Name:	Index Number:	Class:

YIO CHU KANG SECONDARY SCHOOL
O-LEVEL PRELIMINARY EXAMINATION 2024
SECONDARY FOUR EXPRESS

CHEMISTRY 6092/02
Paper 2 1 hour 45 minutes

28 August 2024 (Wednesday)

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.
Write your answers in the spaces provided.

Section B

Answer one question.
Write your answers 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 printed on page 24.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use

Section A	/ 70
Section B	/ 10
Total	/ 80

Setter: Mdm Connie Yeo

Section A [70 marks]

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

A1 The diagram shows part of the Periodic Table.

										He
					B	C	N	O	F	Ne
					Al	Si	P	S	Cl	Ar
Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
									I	Xe

Answer these questions using only the elements shown in the diagram.
Each element can be used once, more than once or not at all.

Write the symbol for

(a) an element which is in Group 14 and Period 3, ..……..….. [1]

(b) an element which is used to fill light bulbs and in the manufacture of steel, …… [1]

(c) an element whose ions in aqueous solution gives a yellow precipitate on reaction with aqueous silver nitrate, …… [1]

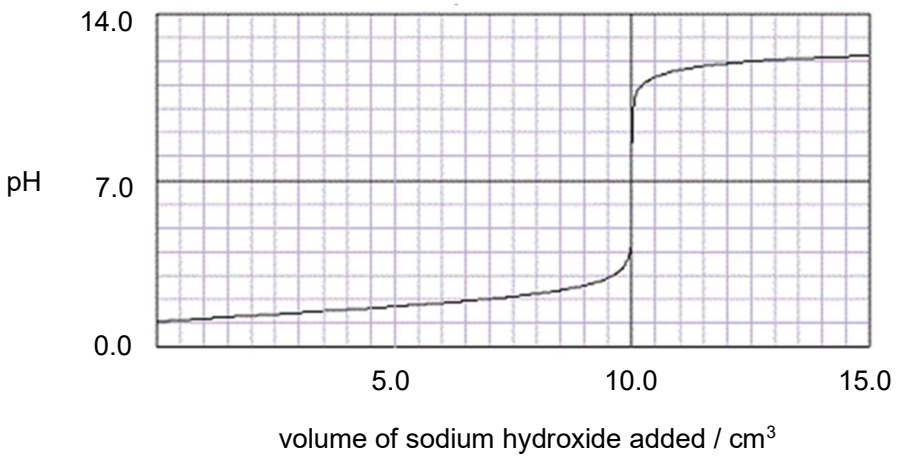
(d) an element which forms an ion of type Y^{3-}, …… [1]

(e) an element which is a catalyst for the hydrogenation of alkenes, ……..…… [1]

(f) two elements which combine to form a compound which causes acid rain. ..…… and …… [1]

[Total: 6]

A2 The graph below shows how the pH changes when aqueous sodium hydroxide is added slowly to 5.0 cm^3 of 0.100 mol/dm^3 sulfuric acid until the alkali is in excess.



(a) Calculate the concentration of sodium hydroxide solution that completely neutralised 5.0 cm^3 of 0.100 mol/dm^3 sulfuric acid.

concentration = …… mol/dm^3 [2]

(b) The experiment was repeated using ethanoic acid of the same concentration as the sulfuric acid. Other conditions were kept constant.

(i) Deduce the volume of ethanoic acid required for the neutralisation reaction.

……..

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

……..

……..

…….. [2]

A2 **(c)** Sulfuric acid is a strong acid whereas ethanoic acid is a weak acid.

Describe the difference between a strong acid and a weak acid.
Include equations to support your answer.

……

……

……

…… [2]

[Total: 6]

A3 Resistivity is a property that describes the extent to which a material opposes the flow of electric current through it. The lower the resistivity of the material, the more readily electric current can flow through the material, the better its electrical conductivity.

The table below shows the resistivity values of three precious metals and carbon.

metal	resistivity (Ωm) at 20°C
carbon (diamond)	1.00×10^{12}
carbon (graphite)	
gold	2.44×10^{-8}
platinum	1.06×10^{-7}
silver	1.59×10^{-8}

(a) With reference to their bonding and structures, explain the difference in resistivity between diamond and the precious metals.

……

……

……

…… [2]

(b) A student commented that graphite's resistivity will be similar to diamond's since they contain the same element carbon.

Do you agree with the student's comment? Briefly explain your reasoning.

……

……

…… [1]

A3 **(c)** Precious metals sold commercially often have a purity of about 90-99.9%.

Explain why precious metals are sold commercially in the form of alloys instead of the pure metal.

……

……

……

…… [2]

(d) The resistivity values given in the table are measured at 20 °C.

Using kinetic particle theory, describe and explain how you would expect the resistivity of the materials to change if the temperature was raised to 40 °C.

……

……

…… [2]

[Total: 7]

A4 Alkynes are a homologous series of organic compounds. Alkynes are unsaturated hydrocarbons containing carbon-carbon (C≡C) triple bonds.

The table below shows the names, formulae and boiling points of some alkynes.

name	**formula**	**boiling point / °C**
ethyne	C_2H_2	−84
		−23.2
butyne	C_4H_6	8.1
pentyne	C_5H_8	40.2

(a) **(i)** Deduce the general formula for alkynes. …… [1]

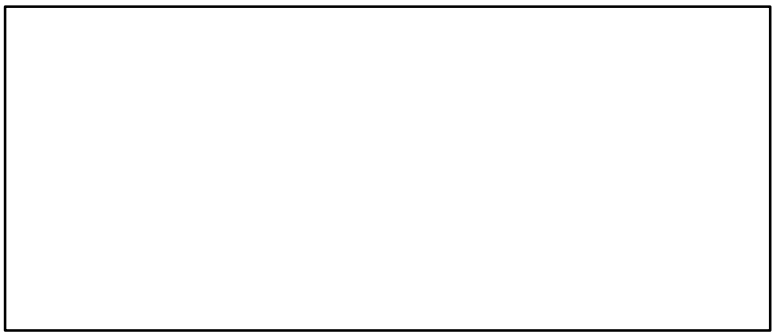
(ii) Give one **other** evidence that suggest that the alkynes are a homologous series.

…… [1]

A4 **(b)** Give the name and full structural formula of the alkyne member with 3 carbon atoms.

name : …….

full structural formula :



[2]

(c) **(i)** Name the two products formed when alkynes undergo complete combustion.

…… [1]

(ii) Ethyne burns with a sootier flame compared to ethene.

Do you agree with this statement? Explain your answer.

……

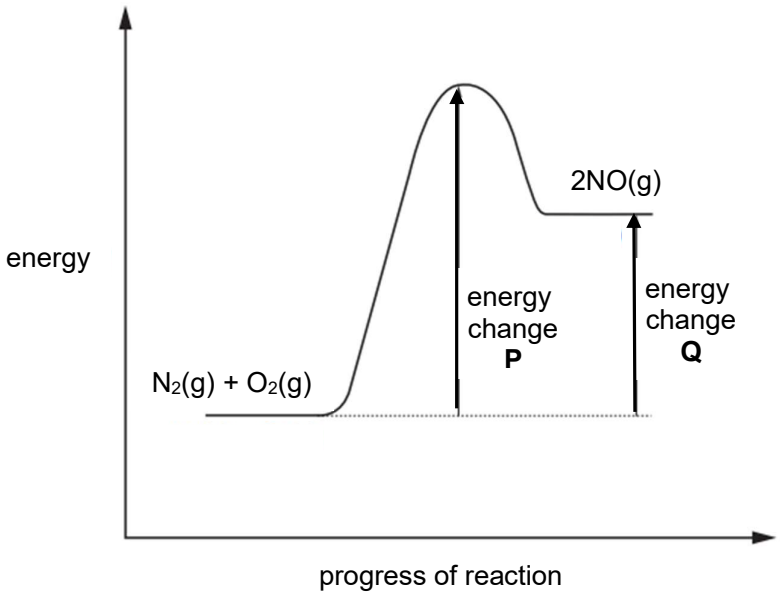
…… [1]

[Total: 6]

A5 Oxides of nitrogen are atmospheric pollutants. Nitrogen monoxide, NO, is formed in an internal combustion engine when nitrogen and oxygen react together.

$$N_2(g) + O_2(g) \rightarrow 2NO(g)$$

The diagram shows the energy profile for this reaction.



(a) Identify the energy changes **P** and **Q**.

P : ……..

Q : …….. [2]

(b) The reaction between nitrogen and oxygen is endothermic.

(i) Explain how you can tell from the diagram that the reaction is endothermic.

…….. [1]

(ii) Explain, using ideas about bond breaking and bond making, why the overall reaction is endothermic.

……..

……..

……..

…….. [2]

A5 **(c)** The exhaust system of a motor car is fitted with a catalytic converter. When nitrogen monoxide passes through the converter, it reacts with carbon monoxide.

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

The catalyst increases the rate of this reaction

(i) Explain how the catalyst in the converter increases the rate of this reaction.

……..

…….. [1]

(ii) During the course of a journey 2.4 dm^3 of nitrogen monoxide was produced by the engine. Calculate the volume of nitrogen gas produced if all the nitrogen monoxide reacted in the converter.

volume = …… dm^3 [1]

(iii) In reality, only 1.0 dm^3 of nitrogen was produced after the gases had passed over the catalytic converter. Calculate the percentage of nitrogen monoxide that had reacted.

percentage = …… % [2]

[Total: 9]

A6 The table shows part of the reactivity series of metals.

metal	relative reactivity
zinc	most reactive ↓
iron	
tin	least reactive

(a) An iron object plated with either zinc or tin will not rust.

(i) Suggest how tin stops iron from rusting.

……..

…….. [1]

(ii) An iron object plated with tin will start to rust if the layer of tin is scratched.
An iron object plated with zinc will not rust if the layer of zinc is scratched.
Use the information in the table to explain these two observations.

……..

……..

……..

……..

…….. [2]

(b) **(i)** Aluminium is placed above zinc in the reactivity series.

Explain why aluminium will not corrode in the presence of oxygen and water.

……

……

(ii) State a use of aluminium and explain why this metal is particularly suited for the stated use.

……

…… [3]

[Total: 6]

A7 Hydrogen peroxide is a colourless liquid.

An aqueous solution of hydrogen peroxide reacts with the iodide ions in acidified potassium iodide to form water and iodine.

$$H_2O_2\ (aq) + 2H^+\ (aq) + 2I^-\ (aq) \rightarrow 2H_2O\ (l) + I_2\ (aq)$$

(a) **(i)** Explain why iodide ions are acting as the reducing agent in this reaction.

……..

……. [1]

(ii) What colour change would you observe in this reaction?

……... [1]

(b) The table shows how the speed of this reaction changes when different concentrations of potassium iodide and sulfuric acid are used. The hydrogen peroxide is always in excess and the temperature remains constant.

experiment	concentrations of potassium iodide (mol/dm^3)	concentrations of sulfuric acid (mol/dm^3)	speed of reaction ($moldm^{-3}s^{-1}$)
1	0.2	0.2	0.00025
2	0.4	0.2	0.00050
3	0.2	0.4	0.00025
4	0.6	0.2	0.00075
5	0.2	0.6	0.00025

Use the information in the table to describe how increasing the concentration of the following reagents affects the speed of reaction.

potassium iodide : ……...

……

……

sulfuric acid : ……

……

……. [4]

A7 **(c)** Explain, in terms of collisions between reacting particles, why decreasing the temperature decreases the speed of reaction between hydrogen peroxide and acidified potassium iodide.

……

……

……

…… [2]

(d) Isotopes of iodine is widely used for radiotherapy and imaging. One such isotope is $^{131}_{53}I$.

State the number of subatomic particles in the ion formed by this isotope, $^{131}_{53}I^-$.

number of protons	
number of electrons	
number of neutrons	

[2]

[Total: 10]

A8 Sunglasses can be made from photochromic glass. When bright light strikes photochromic glass, it darkens.

Photochromic glass contains small amounts of silver chloride, AgC*l*, and copper(I) chloride, CuC*l*. In the presence of bright light, silver chloride decomposes into silver atoms which make the glass go dark, and into chlorine atoms.

$$AgCl \rightarrow Ag + Cl$$

Chlorine atoms immediately react with copper(I) chloride to make copper(II) chloride.

$$CuCl + Cl \rightarrow CuCl_2$$

When the exposure to bright light ends, silver atoms reduce copper(II) chloride back into copper(I) chloride and silver chloride.

(a) Calculate the maximum mass of silver that can be formed when 0.287 g of silver chloride decomposes.

maximum mass = …… g [2]

(b) Explain why the reaction between copper(I) chloride and chlorine involves both oxidation and reduction.

……

……

……

…… [2]

(c) Construct the equation for the reaction between silver and copper(II) chloride.

…… [1]

(d) Aqueous copper(II) chloride reacts with aqueous sodium hydroxide to form a precipitate.

(i) Write the ionic equation, including state symbols, for the precipitation reaction.

……..

(ii) What is the colour of the precipitate?

…….. [3]

[Total: 8]

A9 For a reversible chemical reaction, a state of chemical equilibrium occurs when the rate of a forward reaction is equal to the rate of the reverse reaction. At equilibrium, the concentrations of the reactants and products do not change.

When a chemical system is in equilibrium, a simple relationship known as the equilibrium law exists between the molar concentrations of the products and reactants.

For the reaction:

$$aA + bB \rightleftharpoons cC + dD$$

the equilibrium law may express equilibrium constant K_c as:

$$K_C = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

K_C is the equilibrium constant for the reaction expressed in terms of concentrations.
[ ] denotes the concentrations of the respective reactants or products in mol/dm^3.

A reversible reaction involving H_2, I_2 and HI is represented by the following equation:

$$H_2\,(g) + I_2\,(g) \rightleftharpoons 2HI\,(g)$$

In an experiment, H_2, I_2 and HI were introduced into a 5.0 dm^3 vessel at 900K.
The graphs of the concentrations of H_2, I_2 and HI against time are shown in Fig. 9.1.

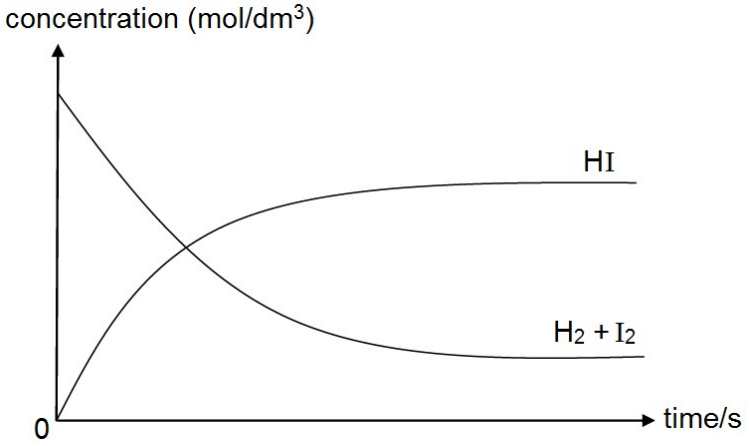


Fig. 9.1

Le Châtelier's Principle

In 1884, Henry Louis Le Châtelier developed a rule to predict how a system in equilibrium will shift when the conditions of the system are changed.

Le Châtelier's Principle states that:

"When conditions change for a system at equilibrium, the system will respond by reducing the effect of the change."

A9 Some examples of how the state of equilibrium of a reversible reaction will shift, based on Le Châtelier's Principle, are shown in Table 9.2 below.

Table 9.2

external stress	**equilibrium shift to relieve stress on system**
decreased concentration of reactant(s)	equilibrium shift to the left, less products are formed
decreased concentration of product(s)	equilibrium shift to the right, more products are formed
increased concentration of reactant(s)	equilibrium shift to the right, more products are formed
increased concentration of product(s)	equilibrium shift to the left, less products are formed
increased temperature for exothermic reaction	equilibrium shift to the left, less products are formed
increased temperature for endothermic reaction	equilibrium shift to the right, more products are formed

For example, in the reversible reaction of decomposition of sulfur trioxide, represented by the following equation:

$$2SO_3 \rightleftharpoons 2SO_2 + O_2$$

If more oxygen is added to the system, the state of equilibrium will shift to the left, producing more sulfur trioxide in order to relieve the "stress" on the system when there is an addition or increased concentration of products.

Another example of a common usage of equilibrium is the manufacturing of ammonia from nitrogen and hydrogen by the Haber process. The reaction requires the use of a catalyst, which operates most efficiently within the temperature range 280 – 450°C.

A9 Fig. 9.2 gives information about the percentage of ammonia present in the equilibrium mixture at different temperatures and pressures.

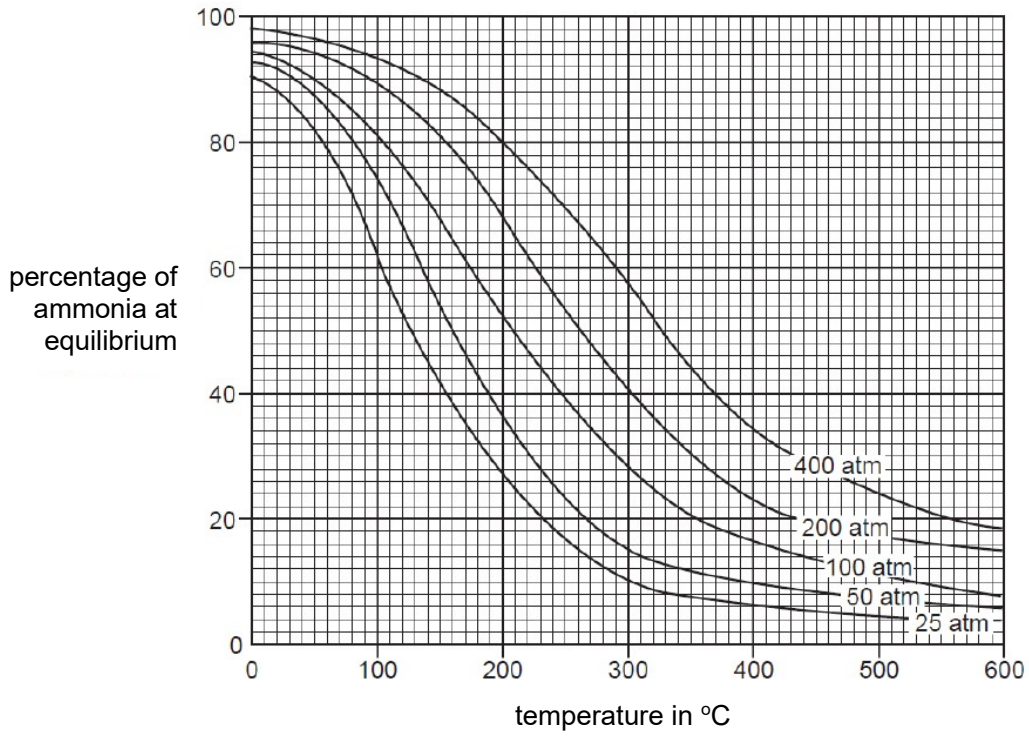


Fig. 9.2

(a) (i) With reference to the equilibrium law and Fig. 9.1, write an expression for the equilibrium constant, K_C, for the formation of HI from H_2 and I_2.

[1]

(ii) Given that the equilibrium constant, K_c is 2000, and the equilibrium concentration of H_2 and I_2 are 0.60 mol/dm^3 and 0.30 mol/dm^3 respectively, calculate the equilibrium concentration of HI.

equilibrium concentration = …… mol/dm^3 [1]

A9 **(a)** **(iii)** Using your answer in **(a)(ii)**, calculate the number of moles of HI in the vessel at equilibrium.

number of moles = ……..mol [1]

(iv) With reference to Fig. 9.1, explain how it can be determined when the reversible reaction involving H_2, I_2 and HI has reached a state of equilibrium.

……

…… [1]

(v) A student commented that when a state of equilibrium is achieved for a reversible reaction, the chemical reaction is complete and no further reaction occurs.

This statement is inaccurate. Explain why.

……

……

……

…… [2]

(b) Write an equation for the manufacture of ammonia in the Haber Process.

…… [1]

(c) The percentage yield of ammonia at the recommended temperature and pressure is about 15%. Using Le Châtelier's Principle, explain how condensing the gaseous ammonia in the Haber process produces more ammonia.

……

……

……

…… [2]

A9 **(d)** **(i)** With reference to Fig. 9.2, state the relationship between temperature and the percentage of ammonia at equilibrium.

……. [1]

(ii) Using Le Châtelier's Principle and your answer in **(d)(i)**, predict with a reason, if the production of ammonia is an exothermic or endothermic reaction.

……..

……..

……..

……. [2]

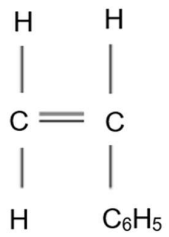
[Total: 12]

Section B [10 marks]

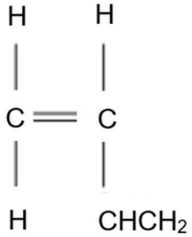
Answer one question in this section in the spaces provided.

EITHER

B10 Styrene-butadiene rubber, or SBR, is a common type of synthetic rubber. It is made by polymerising a mixture of the monomers butadiene and styrene.



styrene



butadiene

SBR is known for its toughness and elasticity, making it ideal for car tyres and shoe soles. Unlike natural rubber, SBR is derived from petroleum and not eco-friendly as it takes a long time to break down.

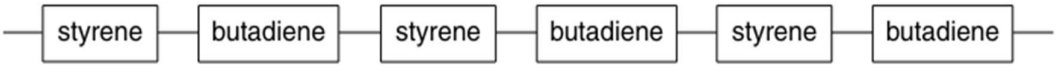
(a) What type of polymerisation will take place when the monomers polymerise? Explain your reasoning.

……

……

…… [2]

One possible structure for the polymer is shown below.



(b) Give the structural formula for the repeating unit in this polymer structure.

[1]

(c) When the mixture of styrene and butadiene polymerises, the polymer is unlikely to contain only this regular, repeating pattern. Explain why.

……

……

…… [1]

EITHER

B10 (d) SBR can be recycled using the pre-treatment phase of the physical method of recycling.

(i) Explain why it is important to recycle SBR.

……..

……..

……..

…….. [2]

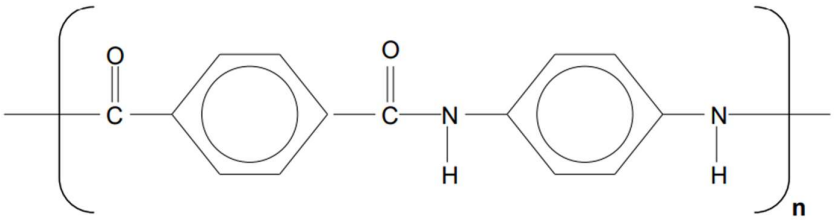
(ii) Briefly describe the physical method of recycling SBR.

……..

……..

…….. [1]

(e) Kevlar® is another type of polymer known for its variety of applications such as in bicycle tyres, racing sails and even personal protective cryogenic gear.
The structure of Kevlar® is shown below.



Kevlar®

(c) (i) Name the type of linkage present in Kevlar®.

…….. [1]

(ii) If the formation of Kevlar® releases hydrogen chloride as a by-product, draw the structural formula of the two monomers that make up Kevlar®.

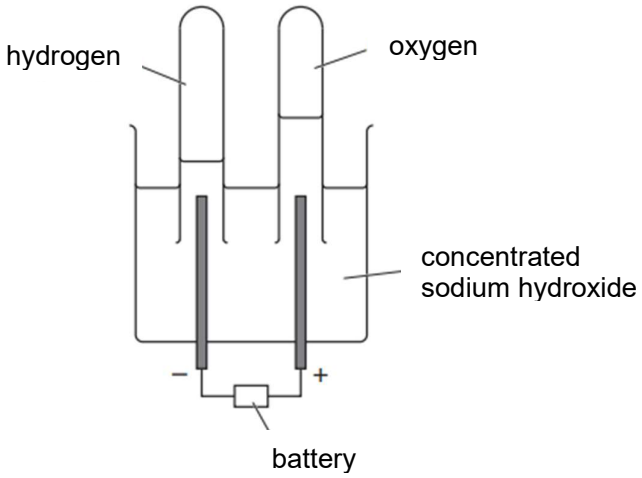
monomer 1	monomer 2

[2]

[Total: 10]

OR

B10 The diagram below shows the apparatus used to electrolyse concentrated sodium hydroxide in the laboratory.



Electrolysis of the aqueous sodium hydroxide results in the formation of hydrogen at the cathode (negative electrode) and oxygen at the anode (positive electrode).

(a) (i) Write ionic equations for the reactions at the cathode and anode.

at the cathode : ……

at the anode : …… [2]

(ii) Why is the theoretical ratio of hydrogen to oxygen collected 2:1?

……..

……..

…….. [2]

(b) (i) When the battery is replaced by a voltmeter, the apparatus acts like a fuel cell. The cathode becomes the positive pole of the cell and the anode becomes the negative pole.

State the direction of the electron flow in the external circuit.
Give a reason for your answer.

……..

…….. [1]

(ii) In this fuel cell, hydrogen reacts with aqueous hydroxide ions to form water.
Construct an equation for this reaction.

…….. [1]

OR

B10 **(c)** Ethanol can also be used as a car fuel.

In some countries, it is produced from the sugars in sugar cane.

(i) Name the process used to produce ethanol from sugar.

…….. [1]

(ii) An environmentalist claims that ethanol as a fuel is 'carbon neutral' because using it does not add to the amount of carbon dioxide in the atmosphere. Explain why this is true.

……..

……..

……..

……..

……..

…….. [3]

[Total: 10]

BLANK

BLANK

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							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	3	4	5	6	7	8	9	10	11	12	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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).
The Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$.