ST JOSEPH'S INSTITUTION
PRELIMINARY EXAMINATION 2021
(YEAR 4)

CANDIDATE NAME								
CLASS						INDEX NUMBER		

CHEMISTRY **6092/02**

Paper 2 **20 August 2021**

Candidates answer on the Question Paper.
No Additional Materials are required.

1 hour 45 minutes
(11:15 – 13:00)

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black fluid ink pen.
You may use a soft pencil for any diagrams, graphs or rough working.
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.

Candidates are reminded that all quantitative answers should include appropriate units.
Candidates are advised to show all their working in a clear and orderly manner.
The number of marks is given in brackets [ ] at the end of each question or part question.
The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table is printed on page 2 of this question paper.

For Examiner's Use	
Section A	**/ 50**
B7	**/ 12**
B8	**/ 8**
B9	**/ 10**
Total	**/ 80**

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		Key proton (atomic) number atomic symbol name relative atomic mass									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 flerovium –		116 Lv livermorium –		

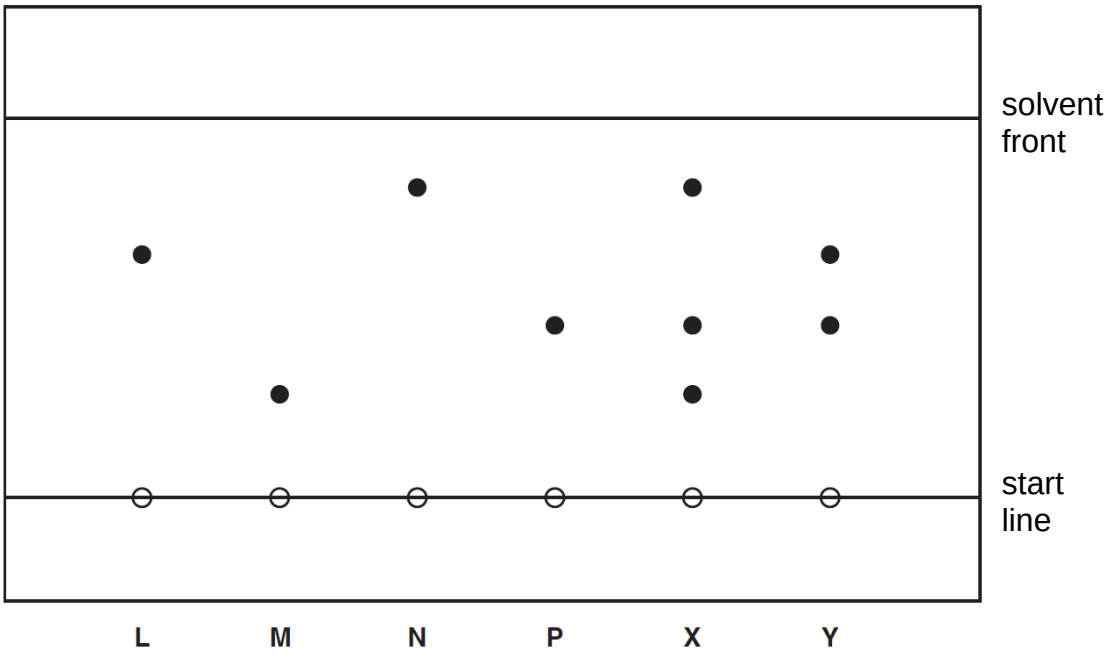
lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
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.).

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The chromatogram below shows the results of a paper chromatography experiment.



(a) Draw a line, labelled **S**, on the chromatogram to show the solvent level at the beginning of the experiment. [1]

(b) In this experiment, a locating agent is used on the chromatogram. What is the purpose of a locating agent?

.....[1]

(c) Use the chromatogram to answer the following questions.

(i) Which substances are impure?

.....[1]

(ii) Which substances are pure?

.....[1]

(d) With the aid of a ruler and indicating the measurements on the chromatogram clearly, calculate the R_f value of the most soluble spot in **X**.

R_f value = ... [2]

[Total: 6]

A2 This question is about ammonia.

(a) Ammonia is manufactured industrially using the Haber Process and is an important precursor used in the manufacture of ammonium-based fertilisers.

(i) State the reaction conditions for the Haber Process.

……[1]

(ii) Explain why it is not advisable to add ammonium-based fertilisers to soil which has been limed with calcium hydroxide.

……

……

……[2]

(b) Aqueous ammonia is commonly used to identify cations which are present in salt solutions.

(i) Describe how aqueous ammonia can be used to identify iron(II) ions.

……

……[1]

(ii) Write an ionic equation with state symbols to represent the reaction in **(b)(i)**.

[2]

(c) Aqueous ammonia reacts with dilute hydrochloric acid to form aqueous ammonium chloride.

(i) Explain why evaporation to dryness is not suitable to obtain solid ammonium chloride salt from its salt solution.

……

……[1]

(ii) Hence, suggest a suitable method used to obtain solid ammonium chloride salt.

……[1]

(d) What is a suitable drying agent that can be used to dry a sample of ammonia gas?

……[1]

[Total : 9]

A3 Ethanoic acid is a weak acid and hydrochloric acid is a strong acid.

(a) **(i)** Define the term '*acid*'.

……

……[1]

(ii) The equation below shows the changes which occur when hydrochloric acid is dissolved in water.

$$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$$

Write the equation with state symbols to show the changes which occur when ethanoic acid (CH_3COOH) is dissolved in water.

[2]

(b) Jared conducted two experiments as shown below.

Experiment 1: He added a portion of copper(II) carbonate to excess dilute hydrochloric acid in a test tube.

Experiment 2: He added a portion of copper(II) oxide to excess dilute hydrochloric acid in a test tube.

State one similarity and one difference in observations for both experiments.

……

……

……

……[2]

(c) The salt formed in **(b)** is aqueous copper(II) chloride.

Aqueous potassium iodide reacts with aqueous copper(II) chloride to produce iodine.

(i) Balance the chemical equation for this reaction.

……. KI + ……. $CuCl_2$ → ……. CuI + ……. I_2 + ……. KCl [1]

(ii) Is the reaction in **(c)(i)** a redox reaction?

Explain your answer in terms of oxidation numbers.

……

……

……[2]

(d) Complete the method of preparing pure dry crystals of zinc chloride from dilute hydrochloric acid and a base.

step 1:

Add …..……. to dilute hydrochloric acid.

step 2:

……..……..

step 3:

Heat the ……..…….. to ……, leave the solution to cool.

Collect the crystals by filtration.

step 4:

……..……..…….

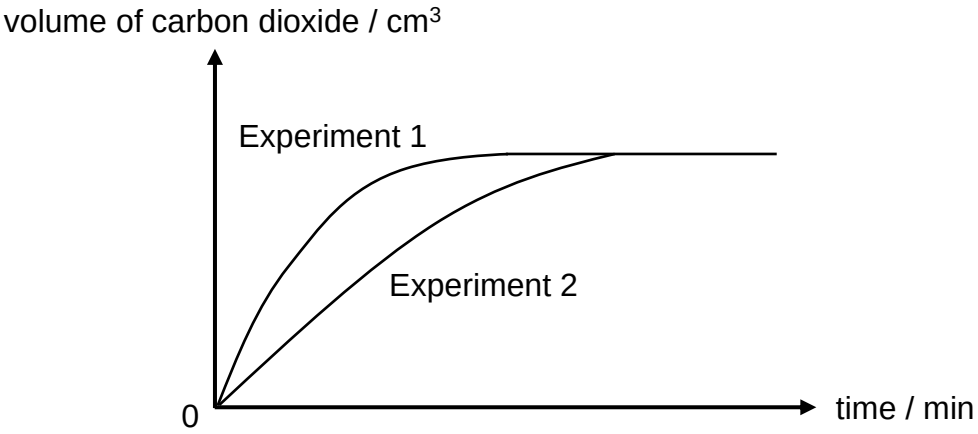
……..[4]

[Total: 12]

A4 Two experiments are carried out to investigate the rate of reaction between excess powdered zinc carbonate and dilute hydrochloric acid.

The results are shown in the graph below.

In Experiment 1, 30.0 cm^3 of 0.500 mol dm^{-3} hydrochloric acid is used.



(a) Below shows the suggestions by two students to modify Experiment 1 to obtain the graph for Experiment 2.

Student **A**: The concentration of the hydrochloric acid should be decreased.

Student **B**: Use granulated zinc carbonate granules.

Comment on the suggestions made by the students.

.....

.....

.....

.....

.....

.....[2]

(b) **(i)** Besides the factors in **(a)**, suggest one other factor that can be changed to produce the graph in Experiment 2.

.....[1]

(ii) Explain your answer in **(b)(i)** in terms of reacting particles.

……

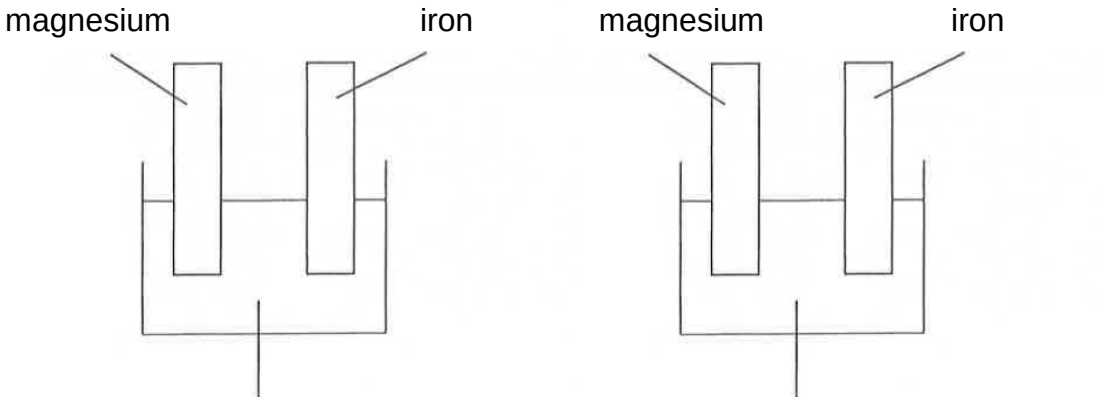
……

……

……[2]

[Total: 5]

A5 The diagrams below show two separate experiments involving a piece of magnesium and a piece of iron.



Experiment 1 Experiment 2

(a) Describe and explain an observation made in Experiment 1.

……

……[2]

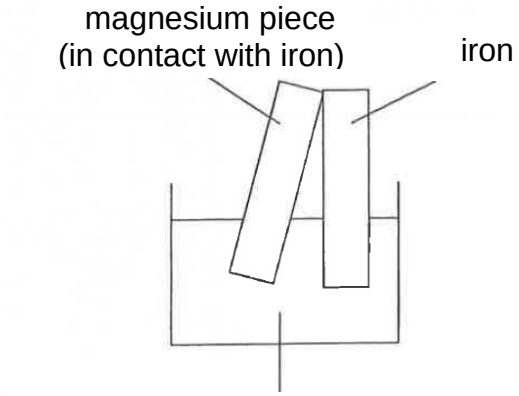
(b) State and explain one observation that would be made in Experiment 2 but not in Experiment 1.

……

……

……[2]

(c) Experiment 3 was conducted as shown in the diagram below.



Experiment 3

(i) State and explain an observation that is made in Experiment 3 that is different from Experiments 1 and 2.

……

……

……[2]

(ii) A student replaced the piece of magnesium used in Experiment 3 with a piece of old aluminium found in the laboratory. There was no visible reaction.

Suggest a reason why there was no visible reaction and explain your answer.

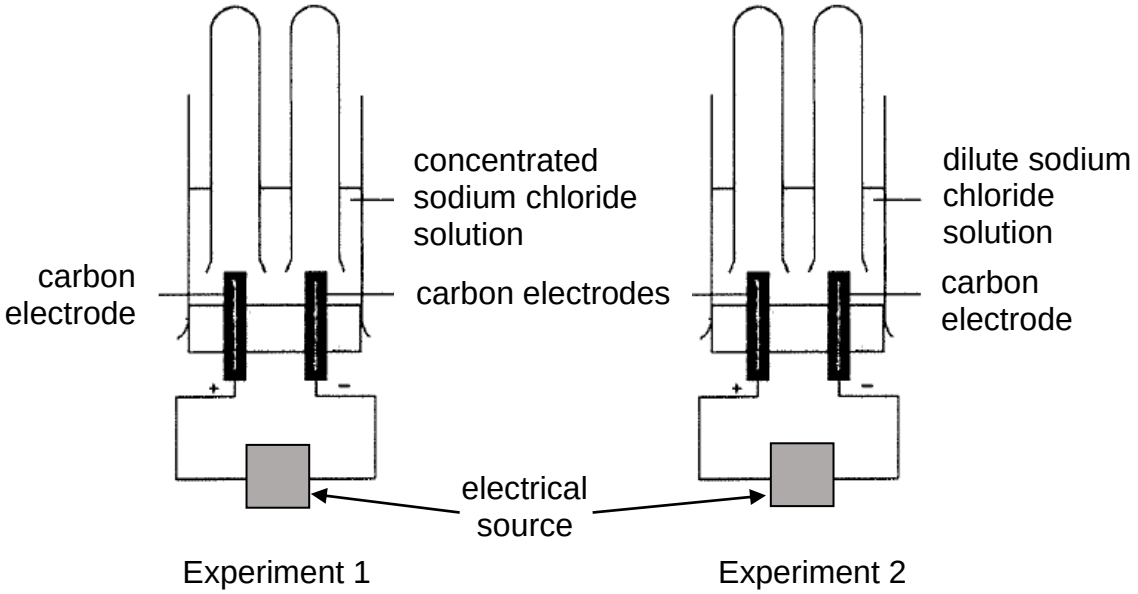
……

……

……[2]

[Total: 8]

A6 A chemist carried out two different electrolysis investigations with different concentrations of sodium chloride solution.



(a) **(i)** Write the half-equation, with state symbols, for the reaction at the anode for Experiment 1.

[1]

(ii) Explain your answer to **(a)(i)**.

……

……[1]

(iii) In Experiment 2, 25 cm^3 of gas is produced at the cathode.

What volume of gas is produced at the anode?

……[1]

(b) The electricity supplied by the electrical source is generated from a coal-burning power station.

(i) Name the air pollutant that is formed from burning coal that causes acid rain.

……[1]

(ii) Explain, using relevant equations, how the air pollutant in **(b)(i)** forms acid rain.

……

……

……

……

……[2]

(iii) What is the process used to reduce the release of the pollutant in **(b)(i)** into the atmosphere?

……[1]

(c) Hydrogen gas is produced in both Experiments 1 and 2. It can be used as a fuel and is a more environmentally friendly fuel than petrol.

(i) Explain why hydrogen is an environmentally friendly fuel.

……

……[1]

(ii) Explain why the burning of petrol in excess oxygen is harmful to the environment.

……

……

……[2]

[Total: 10]

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

B7 The standard reduction potential (E°) of a substance measures the likelihood that a substance is reduced.

The E° value of a substance can be measured by connecting the electrode of the substance being measured to a 'standard hydrogen electrode' at standard conditions of 25 °C and 1 atm. The 'standard hydrogen electrode' is used as a reference electrode and has a E° value of 0.00 V.

The diagram below shows the set-up used to measure the standard electrode potential of a substance.

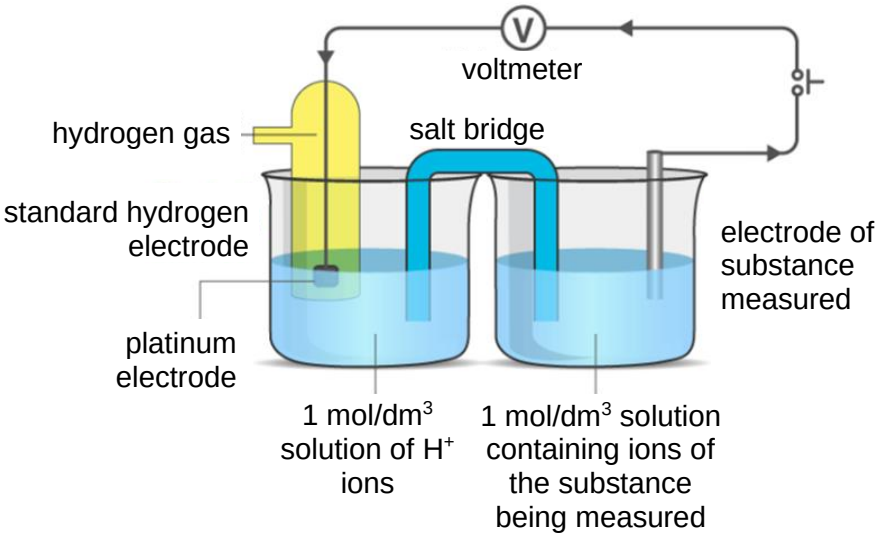


Table 1 shows the electrode reactions and E° values of some metals. The more negative the E° value, the more easily a substance is reduced. Conversely, the more positive the E° value, the more easily a substance is oxidised.

Table 1

metal	electrode reaction	E° / V
copper	$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
iron	$Fe^{3+}(aq) + 3e^- \rightleftharpoons Fe(s)$	-0.04
magnesium	$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	-2.38
nickel	$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	-0.25
sodium	$Na^{+}(aq) + e^- \rightleftharpoons Na(s)$	-2.71
zinc	$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	-0.76

When different compounds of metals are heated strongly, they decompose differently. Tables 2 and 3 below show how different compounds of metals decompose.

Table 2: Decomposition of carbonates

metal carbonate	products
sodium carbonate	-
zinc carbonate	zinc oxide and carbon dioxide
copper(II) carbonate	copper(II) oxide and carbon dioxide

Table 3: Decomposition of nitrates

metal nitrate	products
sodium nitrate	sodium nitrite and oxygen
zinc nitrate	zinc oxide, nitrogen dioxide and oxygen
copper(II) nitrate	copper(II) oxide, nitrogen dioxide and oxygen

The carbonates of the metals in Table 1 were heated strongly and the time taken for 50 cm^3 of gas to be collected in a gas syringe was measured for each carbonate. The results are shown in Table 4.

Table 4

metal carbonate	time taken to collect 50 cm^3 of gas / s
copper(II) carbonate	44
iron(III) carbonate	85
magnesium carbonate	221
nickel(II) carbonate	?
sodium carbonate	no gas produced
zinc carbonate	153

(a) **(i)** What is the relationship between the E° value and reactivity of metals?

……

……[1]

(ii) Hence, arrange the metals in Table 1 in order of increasing reactivity.

……[1]

(b) **(i)** Some E° values are shown below.

-2.55 V -0.44 V +0.16 V +0.80 V

What is the most suitable E° value for silver?

Explain your reasoning.

……

……[1]

(ii) Write the equation for the electrode reaction for silver.

[1]

(c) Suggest the purpose of the salt bridge used in the set-up to measure the standard electrode potential.

……

……[1]

(d) Compare between the decomposition of carbonates and the decomposition of nitrates.

……

……

……

……

……[2]

(e) What products could be formed from the decomposition of potassium nitrate?

Explain your reasoning.

……

……

……[2]

(f) **(i)** Predict the time taken to collect 50 cm^3 of gas for nickel(II) carbonate.

……[1]

(ii) Does the data in Table 4 support your answer in **(a)(ii)**?

Explain your answer using relevant information from the table.

……

……

……

……[2]

[Total: 12]

B8 The tables below show the atomic radii of elements in Group I and Group VII of the Periodic Table.

Table 1

Group I	
element	**atomic radius / pm**
Li	152
Na	186
K	231
Rb	244

Table 2

Group VII	
element	**atomic radius / pm**
F	64
C*l*	99
Br	114
I	133

(a) **(i)** What do you observe about the atomic radius of a Group I element compared to a Group VII element in the same period?

……

……[1]

(ii) Explain your answer in **(a)(i)**.

……

……

……

……[2]

(b) State the trend in reactivity of the elements down Group I.

Explain and support your answer using information from Table 1.

……

……

……

……

……

……

……[3]

(c) State the trend for the melting points of the elements down Group VII.

Explain your answer.

……..……..……

……..……..……

……..……..……

……..……..……[2]

[Total: 8]

B9 EITHER

Hydrogen gas is used as a fuel in rockets and it undergoes combustion in the engine to form water vapour as shown in the equation below.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

In Experiment 1, 40.0 g of hydrogen gas was reacted with 30.0 g of oxygen gas to form water vapour.

(a) Calculate the mass of water vapour formed in Experiment 1.

[3]

(b) Draw the energy profile diagram for Experiment 1.

Indicate the enthalpy change, ΔH, and activation energy, E_a, on the diagram clearly.

[3]

(c) Karl suggested adding a suitable catalyst to lower the enthalpy change of the reaction in Experiment 1.

Do you agree with Karl? Explain your answer.

……

……

……

……

……

……[2]

(d) Experiment 2 was carried out and the equation for the reaction is shown below.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

The energy involved for the above reaction was found to be higher than that of the earlier reaction in Experiment 1.

(i) Describe the change in movement of the particles in the reaction for Experiment 2.

……

……[1]

(ii) Suggest a reason why the energy for the reaction in Experiment 2 was higher than Experiment 1.

……

……

……[1]

[Total: 10]

B9 OR

The table below shows some information about some elements in Period 2.

element	carbon	nitrogen	fluorine	neon
structure	giant molecular	simple molecular	simple molecular	monatomic
electrical conductivity	good	poor	poor	poor
boiling point / °C	3800	-196	-188	-246

(a) Explain why neon exists as single atoms but fluorine as molecules.

.....

.....

..... [2]

(b) When liquid nitrogen boils, the following change occurs.

$$N{\equiv}N(l) \rightarrow N{\equiv}N(g)$$

Explain why the boiling point of nitrogen is very low even though the bonds between the atoms in a nitrogen molecule are very strong.

.....

..... [1]

(c) **(i)** Which form of carbon, diamond or graphite, is shown in the table?

Explain your reasoning.

……

……...[1]

(ii) Explain your answer in **(c)(i)** terms of structure.

……

……

……...[2]

(d) **(i)** Carbon reacts with fluorine and hydrogen to form difluoroethene, $C_2H_2F_2$, a hazardous chemical that is toxic when inhaled.

Draw a 'dot-and-cross' diagram to represent the bonding in difluoroethene, showing only valence electrons.

[2]

(ii) Compare the structure and bonding present between the carbon sample in **(c)(i)** and difluoroethene.

……..……

……..……

……..……..[2]

[Total: 10]

- End of Paper -