Name: _____ ( ) Class:_____

PRELIMINARY EXAMINATION
GENERAL CERTIFICATION OF EDUCATION ORDINARY LEVEL

CHEMISTRY **6092/02**
Paper 2 **23 August 2021**
1hour 45minutes

READ THESE INSTRUCTIONS FIRST

Write your name, register number, and class clearly in the spaces provided at the top of this page.
Write in dark blue or black pen only.
You may use a soft pencil for any diagrams or graphs.
Do not use highlighters, glue, and correction fluid or correction tape.

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

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

A copy of Periodic Table is provided on page 2.
The number of marks is given in brackets [ ] at the end of each question or part question.
The use of a scientific calculator is expected, where appropriate.

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

This document consists of 20 printed pages.

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** the questions in this section in the space provided.
The total mark for this section is 50.

A1 The following table shows some substances and their properties.

substance	melting point (°C)	boiling point (°C)	solubility in water	electrical conductivity	
				when solid	when liquid
A	3550	4830	insoluble	poor	poor
B	-114	-85	soluble	poor	poor
C	1538	2862	insoluble	good	good
D	801	1413	soluble	poor	good
E	98	882	soluble	good	good

(a) Explain why

(i) **B** has a low melting point while **A** has a very high melting point, in terms of bonding.

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……[3]

(ii) **E**, but not **D**, can conduct electricity at room temperature, in terms of bonding and structure.

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……[3]

(b) Given that **E** is an element, suggest a possible identity for **E**.

……[1]

(c) **C** is an element used as a catalyst in the Haber process.

State the identity of **C**.

…….....[1]

[Total: 8 marks]

A2 Silver dichromate(VI), $Ag_2Cr_2O_7$, is a red insoluble salt. Silver dichromate(VI) can be made by reacting silver nitrate solution with ammonium dichromate(VI) solution. The chemical equation for the reaction is shown below.

$$2AgNO_3\ (aq) + (NH_4)_2Cr_2O_7\ (aq) \rightarrow 2NH_4NO_3\ (aq) + Ag_2Cr_2O_7\ (s)$$

(a) Describe how you could obtain pure dry silver dichromate(VI) after mixing silver nitrate solution and ammonium dichromate(VI) solution.

……..…

……..

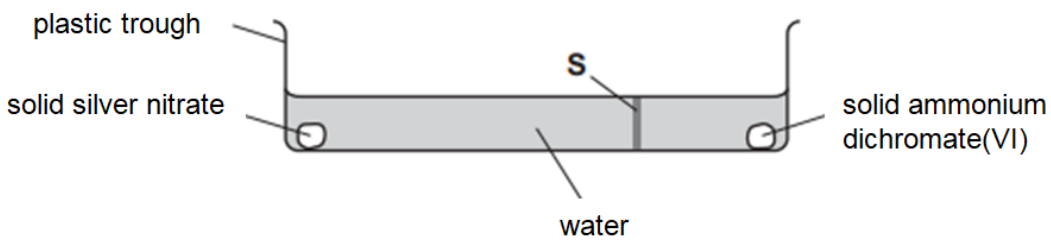
…….[2]

(b) Aqueous sodium hydroxide was added to a sample of ammonium dichromate(VI) solution. The mixture was then warmed and damp Universal Indicator paper was held above the mixture.

State what would happen to the Universal Indicator paper.

…….[1]

(c) The apparatus shown was set up.



After five minutes, a red solid appeared along the line marked **S** on the diagram.

(i) With the use of an ionic equation, explain how the red solid is formed at **S**.

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……[3]

(ii) The experiment was repeated with ammonium chloride in place of ammonium dichromate(VI).

Describe and explain the differences in the observation.

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……[2]

[Total: 8 marks]

A3 Hydroxypropanoic acid, also known as lactic acid, is a weak acid produced through anaerobic metabolism.

(a) A student claims that pure liquid hydroxypropanoic acid conducts electricity.

Do you agree with the student? Explain your answer.

……[1]

(b) Describe what you would observe when Universal Indicator is added to a 0.1mol/dm^3 solutions of hydroxypropanoic acid and sulfuric acid respectively.

Explain your answer.

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……....[3]

(c) A solution containing 0.172 g of hydroxypropanoic acid (HA) is titrated with 0.100 mol/dm^3 aqueous sodium hydroxide according to the equation below.

$$HA + NaOH \rightarrow NaA + H_2O$$

The volume of sodium hydroxide solution needed to exactly neutralise the acid is 23.2 cm^3.

Calculate the relative molecular mass of the hydroxypropanoic acid.

[2]

[Total: 6 marks]

A4 Iron metal can be extracted from its ore using the Blast Furnace.

(a) When iron is extracted from haematite in the Blast Furnace, waste gases are formed. Name the waste gases from the Blast Furnace.

……[1]

(b) Can electrolysis of aqueous iron(III) sulfate be used to extract iron? Explain your answer.

……..…

……..

……[2]

(c) Write ionic equations for the reactions at the electrodes for the electrolysis of molten iron(III) oxide.

Anode: ……

Cathode: ……[2]

(d) Calculate the mass of iron that can be extracted by the electrolysis of 10 tonnes of molten iron(III) oxide. [1 tonne = 1000 kg]

[3]

(e) Can aluminium be extracted from its ore, Al_2O_3, by the blast furnace method? Explain your answer.

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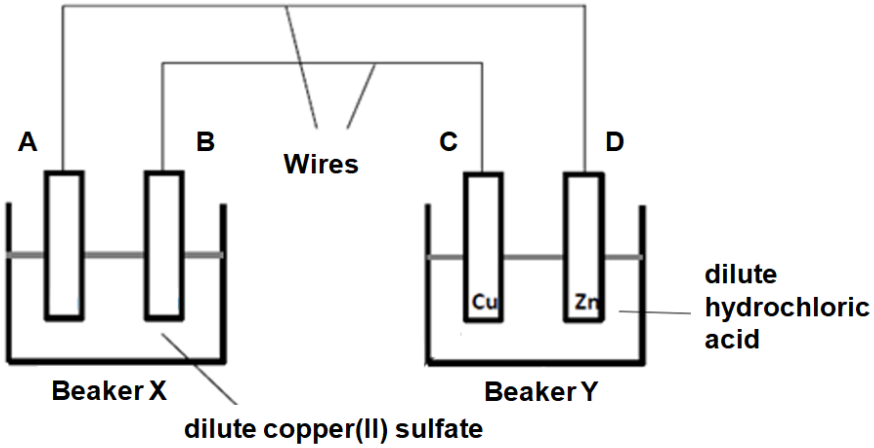
……[2]

[Total: 10 marks]

A5 The diagram below shows an experimental set-up of a simple cell and an electrolytic cell. Electrodes **A** and **B** are platinum electrodes.



(a) Which beaker is the simple cell? Explain your answer.

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……

……[2]

(b) Draw arrows on both wires to show the flow of electrons in the circuit above.

[2]

(c) Describe what would be observed at electrodes **A** and **B**.

……

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……[2]

(d) The experiment is repeated with electrode **B** in beaker **X** changed to copper.

How would you expect the results for this experiment to differ from the first experiment? Explain your answer.

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……[2]

[Total: 8 marks]

A6 The table below shows the results of two chemical reactions of four unknown metals and their compounds.

Metals	Reaction of metal with cold water	Thermal decomposition of metal carbonates
A	No reaction.	Greenish-blue solid turns black. White precipitate formed when gas produced is being passed through limewater.
B	Very vigorous reaction.	White solid remains. No gas is produced.
C	No reaction.	White solid turns yellow, turns back to white when cooled. White precipitate formed when gas produced is being passed through limewater.
D	Little bubbles formed on the surface of the metal.	White solid remains white. White precipitate formed when gas produced is being passed through limewater.

(a) Arrange the four metals in ascending order of their chemical reactivity.

…….....[1]

(b) Which carbonate will decompose at the fastest rate when heated? Explain your answer.

……..……

…….....……

…….....[2]

(c) Metals **A** and **D** are placed into two separate beakers of iron(II) sulfate solution.

(i) Describe the observations you will see in each beaker.

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……...[2]

(ii) Describe how to prepare a pure, dry sample of crystals of iron(II) sulfate.

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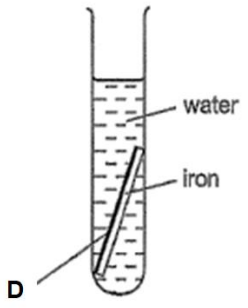
.....[3]

(d) In an experiment, an iron rod is covered partially with metal **D**. The test tube was set up as shown below.



Will the iron rod rust? Explain your answer.

……

……

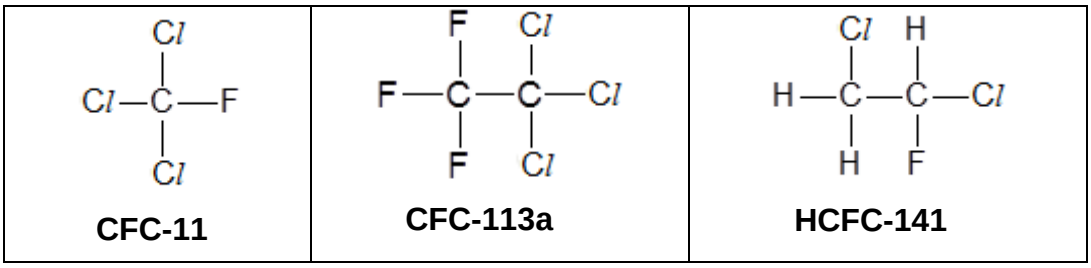
……[2]

[Total: 10 marks]

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. The total mark for this section is 30.

B7 The haloalkanes are a group of chemical compounds derived from alkanes containing one or more halogens. Haloalkanes are widely used commercially and hence have many chemical and commercial names. They are used as refrigerants, propellants, solvents and pharmaceuticals. Some examples of haloalkanes are chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs) and perfluorocarbons (PFCs). Some common examples of CFC and HCFC molecules are shown below with their names.



These compounds are often designated by a combination of letters and numbers (e.g., CFC-11, CFC-113a).

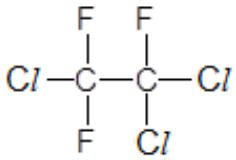
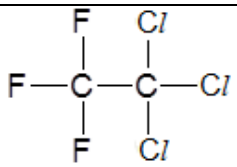
A naming system for these substances was devised several decades ago. The prefixes to the name tell us the elements present in the compound as shown in the table below.

Prefix	Elements present
PFC	carbon, fluorine
CFC	carbon, fluorine, chlorine
HFC	hydrogen, carbon, fluorine
HCFC	hydrogen, carbon, fluorine, chlorine

The numbers suffixed to the names of the compounds give us the number of each type of atom present in one molecule of the compound. The key to decoding the number is simply to add 90 to the number suffixed to the name.

For example, to decode the number of atoms in CFC-113a, we add 113 to 90 to obtain 203. The first number, 2, tells us the number of carbon atoms, the second number, 0, tells us the number of hydrogen atoms, and the third number, 3, tells us the number of fluorine atoms. Chlorine atoms make up the remaining bonds since all these compounds are saturated.

The letter ‘a’ in CFC-113a tells us about the structural formula of the compound. The arrangement of the type of atoms on the compound with the most even distribution of atomic masses has no letter. The second most even distribution is given the letter ‘a’, the third most even distribution is given the letter ‘b’, so on and so forth.

molecule	atomic mass on left carbon	atomic mass on right carbon
 **CFC-113**	73.5	90
 **CFC-113a**	57	106.5

(a) Draw the structural formula of a PFC molecule with two carbon atoms.

[1]

(b) A student comments that HFCs are safe alternatives to CFCs as HFCs do not harm the environment like CFCs do. Explain why the student is correct.

……..[1]

(c) How many fluorine atoms are there in HCFC-132b?

……[1]

(d) Draw the full structural formulae of HCFC-141a and HCFC-141b.

[2]

(e) Difluoromethane CH_2F_2 is a hydroflourocarbon. It can be used instead of CFCs in aerosols.

Difluoromethane CH_2F_2 can be produced from methane.

(i) Give the condition of this reaction.

……[1]

(ii) Write equations to show how difluoromethane is produced from methane.

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……[2]

(iii) Gaseous bromine will also react with methane.
Suggest whether the reaction is faster or slower than with fluorine. Explain your reasoning.

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……[2]

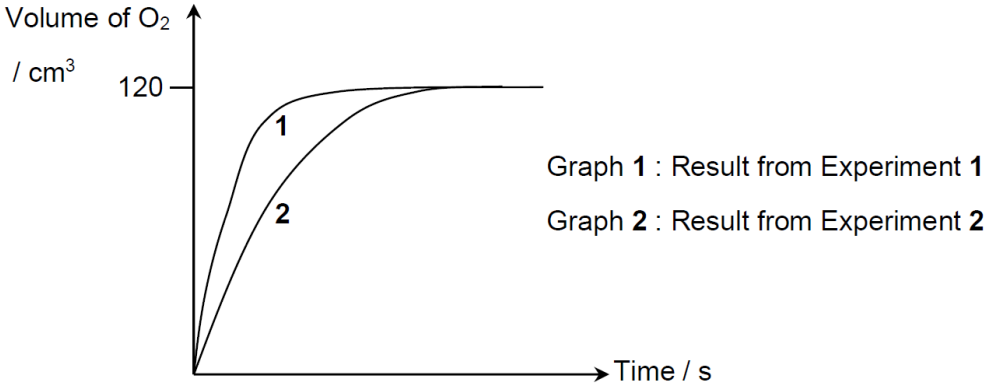
[Total : 10 marks]

B8 Hydrogen peroxide decomposes according to the equation:

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g) \qquad \Delta H = -196 \text{ kJ/mol}$$

Two experiments were carried out with identical conditions except for the catalyst used.
0.5 g of manganese(IV) oxide was the catalyst used in Experiment **1** and 0.5 g of copper(II) oxide in Experiment **2**.

The results obtained are shown in the graph below.



(a) Explain whether manganese (IV) oxide or copper(II) oxide is a better catalyst for this reaction using the given data.

……[1]

(b) In each experiment, the volume of the hydrogen peroxide used was 50 cm^3 and the volume of oxygen gas was measured at room temperature and pressure. Calculate the concentration of the hydrogen peroxide solution.

[2]

(c) Experiment **2** was repeated two more times; Experiment **3** and **4**, both with only one condition changed. On the diagram on page 14, sketch and label the graphs representing Experiments 3 and 4.

[2]

	Conditions changed
Experiment 3	25 cm^3 of hydrogen peroxide solution
Experiment 4	adding some 0.1 mol/dm^3 aqueous hydrogen peroxide

(d) Give one other method of increasing the initial rate of reaction.

……[1]

(e) Explain why ΔH of the reaction is negative, in terms of bond-breaking and bond-forming.

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……[2]

(f) Hydrogen peroxide can react with silver oxide. The chemical equation for the reaction is shown.

$$Ag_2O + H_2O_2 \rightarrow 2Ag + H_2O + O_2$$

Is hydrogen peroxide acting as an oxidising agent or reducing agent? Explain your answer.

……

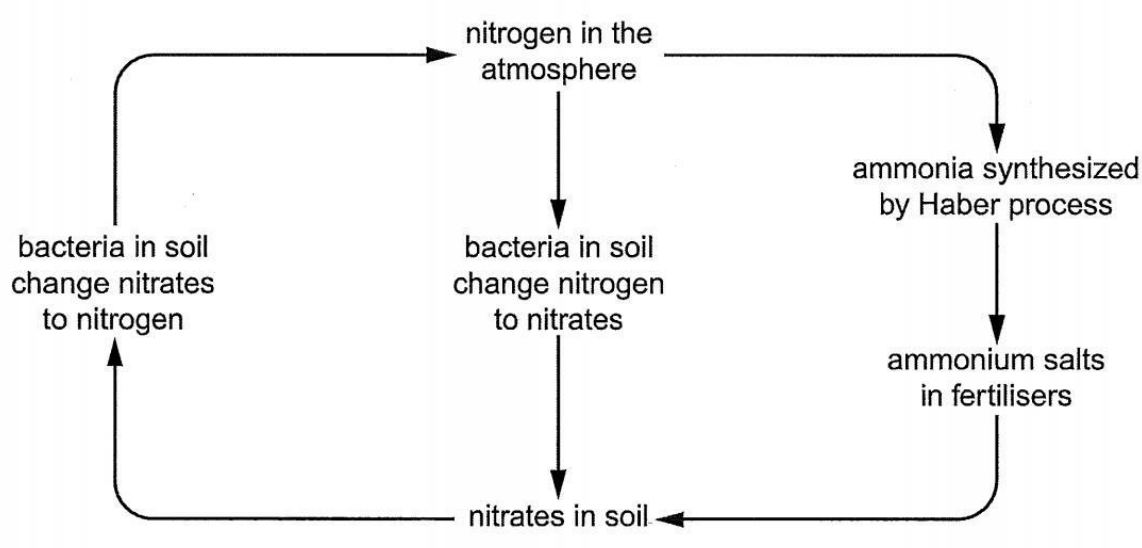
……

……[2]

[Total : 10 marks]

EITHER

B9 The nitrogen cycle is a repeating cycle of processes during which nitrogen moves through both living and non-living things: the atmosphere, soil, water, plants, animals and bacteria. To complete the nitrogen cycle, denitrifying bacteria in the soil carry out a process known as denitrification which converts nitrates back to nitrogen gas. A simplified diagram of the nitrogen cycle is shown.



(a) Although certain bacteria in the soil convert nitrogen gas into nitrates, other bacteria convert nitrogen into ammonium salts. The ionic equation for this second reaction is as follows:

$$N_2 + 8H^+ + 6e^- \rightarrow 2NH_4^+$$

Is this reaction an oxidation or reduction? Explain your answer, in terms of electron transfer.

……

…….....[1]

(b) Denitrifying bacteria convert nitrate ions and hydrogen ions into nitrogen gas and water.

Balance the ionic equation for this reaction.

$$\_\_\_\_\_\ NO_3^- + 12\ H^+ + 10\ e^- \rightarrow \_\_\_\_\_\ N_2 + \_\_\_\_\_\ H_2O$$

[1]

(c) A student wants to verify whether a soil sample contains nitrate or ammonium ions. Describe how the student should carry out the test.

……

……

……[2]

(d) A side product of the denitrification reaction is the production of a gas known as nitrous oxide, N_2O. Nitrous oxide, also known as "laughing gas" is a mild anaesthetic. It can also be added to petrol in racing cars. The two polluting emissions from cars are oxides of nitrogen and carbon monoxide.

When nitrous oxide is heated, it decomposes.

$$2N_2O(g) \rightarrow 2N_2(g) + O_2(g)$$

This reaction increases the power of the engine for two reasons.

1. It causes a sudden increase in volume of the gases in the engine.
2. It causes the rate of combustion of the petrol to increase.

(i) Explain why this reaction causes these two effects.

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……[3]

(ii) Describe how oxides of nitrogen affect the environment.

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……[2]

(iii) Write a balanced chemical equation for a reaction in the catalytic converter that leads to lower emissions of both oxides of nitrogen and carbon monoxide.

……[1]

[Total : 10 marks]

OR

B9 Hydrogen is used in large quantities in industry to convert nitrogen into ammonia, for use in fertilizers. One of the methods of manufacturing hydrogen is to pass methane and steam over a heated catalyst. The equation is shown below:

$$CH_4 + H_2O \rightarrow CO + 3H_2 \quad \Delta H = +206 \text{ kJ/mol}$$

(a) **(i)** Using the information provided in the table below, calculate the bond energy in carbon monoxide.

bond	bond energy kJ/mol
C-H	410
O-H	460
H-H	436
C-C	348
C=C	612

[2]

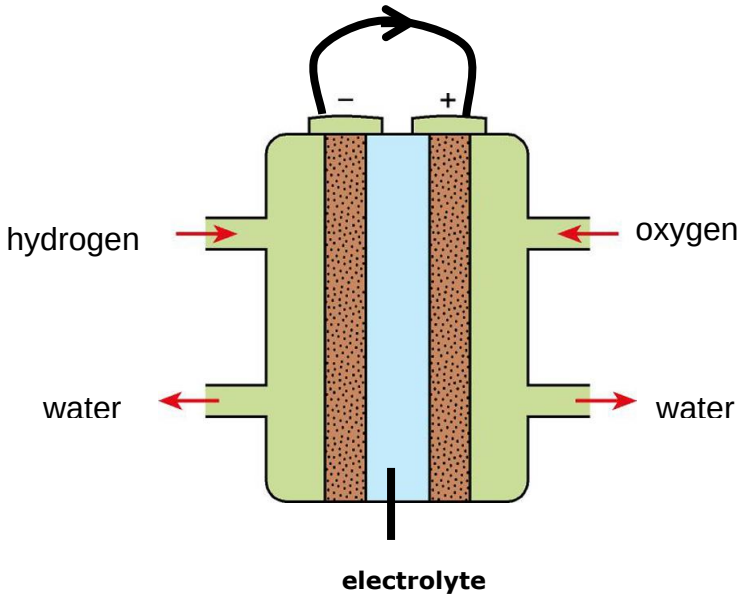
(ii) Given that the energy required to break one mole of C-O bond is 360 kJ/mol and of C=O bond is 740 kJ/mol, predict the type of covalent bond in carbon monoxide.

……[1]

(iii) Calculate the energy change when 1000 dm^3 of hydrogen is produced by the reaction.

[2]

(b) Hydrogen is also used by car manufacturers to develop fuel cells for use in cars. Hydrogen powered cars use hydrogen as fuel to produce electricity. The diagram below shows a hydrogen-oxygen fuel cell.



The overall reaction in a hydrogen-oxygen fuel cell is

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

The reaction at the positive electrode is

$$O_2\ (g) + 4H^+\ (aq) + 4e^- \rightarrow 2H_2O\ (l)$$

(i) Give the ionic equation for the reaction at the negative electrode.

……[1]

(ii) Describe how electricity is generated in a hydrogen-oxygen fuel cell.

……

……

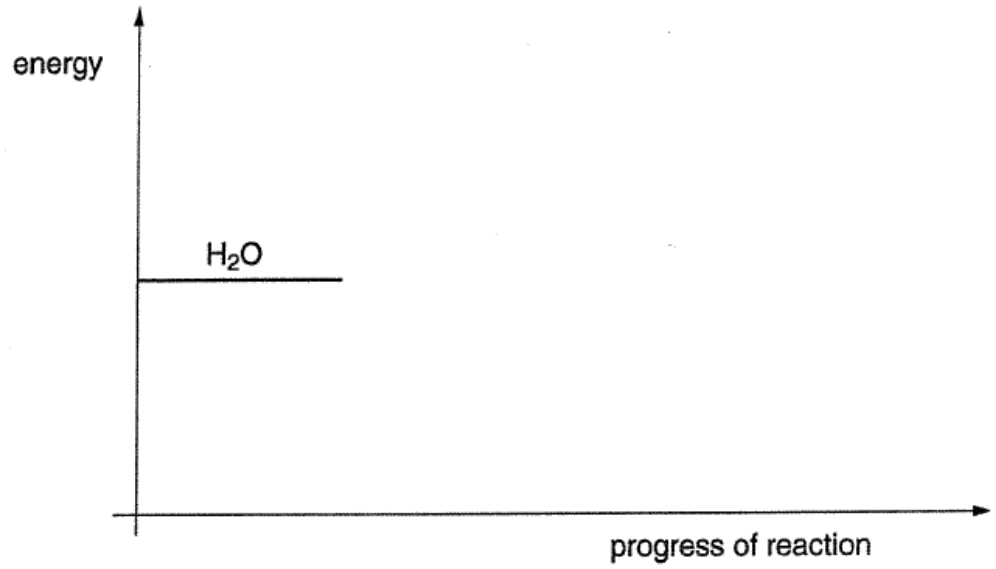
……[2]

(iii) Hydrogen for fuel cells can be obtained from water by electrolysis.

Complete the energy profile diagram for the electrolysis of water.

Your diagram should include

- the formulae of the products of the electrolysis,
- a label for the enthalpy change of the reaction.



[2]

[Total : 10 marks]

-- End of Paper --