Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Wednesday 9 January 2019

Morning (Time: 1 hour 30 minutes) | Paper Reference **WCH01/01**

Chemistry

Advanced Subsidiary

Unit 1: The Core Principles of Chemistry

Candidates must have: Scientific calculator
Ruler

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **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.*
- 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.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ▶

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P 5 4 4 5 7 A 0 1 2 4

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 European Union limit for nitrogen dioxide in the atmosphere is 0.0209 cm^3 in 1 m^3.
In units of parts per million (ppm) this is

☒ **A** 2.09×10^{-5}

☒ **B** 2.09×10^{-2}

☒ **C** 20.9

☒ **D** 2.09×10^{4}

(Total for Question 1 = 1 mark)

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** 1.35×10^{-1}

☒ **B** 2.82×10^{-1}

☒ **C** 1.35×10^{-4}

☒ **D** 2.82×10^{-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)

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 = $6.0 \times 10^{23}\,mol^{-1}$]

☒ **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)

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

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

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)

6 When 0.127 g of copper is added to excess silver nitrate solution, the following reaction occurs.

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

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)

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)

8 Aluminium reacts with hydrochloric acid.

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

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)

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

$$C_2H_6(g) + 3½O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$$

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

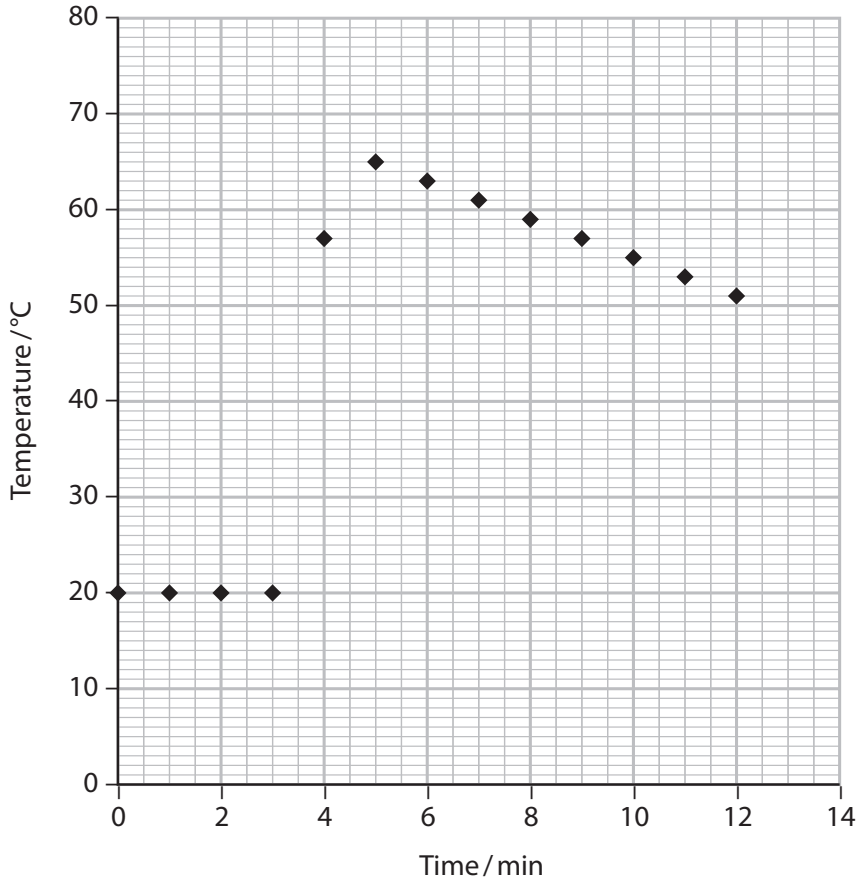
☒ **B** 300 cm^3

☒ **C** 325 cm^3

☒ **D** 475 cm^3

(Total for Question 9 = 1 mark)

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.



What is the temperature change?

- ☒ **A** 45°C
- ☒ **B** 48°C
- ☒ **C** 65°C
- ☒ **D** 68°C

(Total for Question 10 = 1 mark)

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

11 The enthalpy changes of two reactions are

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

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

For the reaction

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

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)

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)

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

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)

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

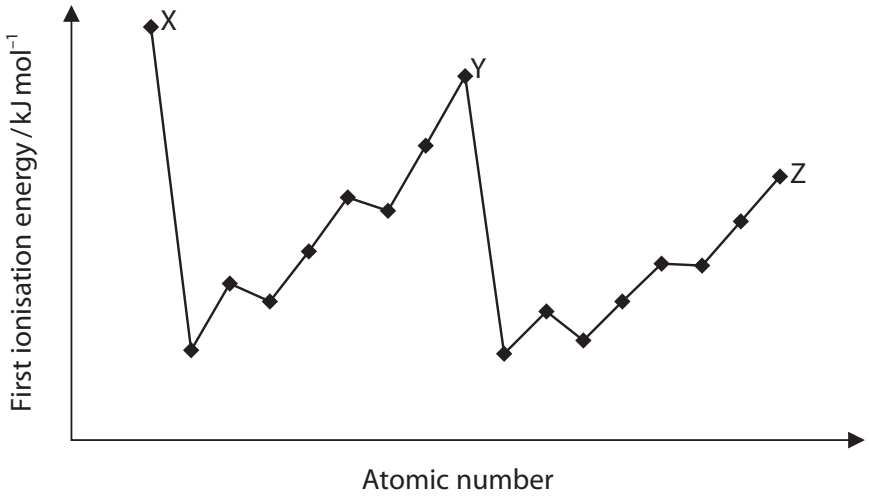
☒ **C** Ne and Na^+ only

☒ **D** Ne, F^- and Na^+

(Total for Question 14 = 1 mark)

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

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)

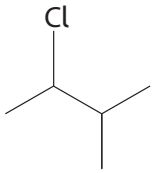
16 The electrostatic interactions involved in a covalent bond are electron-electron, nucleus-nucleus and electron-nucleus.
What types of interaction occur?

	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)

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

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)

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)

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)

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

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.

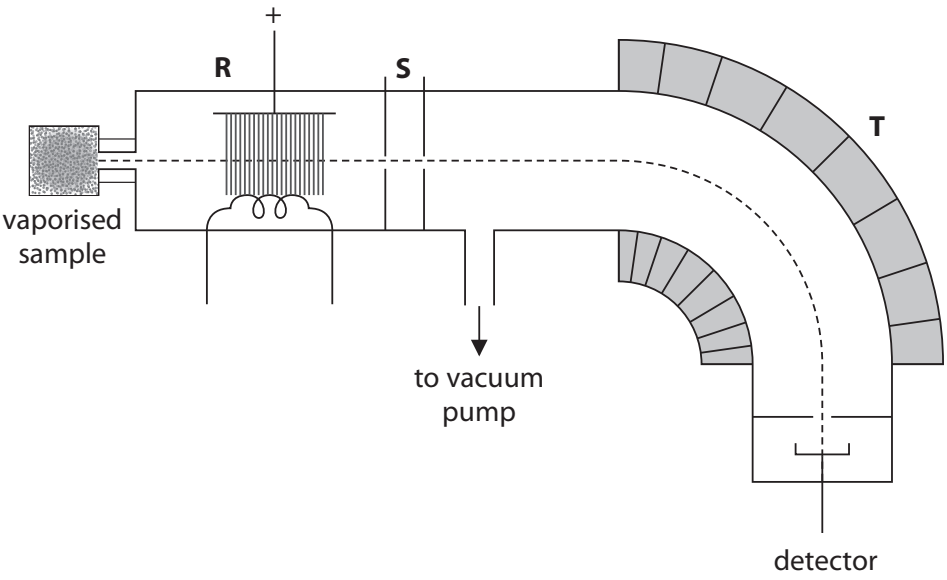
(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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.



(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)

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

(2)

S

T

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

(1)

.....

.....

.....

(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

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

(2)

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

(2)

(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)

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

(1)

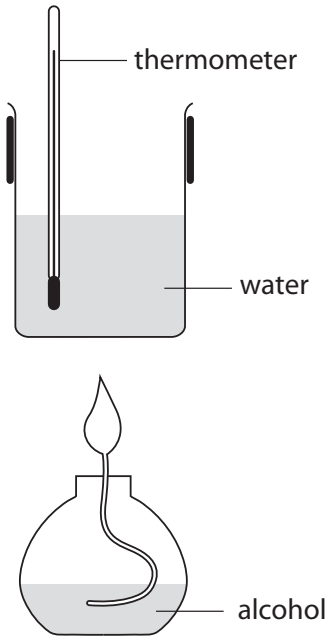
(Total for Question 21 = 12 marks)

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)

(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

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

(1)

Use the expression

Energy transferred (J) = mass of water × 4.18 × temperature change

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

(3)

(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)

*(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)

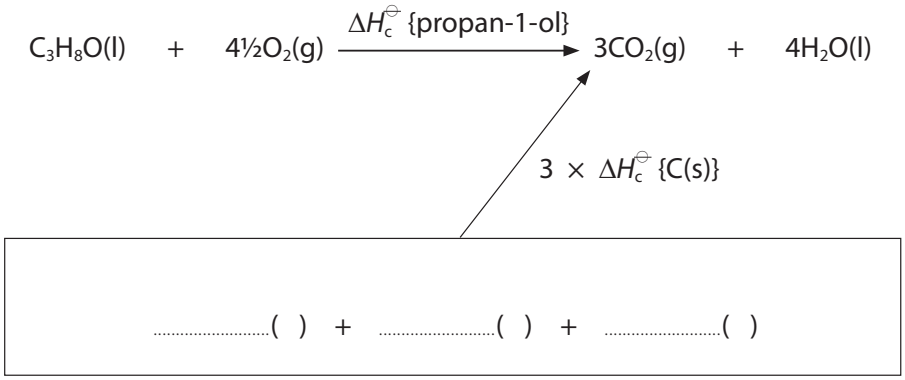
*(iii) Suggest **one** factor that could have caused the difference between the students' values and the Data Book value. Justify your answer.

(2)

(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)



(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)

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

(Total for Question 22 = 16 marks)

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)

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

(1)

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

(3)

(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.

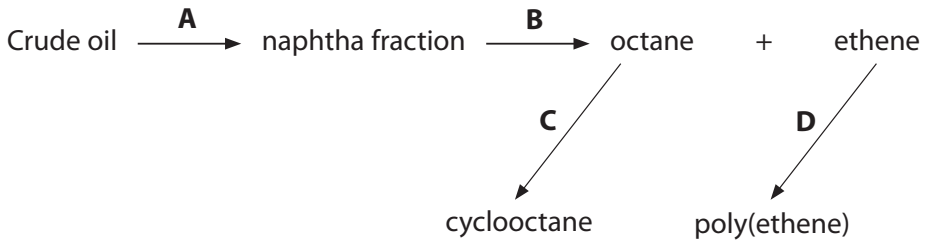
(1)

*(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)

(Total for Question 23 = 9 marks)

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)

A .....

B .....

C .....

D .....

(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)

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(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)

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

(1)

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

(2)

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

(2)

(Total for Question 24 = 13 marks)

25 Alkanes and alkenes react with halogens.

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

$$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$

(i) State the essential condition for this reaction.

(1)

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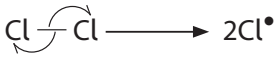
(ii) The first stage in the mechanism of this reaction is the formation of the chlorine free radical.



Explain fully what a curly half-arrow represents in this equation.

(2)

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(iii) Write the two equations of the propagation stage of the reaction. Curly half-arrows are **not** required.

(2)

(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)

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

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

(1)

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

(1)

(Total for Question 25 = 10 marks)

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

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