DAMAI SECONDARY SCHOOL
Preliminary Examination 2022

CANDIDATE NAME				
CLASS			INDEX NUMBER	

CHEMISTRY **6092/02**

Paper 2 **23 August 2022**

Secondary 4 Express **1 hour 45 minutes**

Setter: Ms See Pei Zhen **80 marks**

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions. The last question is in the form either/or.
Answer all questions in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is provided on page 20.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	/ 50
Section B	/ 30
Total	/ 80

Section A

Answer **all** questions in this section in the spaces provided.

A1 **(a)** Select elements from the list to answer the following questions.

You may use each element once, more than once or not at all.

aluminium

astatine

chlorine

helium

manganese

neon

phosphorus

rubidium

strontium

tin

(i) Which of the elements is a diatomic gas at room temperature?

…….. [1]

(ii) Which of the elements forms an oxide which reacts with an acid and an alkali separately?

…….. [1]

(**iii)** Which of the elements forms a stable ion of type X^{2+} ?

…….. [1]

(iv) Which of the elements changes the colour of aqueous potassium iodide from colourless to brown?

…….. [1]

(v) Which of the elements can have possible oxidation states of +2 and +4?

…….. [1]

(b) One isotope of rubidium is rubidium-87.

State the number of sub-atomic particles found in an ion of rubidium-87.

sub-atomic particle	number of particles
protons	
neutrons	
electrons	

[2]

[Total: 7]

A2 Fragrance of perfumes spreading around the room is an example of diffusion.

(a) Define *diffusion*.

……..

……[1]

(b) Explain, using kinetic particle theory, why gases diffuse faster than solids and liquids.

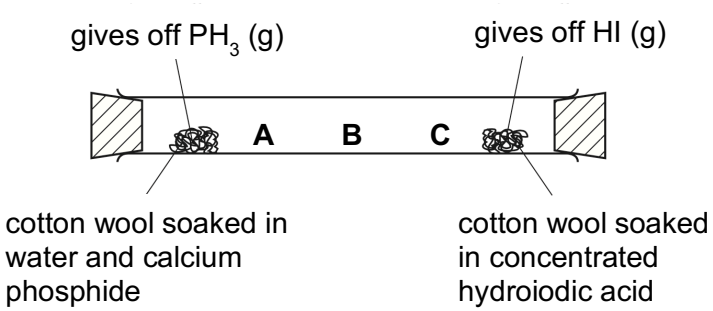
……..

……[2]

(c) When colourless phosphine, PH_3, and colourless hydrogen iodide, HI, come into contact, a brown solid is formed.

$$PH_3\ (g) + HI\ (g) \rightarrow PH_4I\ (s)$$
brown solid

The following apparatus can be used to compare the rate of diffusion of the two gases, phosphine and hydrogen iodide.



Predict at which position, **A**, **B** or **C,** the brown solid will form.

Explain your answer.

……..

……..

……[3]

[Total: 6]

A3 Table 3.1 shows some information about planet Mars.

Table 3.1

current surface temperature/ºC	–143 to 35
composition of planet	93 % iron 7 % nickel
composition of atmosphere	95.3 % carbon dioxide 2.7 % nitrogen 1.6 % argon 0.13 % oxygen 0.07 % carbon monoxide

(a) Using Table 3.1, state two differences between the compositions of atmosphere on Mars and on Earth.

……..

……..

……..

…….[2]

(b) Due to the presence of underground ice and soil nutrients that are suitable for plant growth, astronomers believe that there is a potential for plant life to appear on Mars in future.

The appearance of plant life could potentially change the percentages of oxygen and carbon dioxide in the atmosphere of Mars.

How would you expect the percentages of these two gases to change?

Give a reason for your answer. Include a suitable equation in your explanation.

……..

……..

……..

……..

……..

…….[3]

[Total: 5]

A4 Sulfamic acid, SO_3NH_3, is a strong acid used to remove limescale from kettles.

(a) Define *strong acid*.

……..

……....[1]

(b) Aqueous sulfamic acid reacts with sodium hydroxide solution to form aqueous sodium sulfamate, $NaSO_3NH_2$.

(i) Write an equation for this reaction.

.....…….[1]

(ii) Limescale contains calcium carbonate.

Describe, with the aid of an equation, how aqueous sulfamic acid reacts with calcium carbonate.

…..……..

....……..

…….. [2]

(c) When sulfamic acid crystals is dissolved in water and heated, sulfuric acid and a colourless gas is formed.

Suggest the identity of the colourless gas.

Describe a test, and the positive observation, for the gas.

identity of gas ..……..

test and observation ...…….

..……..... [2]

[Total: 6]

A5 Zirconium is a metallic element found in Period 5 of the Periodic Table.

Due to its high melting point, zirconium is used to made containers for fuel rods in nuclear reactors.

(a) Use ideas about bonding and structure to explain why zirconium has a high melting point.

……..

……..

……[2]

(b) In the event of a nuclear accident, water can come into contact with the very hot zirconium container. Above 1230 ºC, zirconium reacts with steam to form zirconium(IV) oxide and a gas.

(i) Write an equation, with state symbols, for the reaction.

…… [2]

(ii) Explain why the reaction in **(b)(i)** inside the reactor makes nuclear accidents more dangerous.

……..

……[2]

[Total: 6]

A6 Fig. 6.1 shows some information about the Haber process for making ammonia.

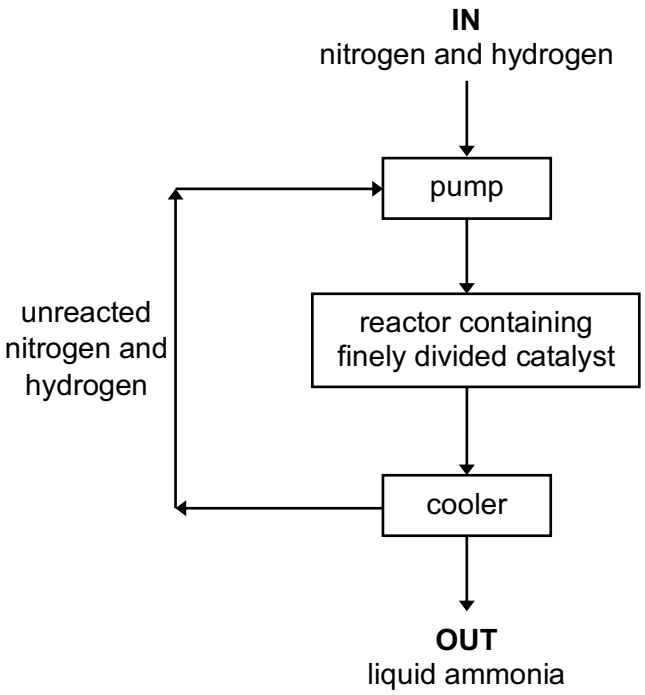


Fig. 6.1

(a) A finely divided catalyst is used in the Haber process.

(i) Name the catalyst used.

……[1]

(ii) Explain how a finely divided catalyst speeds up the rate of a reaction.

……

……

……[2]

(b) Explain why the percentage yield of ammonia from the Haber process is typically low.

Include a suitable equation in your explanation.

……

……[2]

[Total: 5]

A7 Electrolysis is carried out on two substances using platinum electrodes.

(a) Complete Table 7.1.

Table 7.1

	anode (+)		cathode (–)	
	name of product	observation	name of product	observation
molten magnesium chloride				
concentrated magnesium chloride solution				

[4]

(b) Universal indicator is added to the electrolysis set-up of dilute sodium chloride.

Suggest the colour change, if any, of the electrolyte around each electrode.

at anode .....

at cathode .....[2]

[Total: 6]

A8 Fig. 8.1 shows a flowchart of processes involving organic compounds.

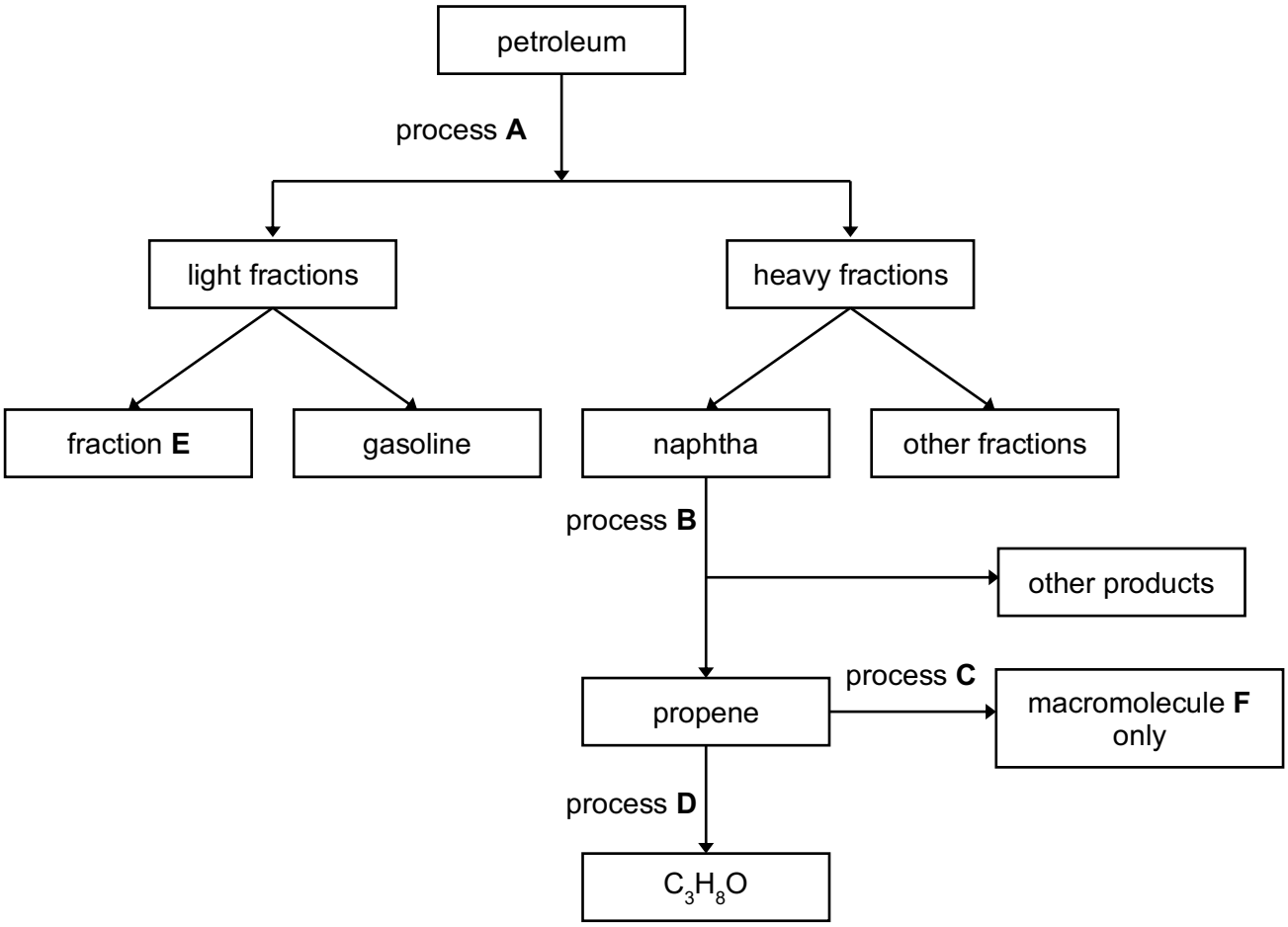


Fig. 8.1

(a) Name processes **A**, **B**, and **C**.

A ……

B ……

C …… [2]

(b) Name fraction **E** and state its use.

……[1]

(c) Propene, C_3H_6, is the second most important raw material in the petrochemical industry.

(i) Draw a 'dot-and-cross' diagram to show the bonding in propene.

Show the outer shell electrons only.

[2]

(ii) When propene undergoes process **D**, it forms two products with the same molecular formula C_3H_8O.

Draw the two different full structural formulae of C_3H_8O.

[2]

(iii) Suggest a method for separating the two products in **(c)(ii)**.

Explain your answer.

……..

……..

……. [2]

[Total: 9]

– End of Section A –

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B9 Electronegativity and Periodic Trends

Electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons. Highly electronegative atoms will attract the bonding pairs of electrons more strongly. Atoms with very low electronegativity values are said to be electropositive.

Fig. 9.1 shows how the electronegativity and atomic radius of the first 20 elements change with increasing atomic number.

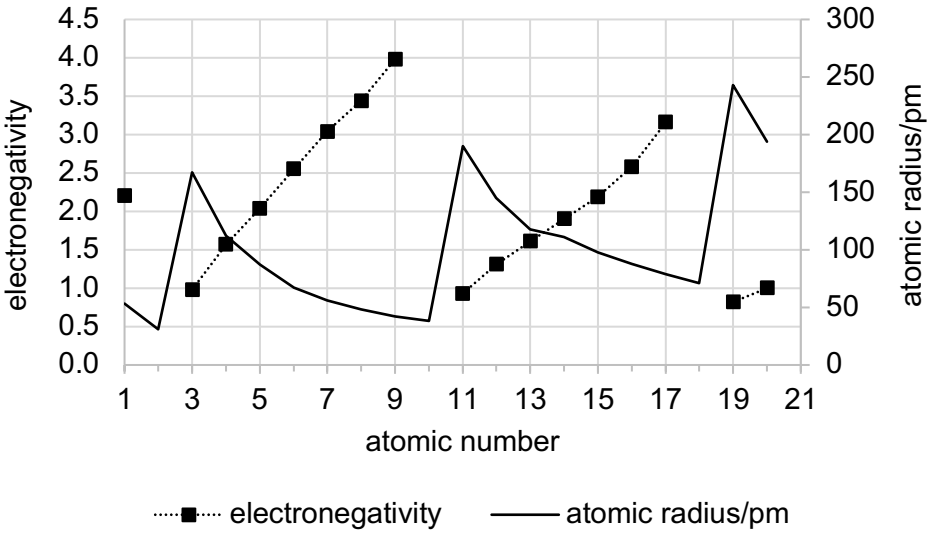


Fig. 9.1

Table 9.1 shows a list of average bond energies in kJ/mol.

Table 9.1

average bond energies in kJ/mol				
H – B	389		C – B	356
H – C	411		C – C	346
H – N	386		C – N	305
H – O	459		C – O	358

(a) There is no electronegativity data available for certain elements in Fig. 9.1.

Suggest a reason why.

….....……

.....…….. [2]

(b) **(i)** Ignoring the lack of electronegativity data for certain elements, describe the general relationship between electronegativity and atomic radius.

……

…….. [1]

(ii) Explain the reason for the relationship observed in **(b)(i)**.

……

……

……

…….. [2]

(iii) Predict how the electronegativity of elements will change down the group.

...……

…….. [1]

(c) Using information in both sources, suggest if there is a relationship between average bond energy and the difference in electronegativity of the elements involved in bonding.

Explain your answer.

……

……

……

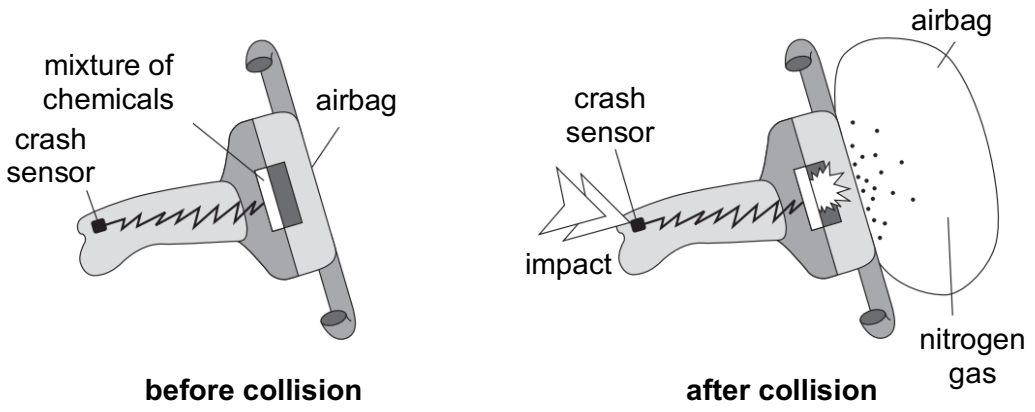
……

……

…….[4]

[Total: 10]

B10 Airbags are an important safety feature in cars to protect passengers during collisions. Nitrogen gas fills up the airbag when a collision is detected by the crash sensor.



before collision **after collision**

During a collision, a mixture of sodium azide, NaN_3, potassium nitrate, KNO_3, and silicon dioxide, SiO_2, will undergo the following reactions.

reaction 1 Sodium azide decomposes to form sodium and nitrogen gas.

$$2NaN_3\ (s) \rightarrow 2Na\ (s) + 3N_2\ (g)$$

reaction 2 Potassium nitrate reacts with the generated sodium metal to produce more nitrogen gas.

$$2KNO_3\ (s) + 10Na\ (s) \rightarrow K_2O\ (s) + 5Na_2O\ (s) + N_2\ (g)$$

(a) Sodium azide is relatively stable at room temperature. For reaction 1 to occur, the sodium azide must first be ignited.

In terms of collision theory and energy changes, explain why the sodium azide must be ignited for decomposition to occur.

……..

……..

……[2]

(b) A final reaction between potassium oxide, sodium oxide and silicon dioxide occur to form a type of silicate.

Identify the type of reaction that occurred. Explain your answer.

……..

……..

……[2]

(c) A typical passenger-side airbag contains 195 g of sodium azide.

Assume all the sodium formed in reaction 1 will continue to react with excess potassium nitrate in reaction 2.

All gas volume measurements are carried out at room temperature and pressure.

(i) Calculate the maximum volume of nitrogen gas that can be produced in a typical passenger-side airbag.

[5]

(ii) In a car crash, the passenger-side air bag was filled with 110 dm^3 of nitrogen.

Calculate the percentage yield of nitrogen in this reaction.

[1]

[Total: 10]

EITHER

B11 Fig. 11.1 was used to study the rate of reaction between zinc carbonate and dilute hydrochloric acid.

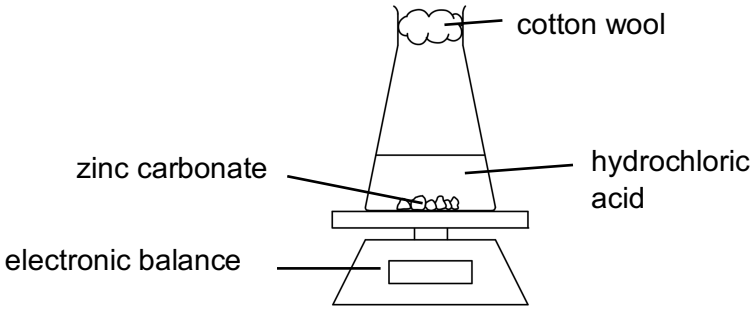


Fig. 11.1

In experiment 1, a fixed mass of zinc carbonate was added to 100 cm^3 of 1.00 mol/dm^3 of hydrochloric acid. The mass of the flask and contents were recorded every 30 seconds until the reaction is complete.

In all the experiments mentioned in this question, the acid is the excess reagent.

The results were plotted as shown in Fig. 11.2.

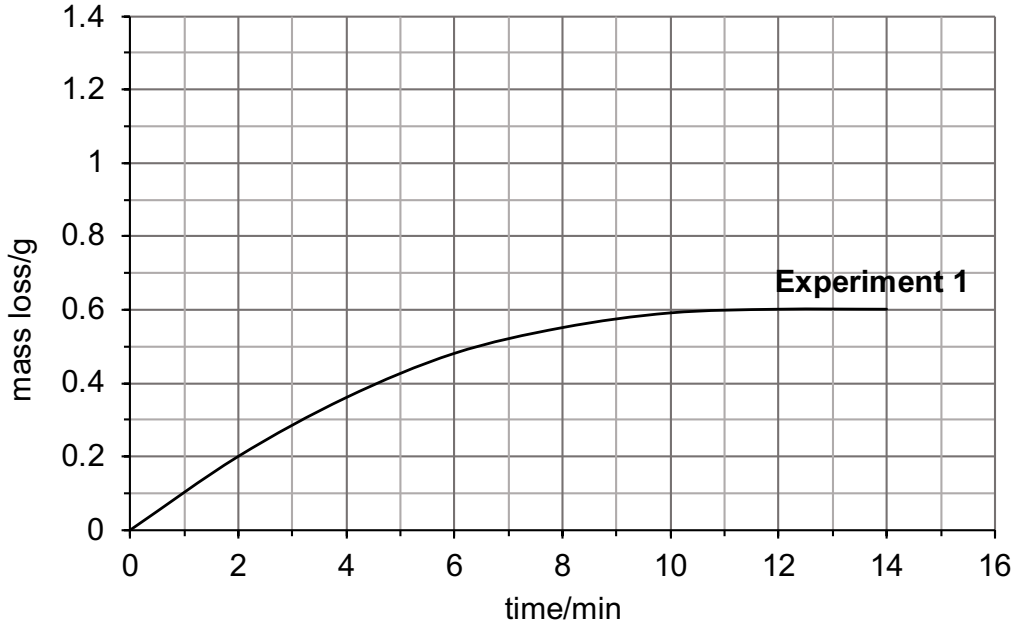


Fig. 11.2

(a) A decrease in mass was observed.

Explain why there was a decrease in mass.

……..

……[1]

(b) State **two** observations that would indicate that the reaction has reached completion.

……..

……..

……[2]

(c) **(i)** The experiment was repeated using the same mass of zinc carbonate but added to 100 cm^3 of 1.00 mol/dm^3 of sulfuric acid.

Sketch the curve obtained on the same grid in Fig. 11.2 and label it Experiment 2. [1]

(ii) Using ideas about reacting particles, explain the shape of your curve in **(c)(i)**.

……..

……..

……. [2]

(iii) The experiment was repeated using **twice** the mass of zinc carbonate added to 100 cm^3 of 1.00 mol/dm^3 of sulfuric acid.

Sketch the curve obtained on the same grid in Fig. 11.1 and label it Experiment 3. [1]

(d) A separate experiment, experiment 4, was carried out using lead(II) carbonate and 100 cm^3 of 1.00 mol/dm^3 of sulfuric acid.

However, the reaction stopped suddenly after a very small mass loss was observed.

(i) Explain why the reaction stopped suddenly.

…….

…….. [1]

(ii) Describe how to prepare a pure and dry sample of the salt formed in experiment 4 safely using sulfuric acid and another named reagent.

……..

……..

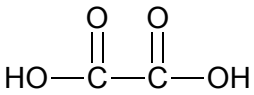
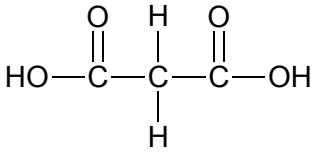
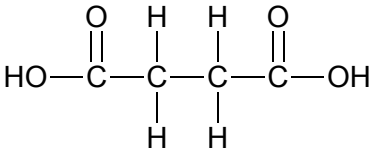
……. [2]

[Total: 10]

OR

B11 Table 11.1 shows information of some dicarboxylic acids.

Table 11.1

name	structural formula
ethanedioic acid	
propanedioic acid	
butanedioic acid	

(a) Dicarboxylic acids are an example of a homologous series.

(i) Explain how the formulae in Table 11.1 shows this.

……

…… [1]

(ii) Give the name and structural formula of the member in this homologous series with five carbon atoms.

name ……

structural formula

[2]

(iii) Suggest the general formula for the members of this homologous series.

…… [1]

(b) Dilute ethanedioic acid reacts with metal.

Dilute ethanoic acid also reacts with metal.

Both acids were reacted in excess with 5 g of magnesium metal (at the same concentration and temperature).

Suggest which reaction will have a faster rate of reaction.

Explain your reasoning.

……..…….....

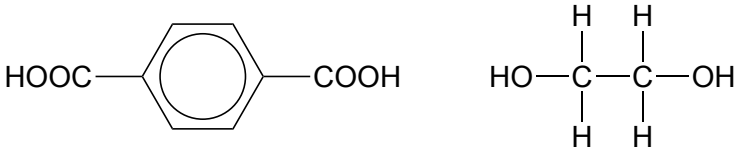
……..…….....

.....……..……..

.....…… [3]

(c) Terephthalic acid is a dicarboxylic that reacts with ethylene glycol to make polyethylene terephthalate (PET).

PET is a common material for making plastic bottles and food containers.



terephthalic acid ethylene glycol

(i) Draw the repeating unit of polyethylene terephthalate.

[1]

(ii) State if PET is an addition or condensation polymer.

Explain your answer.

……..

……..

…… [2]

[Total: 10]

– End of Section B –

– End of Paper 2 –

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** hydrogen 1										2 **He** helium 4
3 **Li** lithium 7	4 **Be** beryllium 9											5 **B** boron 11	6 **C** carbon 12	7 **N** nitrogen 14	8 **O** oxygen 16	9 **F** fluorine 19	10 **Ne** neon 20
11 **Na** sodium 23	12 **Mg** magnesium 24											13 **Al** aluminium 27	14 **Si** silicon 28	15 **P** phosphorus 31	16 **S** sulfur 32	17 **Cl** chlorine 35.5	18 **Ar** argon 40
19 **K** potassium 39	20 **Ca** calcium 40	21 **Sc** scandium 45	22 **Ti** titanium 48	23 **V** vanadium 51	24 **Cr** chromium 52	25 **Mn** manganese 55	26 **Fe** iron 56	27 **Co** cobalt 59	28 **Ni** nickel 59	29 **Cu** copper 64	30 **Zn** zinc 65	31 **Ga** gallium 70	32 **Ge** germanium 73	33 **As** arsenic 75	34 **Se** selenium 79	35 **Br** bromine 80	36 **Kr** krypton 84
37 **Rb** rubidium 85	38 **Sr** strontium 88	39 **Y** yttrium 89	40 **Zr** zirconium 91	41 **Nb** niobium 93	42 **Mo** molybdenum 96	43 **Tc** technetium -	44 **Ru** ruthenium 101	45 **Rh** rhodium 103	46 **Pd** palladium 106	47 **Ag** silver 108	48 **Cd** cadmium 112	49 **In** indium 115	50 **Sn** tin 119	51 **Sb** antimony 122	52 **Te** tellurium 128	53 **I** iodine 127	54 **Xe** xenon 131
55 **Cs** caesium 133	56 **Ba** barium 137	57–71 lanthanoids	72 **Hf** hafnium 178	73 **Ta** tantalum 181	74 **W** tungsten 184	75 **Re** rhenium 186	76 **Os** osmium 190	77 **Ir** iridium 192	78 **Pt** platinum 195	79 **Au** gold 197	80 **Hg** mercury 201	81 **Tl** thallium 204	82 **Pb** lead 207	83 **Bi** bismuth 209	84 **Po** polonium -	85 **At** astatine -	86 **Rn** radon -
87 **Fr** francium -	88 **Ra** radium -	89–103 actinoids	104 **Rf** Rutherfordium -	105 **Db** dubnium -	106 **Sg** seaborgium -	107 **Bh** bohrium -	108 **Hs** hassium -	109 **Mt** meitnerium -	110 **Ds** darmstadtium -	111 **Rg** roentgenium -	112 **Cn** copernicium -		114 **Fl** flevorium -		116 **Lv** livermorium -		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 **La** lanthanum 139	58 **Ce** cerium 140	59 **Pr** praseodymium 141	60 **Nd** neodymium 144	61 **Pm** promethium -	62 **Sm** samarium 150	63 **Eu** europium 152	64 **Gd** gadolinium 157	65 **Tb** terbium 159	66 **Dy** dysprosium 163	67 **Ho** holmium 165	68 **Er** erbium 167	69 **Tm** thulium 169	70 **Yb** ytterbium 173	71 **Lu** lutetium 175
actinoids	89 **Ac** actinium -	90 **Th** thorium 232	91 **Pa** protactinium 231	92 **U** uranium 238	93 **Np** neptunium -	94 **Pu** plutonium -	95 **Am** americium -	96 **Cm** curium -	97 **Bk** berkelium -	98 **Cf** californium -	99 **Es** einsteinium -	100 **Fm** fermium -	101 **Md** mendelevium -	102 **No** nobelium -	103 **Lr** lawrencium -

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).