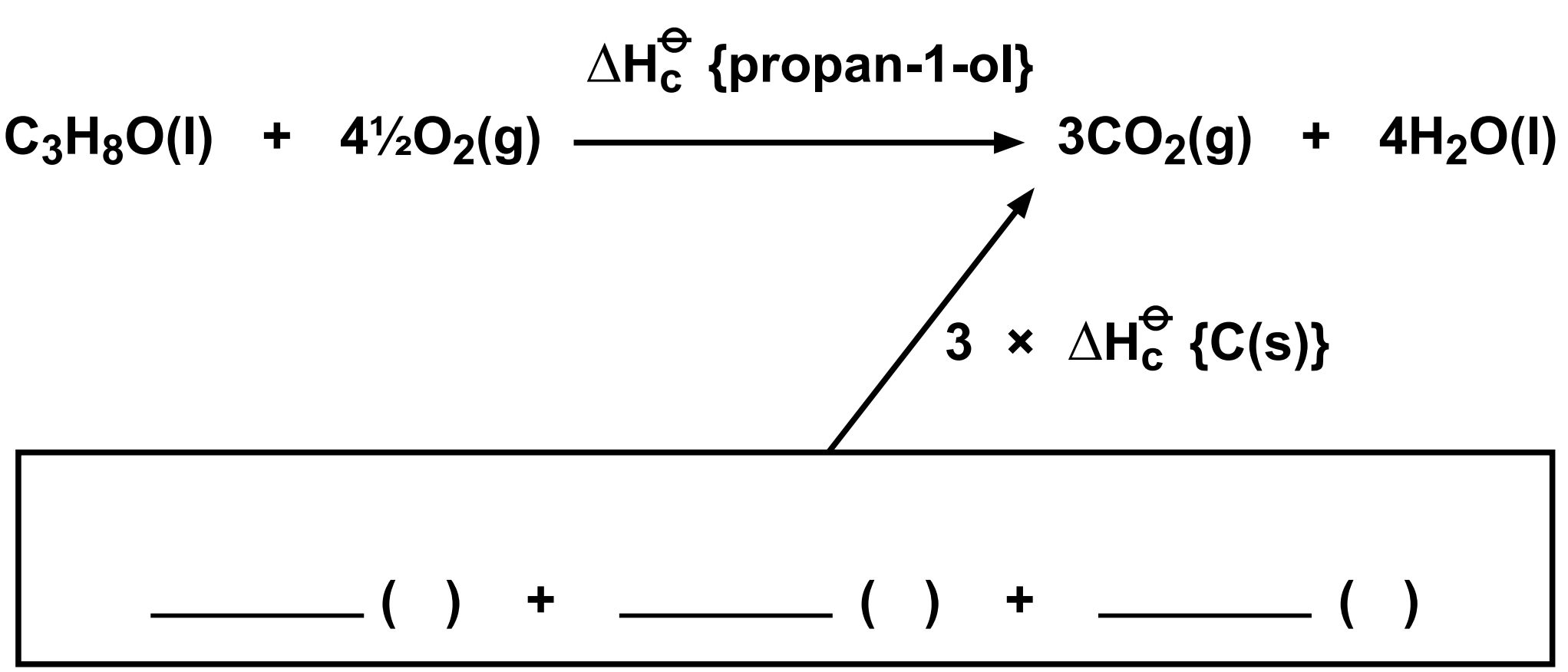
(Question continues on next page)

*(iii) Suggest ONE factor that could have caused the difference between the students' values and the Data Book value. Justify your answer. (2 marks)

(Question continues on next page)

(d) The standard enthalpy change of formation of propan-1-ol cannot be measured directly.

(i) Complete the Hess cycle below, which may be used to calculate the standard enthalpy change of formation of propan-1-ol. Add missing enthalpy changes, arrows and species. Include state symbols. (3 marks)



(Question continues on next page)

(ii) Use your completed cycle in (d)(i) and the data in the table, to calculate the standard enthalpy change of formation of propan-1-ol. (2 marks)

Substance	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
carbon	−394
hydrogen	−286
propan-1-ol	−2021

(TOTAL FOR QUESTION 22 = 16 MARKS)

(Questions continue on next page)

23 This question is about the bonds that chlorine forms in its chemical compounds.

(a) Chlorine forms a covalent bond in its compound with hydrogen.

(i) Give the electronic configuration of chlorine using the s p d notation. (1 mark)

(ii) Draw a dot-and-cross diagram of hydrogen chloride, showing outer electrons only.

(1 mark)

(Question continues on next page)

(iii) Describe fully the formation of the covalent bond in hydrogen chloride in terms of orbital overlap. (3 marks)

(Question continues on next page)

(b) Chlorine forms ionic bonds with metals such as sodium and silver. The lattice energies of ionic compounds provide information about their bonds. The table below shows the experimental and calculated values for the lattice energy of sodium chloride and silver chloride.

Compound	Lattice energy / kJ mol^{-1}	
	Experimental	Calculated
sodium chloride	−780	−770
silver chloride	−905	−833

(i) Draw a dot-and-cross diagram of sodium chloride, showing outer electrons only.

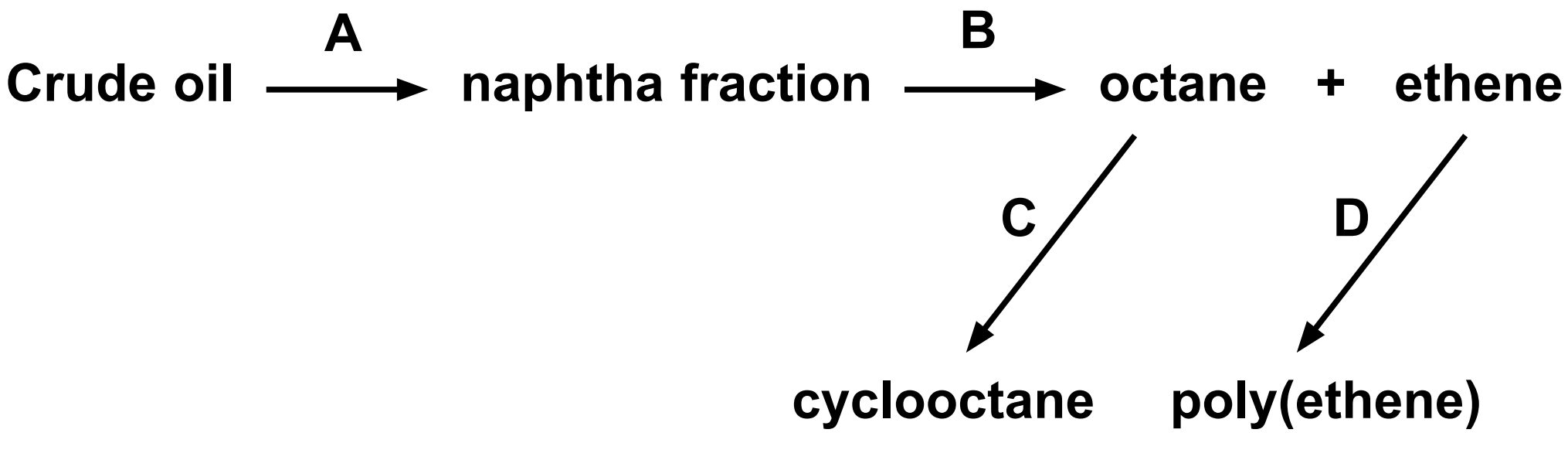
(1 mark)

*(ii) Explain why the experimental and calculated values for the lattice energy of sodium chloride are similar whereas those for silver chloride differ significantly. (3 marks)

(TOTAL FOR QUESTION 23 = 9 MARKS)

(Questions continue on next page)

24 **The diagram summarises some of the processes involved in the production of alkanes from crude oil, and their uses.**



(a) Name the processes shown in the diagram.

(4 marks)

A _____

B _____

C _____

D _____

(Question continues on next page)

(b) State what happens to the compounds present in crude oil during process A. Identify the property of the compounds which allows this process to work. (2 marks)

(Question continues on next page)

(c) The naphtha fraction comprises alkanes with a minimum of four and a maximum of ten carbon atoms. Write an equation for the formation of octane and ethene in process B. State symbols are not required. (2 marks)

(d) (i) Write an equation for the reaction occurring in process C.
State symbols are not required. (1 mark)

(Question continues on next page)

(Turn over)

(ii) Octane is converted into cyclooctane on a large scale.
Explain why cyclooctane is added to petrol.

(2 marks)

(Question continues on next page)

(e) Using displayed formulae, write a balanced equation for process D.
State symbols are not required. (2 marks)

(TOTAL FOR QUESTION 24 = 13 MARKS)

(Questions continue on next page)

25 Alkanes and alkenes react with halogens.

(a) The reaction of methane with chlorine is a free radical substitution.

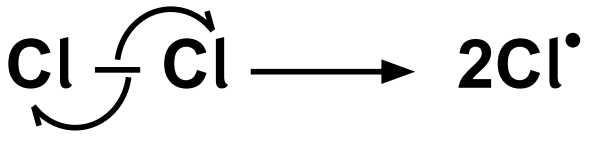
$$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$$

(i) State the essential condition for this reaction.

(1 mark)

(Question continues on next page)

(ii) The first stage in the mechanism of this reaction is the formation of the chlorine free radical.



Explain fully what a curly half-arrow represents in this equation. (2 marks)

(Question continues on next page)

(iii) Write the two equations of the propagation stage of the reaction.
Curly half-arrows are NOT required. (2 marks)

(Question continues on next page)

(iv) Chloromethane is also formed in the termination stage of the reaction. Explain why the amount of chloromethane formed in the propagation stage is very much greater than the amount formed in the termination stage. (3 marks)

(Question continues on next page)

(b) Bromine reacts with propene in normal laboratory conditions.

(i) State the type and mechanism of this reaction.

(1 mark)

(ii) Draw the structure of the product of this reaction. (1 mark)

(TOTAL FOR QUESTION 25 = 10 MARKS)

TOTAL FOR SECTION B = 60 MARKS

TOTAL FOR PAPER = 80 MARKS

END