Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Friday 26 May 2017 – Morning
Time: 1 hour 30 minutes

Paper Reference
6CH01/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes at th**e 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.*
- 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 printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

P53491A

6/6/1/1/1/

P 5 3 4 9 1 A 0 1 3 2

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 The concentration of carbon monoxide in the exhaust gases of a car without a catalytic converter is 0.7 % by volume.

In units of parts per million, this concentration is

☒ **A** 7

☒ **B** 70

☒ **C** 700

☒ **D** 7000

(Total for Question 1 = 1 mark)

2 Ionization occurs in a mass spectrometer when an atom or a molecule

☒ **A** is accelerated to high kinetic energy and loses an electron.

☒ **B** is accelerated to high kinetic energy and gains an electron.

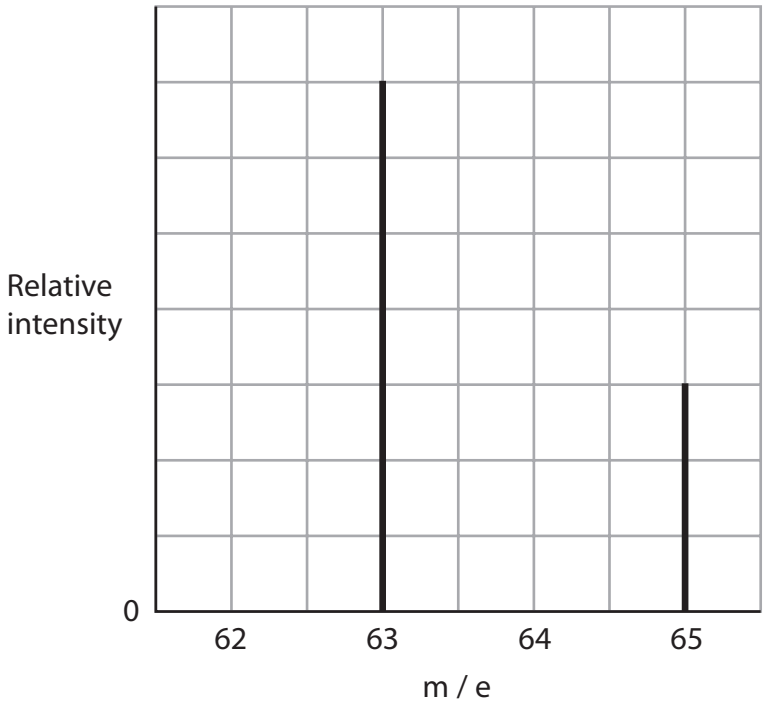
☒ **C** collides with a high energy electron and loses an electron.

☒ **D** collides with a high energy electron and gains an electron.

(Total for Question 2 = 1 mark)

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

3 The mass spectrum of a metal has only the peaks shown in the diagram.



The relative atomic mass of the metal is

☒ **A** 63.0

☒ **B** 63.6

☒ **C** 64.0

☒ **D** 65.0

(Total for Question 3 = 1 mark)

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

4 An atom and an ion with a single positive charge are isoelectronic. Therefore the

☒ **A** atom and the ion have the same mass number.

☒ **B** atom and the ion have the same atomic number.

☒ **C** atomic number of the atom is one more than that of the ion.

☒ **D** atomic number of the atom is one less than that of the ion.

(Total for Question 4 = 1 mark)

5 The electronic configuration of a species which has only one unpaired electron is

☒ **A** $1s^2\ 2s^2\ 2p^2$

☒ **B** $1s^2\ 2s^2\ 2p^3$

☒ **C** $1s^2\ 2s^2\ 2p^4$

☒ **D** $1s^2\ 2s^2\ 2p^5$

(Total for Question 5 = 1 mark)

6 The CFC dichlorodifluoromethane has the molecular formula CCl_2F_2 and its molar mass is 121 g mol^{-1}. What is the total number of **atoms** in 2.42 g of dichlorodifluoromethane?

[Avogadro constant = 6.0×10^{23} mol^{-1}]

☒ **A** 6.0×10^{22}

☒ **B** 4.8×10^{22}

☒ **C** 3.6×10^{22}

☒ **D** 1.2×10^{22}

(Total for Question 6 = 1 mark)

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

7 A chemical compound has a high melting temperature and a high boiling temperature. From this it can be deduced that its bonding could be

☒ **A** ionic but not covalent.

☒ **B** covalent but not ionic.

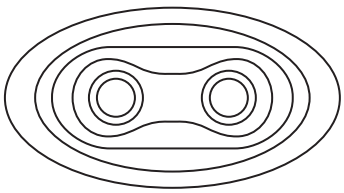
☒ **C** either ionic or covalent.

☒ **D** metallic.

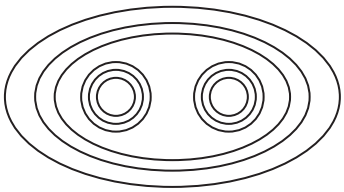
(Total for Question 7 = 1 mark)

8 Which diagram best represents the electron density map of a chlorine molecule?

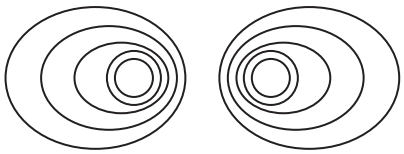
☒ **A**



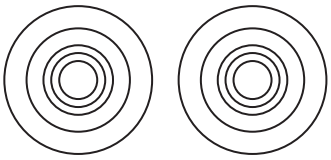
☒ **B**



☒ **C**



☒ **D**



(Total for Question 8 = 1 mark)

9 When gold(III) oxide is heated, it decomposes to form gold and oxygen. Calculate the mass of gold formed when 2.21 g of gold(III) oxide is heated to constant mass.

[Molar masses: O = 16.0 g mol^{-1} Au = 197 g mol^{-1}]

☒ **A** 1.97 g

☒ **B** 2.04 g

☒ **C** 2.10 g

☒ **D** 2.15 g

(Total for Question 9 = 1 mark)

10 One of the reactions in the catalytic converter of a car exhaust is

$$2NO(g) + 2CO(g) \rightarrow 2CO_2(g) + N_2(g)$$

400 cm^3 of NO is mixed with 500 cm^3 of CO. What is the **total** volume of gas when the reaction is complete? All gas volumes are measured at the same temperature and pressure.

☒ **A** 600 cm^3

☒ **B** 700 cm^3

☒ **C** 1300 cm^3

☒ **D** The volume cannot be calculated without the molar volume of gas at the appropriate temperature and pressure.

(Total for Question 10 = 1 mark)

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

11 When dilute sulfuric acid is added to a solution of lead(II) nitrate, the reaction is

$$Pb(NO_3)_2(aq) + H_2SO_4(aq) \rightarrow PbSO_4(s) + 2HNO_3(aq)$$

(a) This reaction is

(1)

☒ **A** displacement.

☒ **B** neutralization.

☒ **C** precipitation.

☒ **D** redox.

(b) When excess sulfuric acid was added to a solution containing 6.62 g of lead(II) nitrate, 4.80 g of lead(II) sulfate was obtained.

What is the percentage yield by mass of lead(II) sulfate in this reaction?

(1)

[Molar masses: $Pb(NO_3)_2 = 331$ g mol^{-1} ; $PbSO_4 = 303$ g mol^{-1}]

☒ **A** 91.5 %

☒ **B** 79.2 %

☒ **C** 72.5 %

☒ **D** 66.4 %

(Total for Question 11 = 2 marks)

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

12 Which is correct for chlorine?

	First ionization energy	First electron affinity
☒ **A**	exothermic	endothermic
☒ **B**	exothermic	exothermic
☒ **C**	endothermic	exothermic
☒ **D**	endothermic	endothermic

(Total for Question 12 = 1 mark)

13 In the solid state, phosphorus exists in three forms: black, red and white. These forms may be interconverted:

$$P(s, \text{white}) \rightarrow P(s, \text{black}) \quad \Delta H^{\ominus} = -43.1 \text{ kJ mol}^{-1}$$

$$P(s, \text{white}) \rightarrow P(s, \text{red}) \quad \Delta H^{\ominus} = -18.0 \text{ kJ mol}^{-1}$$

From these data, it may be calculated that the standard enthalpy change for the conversion of black phosphorus into red phosphorus is

☒ **A** +61.1 kJ mol^{-1}

☒ **B** +25.1 kJ mol^{-1}

☒ **C** −25.1 kJ mol^{-1}

☒ **D** −61.1 kJ mol^{-1}

(Total for Question 13 = 1 mark)

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

14 The reaction between hydrogen and fluorine is highly exothermic. This is mainly because the

☒ **A** F—F bond is weak and the H—F bond is strong.

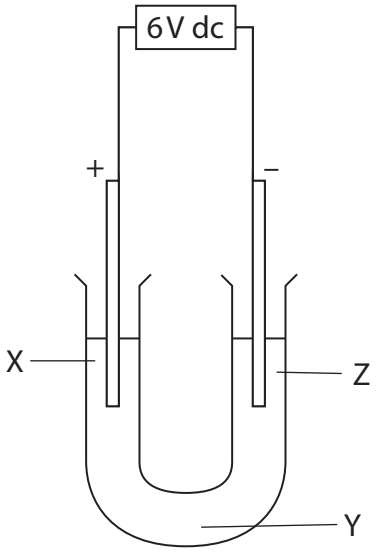
☒ **B** F—F bond is strong and the H—F bond is weak.

☒ **C** F—F bond is weak and the H—F and H—H bonds are strong.

☒ **D** F—F bond is strong and the H—F and H—H bonds are weak.

(Total for Question 14 = 1 mark)

15 An aqueous solution of copper(II) chromate(VI) was electrolysed in the apparatus shown in the diagram using platinum electrodes.

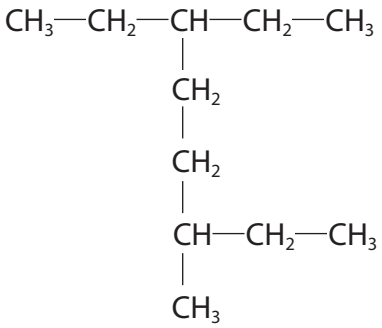


After five minutes, the colours observed in the different parts of the solution in the U-tube were

	X	Y	Z
☒ **A**	green	yellow	blue
☒ **B**	yellow	blue	green
☒ **C**	blue	green	yellow
☒ **D**	yellow	green	blue

(Total for Question 15 = 1 mark)

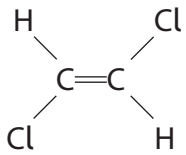
16 Give the systematic name for this hydrocarbon.



- ☒ **A** 1,1,4-triethylpentane
- ☒ **B** 2,5,5-triethylpentane
- ☒ **C** 2,5-diethylheptane
- ☒ **D** 3-ethyl-6-methyloctane

(Total for Question 16 = 1 mark)

17 A compound has the structure



Depending on the naming system used, this compound is

- ☒ **A** *cis*-1,2-dichloroethene or *E*-1,2-dichloroethene.
- ☒ **B** *cis*-1,2-dichloroethene or *Z*-1,2-dichloroethene.
- ☒ **C** *trans*-1,2-dichloroethene or *E*-1,2-dichloroethene.
- ☒ **D** *trans*-1,2-dichloroethene or *Z*-1,2-dichloroethene.

(Total for Question 17 = 1 mark)

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

18 The carbon-carbon bond in ethene consists of

☒ **A** two σ bonds.

☒ **B** one π bond.

☒ **C** one σ bond and one π bond.

☒ **D** two π bonds.

(Total for Question 18 = 1 mark)

19 The terms hazard and risk are used when considering the use of chemical compounds. For a particular characteristic of a pure compound,

☒ **A** hazard is fixed but risk varies.

☒ **B** hazard varies but risk is fixed.

☒ **C** hazard and risk are fixed.

☒ **D** hazard and risk vary.

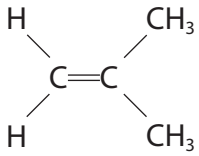
(Total for Question 19 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

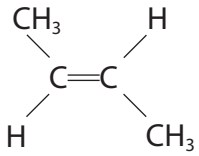
SECTION B

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

20 Compounds **A** and **B** are isomeric alkenes.



A



B

(a) (i) Name compound **A**.

(1)

(ii) Give the molecular formula of compound **B**.

(1)

(iii) Explain why **A** and **B** are isomers.

(2)

(iv) Draw the **geometric** isomer of compound **B**.

(1)

(v) Explain why compound **B** has a geometric isomer but compound **A** does not.

(1)

.....

.....

.....

.....

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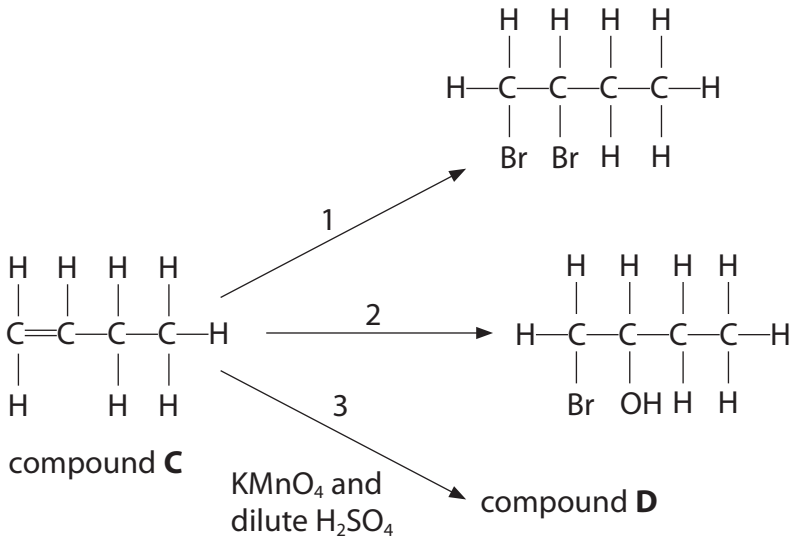
(b) Compound **C** is an isomer of compounds **A** and **B**. Some reactions of compound **C** are shown below.



(i) **Name** the reagent(s) required for reaction 1.

(1)

.....

(ii) **Name** the reagent(s) required for reaction 2.

(1)

.....

(iii) Draw the **displayed** formula of compound **D**.

(1)

(c) Compound **C** also reacts with hydrogen chloride.

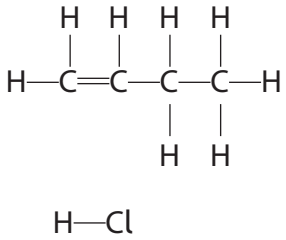
(i) Classify the type and mechanism of this reaction.

(2)

.....

(ii) Complete the diagram below by adding any dipoles and curly arrows relevant to the **first** step of the mechanism of this reaction.

(2)



H—Cl

(iii) Draw the intermediate for the reaction which produces the major product. Hence show the final step of the mechanism and the product.

Include relevant curly arrows, lone pairs and charges.

(4)

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(d) Compound **C** forms a polymer which, because of its temperature resistance, is used in hot water piping.

Draw a section of this polymer, showing **two** repeat units.

(1)

(Total for Question 20 = 18 marks)

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21 Magnesium is in Group 2 of the Periodic Table. It has a number of naturally occurring isotopes, including ^{24}Mg and ^{26}Mg.

(a) (i) Explain, in terms of the subatomic particles in the atoms, why ^{24}Mg and ^{26}Mg are isotopes.

(2)

.....

.....

.....

.....

(ii) A sample of magnesium, which contains only the isotopes ^{24}Mg and ^{26}Mg, has a relative atomic mass of 24.433.

Calculate the percentage abundance of each isotope in this sample of magnesium.

(2)

(b) (i) Give the electronic structure of a magnesium atom, using the s, p, d notation.

(1)

(ii) Write the equation for the first ionization energy of magnesium. Include state symbols.

(1)

*(iii) Explain why the first ionization energy of magnesium is higher than the first ionization energy of sodium.

(2)

(iv) Explain why the first ionization energy of magnesium is higher than the first ionization energy of aluminium.

(2)

(c) Magnesium carbonate decomposes on heating:

$$MgCO_3(s) \rightarrow MgO(s) + CO_2(g) \qquad \Delta H_1$$

The enthalpy change can only be determined indirectly, by applying Hess's Law.

(i) Explain why the enthalpy change of this reaction cannot be determined directly.

(1)

.....

.....

.....

(ii) State Hess's Law.

(1)

.....

.....

.....

(d) A class of students carried out an experiment to measure ΔH_1 indirectly by determining the enthalpy changes of two reactions:

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g) \qquad \Delta H_2$$

$$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) \qquad \Delta H_3$$

One group used the following method to measure ΔH_2.

- Pipette 50.0 cm^3 of 2 mol dm^{-3} hydrochloric acid (a large excess) into a polystyrene cup and note the temperature of the acid.
- Weigh accurately 2.50 g of magnesium carbonate powder.
- Add the magnesium carbonate to the acid, stir continuously and note the highest temperature.

(i) Why is excess hydrochloric acid used?

(1)

.....

.....

(ii) The students were told that using a polystyrene cup gives better results than using a glass beaker because of its good thermal insulation and its low heat capacity. Explain why these properties improve experimental results.

(2)

Good thermal insulation .....

.....

.....

Low heat capacity .....

.....

.....

(iii) One student using this method measured a temperature increase of 18.5°C. Calculate the energy change, in joules, for this reaction. Assume the specific heat capacity of the solution is 4.18 J g^{-1} $°C^{-1}$ and use the expression

energy change (J) = 50.0 × specific heat capacity × temperature change

(1)

*(iv) Use your answer to (d)(iii) to calculate the molar enthalpy change for the reaction between magnesium carbonate and hydrochloric acid.
Give your answer to **three** significant figures and include a sign and units.

(3)

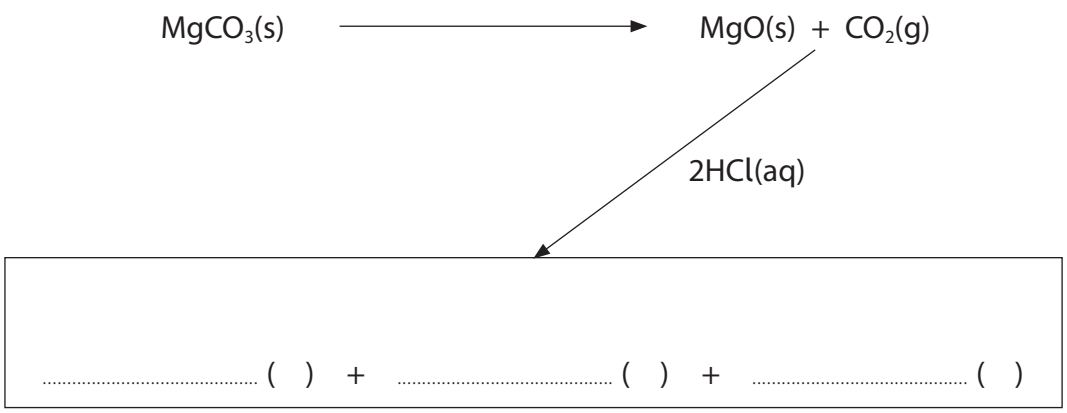
(e) The class collected all their results and, after eliminating anomalous results, calculated the mean values of ΔH_2 and ΔH_3:

$$\Delta H_2 = -126 \text{ kJ mol}^{-1}$$

$$\Delta H_3 = -231 \text{ kJ mol}^{-1}$$

(i) Complete the Hess cycle below by adding the missing arrow and species.

(1)



(ii) Use your completed Hess cycle and the students' mean values for ΔH_2 and ΔH_3 to calculate the enthalpy change for the thermal decomposition of magnesium carbonate. Include a sign and units.

(2)

*(f) Data book values for ΔH_2 and ΔH_3 are

$$\Delta H_2 = -179.4 \text{ kJ mol}^{-1}$$

$$\Delta H_3 = -296.4 \text{ kJ mol}^{-1}$$

Most of the values obtained by the students were close to their mean values, and they suggested that the difference between their values and those from the data book was due to the measurement uncertainties in their experiments.

Evaluate this suggestion.

(2)

(Total for Question 21 = 24 marks)

22 (a) 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) Write the equation for the lattice energy of sodium chloride.
Include state symbols.

(1)

(ii) Name the energy cycle used to calculate lattice energies from experimental data.

(1)

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

(3)

(b) The percentage composition by mass of a sodium compound is
Na = 29.1%; S = 40.6%; O = 30.3%.

Calculate the empirical formula of the compound.

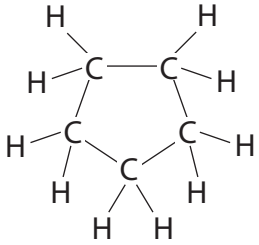
(3)

(c) Draw the dot and cross diagram for sodium oxide.
Show the outer electrons only.

(2)

(Total for Question 22 = 10 marks)

23 Cycloalkanes are hydrocarbons which contain a ring of carbon atoms. Cycloalkanes have essentially the same chemical reactions as alkanes such as butane and pentane. Cyclopentane, which has a five-carbon ring, is a foam-blowing agent used to propel insulation into the doors and cases of refrigerators. The use of cyclopentane, rather than CFCs, reduces greenhouse gas emissions from this process by 99%.



cyclopentane

(a) (i) Write the **empirical** formula of cyclopentane.

(1)

.....

(ii) Suggest the general formula of the cycloalkanes.

(1)

.....

(b) Cyclopentane may be manufactured by reforming pentane, which is obtained from crude oil.

(i) Name the first stage in the process used to obtain compounds such as pentane from crude oil.

(1)

.....

(ii) Write an equation for the reforming of pentane into cyclopentane. State symbols are not required.

(1)

(c) Cyclopentane and methane react with chlorine by the same mechanism.

(i) State the essential condition for the reaction between cyclopentane and chlorine.

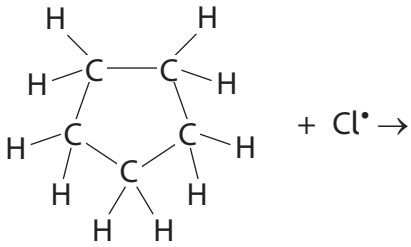
(1)

.....

(ii) Give the **propagation** stage for the reaction between cyclopentane and chlorine by completing the first equation of this stage and then writing the second equation.
Curly half-arrows are **not** required.

(2)

Equation 1



$+ \ Cl^{\bullet} \rightarrow$

Equation 2

(iii) The termination stage of the reaction between cyclopentane and chlorine produces only one hydrocarbon. Draw the displayed formula of this hydrocarbon.

(1)

(Total for Question 23 = 8 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