ORCHID PARK SECONDARY SCHOOL
Preliminary Examination 2022

CANDIDATE NAME				
CLASS			INDEX NUMBER	

CHEMISTRY **6092/02**

Paper 2 **24 August 2022**

Secondary 4 Express **1 hour 45 minutes**

Setter: Mr Goh Chye Joo **80 Marks**

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on all the work you hand in.
Write in dark blue or black ink.
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 printed on page 18.

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

Section A

Answer **all** questions in the space provided.

The total mark for this section is 50.

A1 This table shows some information about atoms of the elements **L**, **M**, **N** and **O**. (The letters do not represent the atomic symbols of the elements.)

element	atomic number	number of protons	number of neutrons	mass number	electronic configuration
L	16	16	16	32	
M	7	7	7	14	
N	1	1	1	2	1
O	11				

(a) **(i)** Complete the table by filling in the information of the four elements. [3]

(ii) Give a reason why element **O** is likely to be a metal.

……..……...

……. [1]

(b) **(i)** Describe the change in electronic configuration that occurs to an atom of element **M** when it forms an ion.

State the formula of ion formed using the chemical symbol **M**.

……..……...

……. [2]

(ii) The accurate relative atomic mass of element **L** is 32.1.

Explain why this is not a whole number.

……..……...

……. [1]

(c) Draw a dot and cross diagram to show the bonding formed between element **N** and **O**.

Show outer electrons only.

[2]

A2 Iron is one of the most important metals. Most iron is used in the alloy steel.

(a) Explain, in terms of metallic bonding, why iron is a good electrical conductor.

……

……

……

…… [2]

(b) Describe how different proportions of carbon can modify the physical properties of steel.

……

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……

…… [2]

(c) When under water, iron pipes will rust relatively rapidly.

(i) State the essential conditions needed for the rusting of iron.

…… [1]

(ii) Pieces of magnesium are often attached to under water pipes.

Explain how the magnesium protects the iron pipes against rusting.

……

……

……

…… [2]

(d) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen.

Calculate the empirical formula of this compound.

empirical formula …….. [2]

A3 This question is about the Periodic Table.

The table shows part of the original Periodic Table first published by Mendeleev in 1869.

	Period 1	Period 2	Period 3	Period 4		Period 5	
Group 1	H	Li	Na	K	Cu	Rb	Ag
Group 2		Be	Mg	Ca	Zn	Sr	Cd
Group 3		B	A*l*	*	*	Y	In
Group 4		C	Si	Ti	*	Zr	Sn
Group 5		N	P	V	As	Nb	Sb
Group 6		O	S	Cr	Se	Mo	Te
Group 7		F	C*l*	Mn	Br	*	I

The asterisks (*) show gaps in the table that Mendeleev deliberately left.

(a) Which group of elements in a modern Periodic Table is missing from Mendeleev's Periodic Table?

…… [1]

(b) State **two** other differences between Mendeleev's original table and a modern Periodic Table.

……

……

…… [2]

(c) Find rubidium, Rb, in the Periodic table provided on page 18.
Predict the reaction between rubidium and cold water.

Include observations and the chemical equation.

……

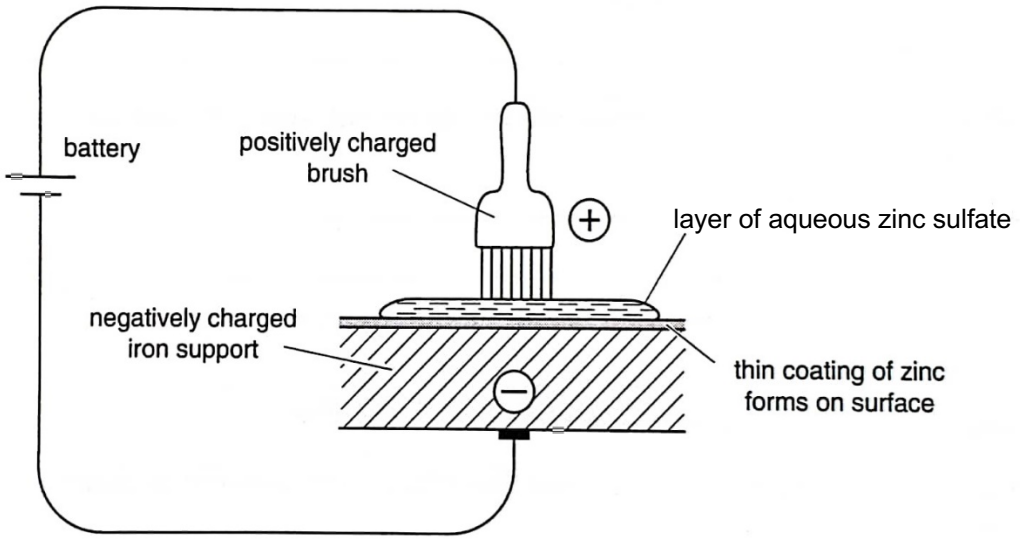
……

……

…… [3]

A4 A new type of electroplating is known as 'brush electroplating'.
It is used to electroplate zinc into very large iron supports to be used in buildings.
The iron supports are too big to be plated in a normal electrolysis tank.

During the process, a metal brush spreads a layer of aqueous zinc sulfate over the iron surface. A battery gives the brush a positive charge and gives the iron support a negative charge. A layer of zinc forms on the surface of the iron support.



(a) **(i)** Other than the prevention of rusting, state another advantage of electroplating the iron support.

…….. [1]

(ii) Write an ionic half-equation, with state symbols, to represent the reaction at the cathode during the electrolysis.

…….. [2]

(b) Two different designs of metal brush are available.
One type of brush is made from zinc, while the other type is made from platinum.
As the electrolysis takes place, each brush has a different effect on the concentration of zinc ions in the solution.

Explain the effect of each type of brush on the concentration of zinc ions in the solution.

……..……..

……..……..

……..…….. [3]

A5 Hydrogen peroxide, H_2O_2, decomposes to give water and oxygen.

hydrogen peroxide → water + oxygen

A student carried out three experiments to investigate the rate of reaction.
He used the same volume and concentration of hydrogen peroxide each time.
His first experiment used only hydrogen peroxide.
His second and third experiments investigated the effects of adding enzyme **A** and enzyme **B** to the reaction mixture.

Fig. 5.1 shows the results.

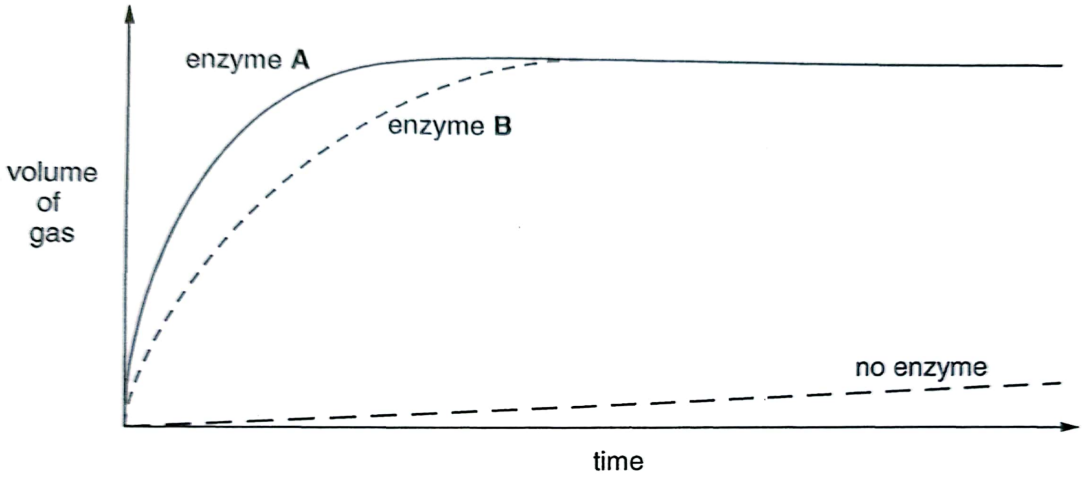


Fig. 5.1

(a) **(i)** Write a chemical equation for the decomposition of hydrogen peroxide.

……..…… [1]

(ii) Explain why the decomposition of hydrogen peroxide is also a redox reaction.

……..……

……..……

……..…… [2]

(b) Suggest a method the student could use to measure the rate of reaction.

……..……...

……..……...

……..……... [2]

(c) **(i)** Describe the effect of each enzyme on the rate of reaction.

……..……...

…….

……..……...

……. [2]

(ii) Use ideas about activation energy to explain why the shape of the graph is different when no enzyme is used.

…….

……..……...

……. [2]

(d) The student repeated the same experiment for enzyme **B**.
This time he used the same volume for hydrogen peroxide but at half the original concentration.
He continued to measure the volume of gas until the reaction was complete.
Sketch a curve on Fig. 5.1 to show the result for this experiment. [2]

A6 More than 60 000 plastic materials, or polymers, are in use.

The table gives some information about five important polymers.

polymer	density in kg / m^3	maximum useable temperature / °C	solubility in organic solvents
low density poly(ethene)	920	85	soluble above 80 °C
high density poly(ethene)	960	120	soluble above 80 °C
poly(phenylethene)	1050	65	soluble
poly(chloroethene)	1390	60	soluble
poly(propene)	900	150	insoluble

(a) Which polymer would be most suited for making a pipe to carry lubricating oil at 100 °C?

Give **two** reasons for your answer.

polymer ……

reasons ……..

…….

……. [2]

(b) State **two** advantages which a poly(ethene) milk bottle has over a glass milk bottle.

……

…… [1]

(c) Describe some of the problems of the disposal of waste polymers.

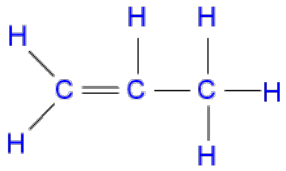
……

……

……

…… [2]

(d) The diagram shows a monomer that can undergo addition polymerisation.



(i) Name the polymer formed when this molecule polymerises and draw the structure of the repeating unit of the polymer.

[2]

name of polymer ……

(ii) A sample of the polymer was analysed and found to have a relative molecular mass of 10500.

How many carbon atoms are present in this sample chain?

number of carbon atoms …… [2]

Section B

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

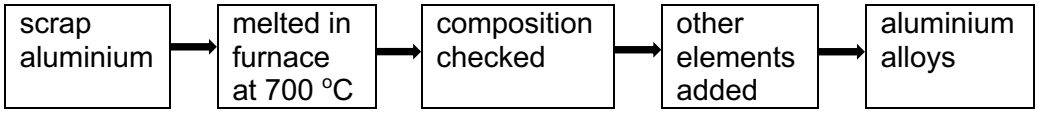
The last question is in the form of either/or and only one alternative should be attempted.

B7 The Importance of Recycling Copper and Aluminium

During the past decade, strong growth in emerging economies, coupled with an increased use of copper and aluminium for innovative and clean energy technologies, has led to significantly higher copper and aluminium demand. The recycling of aluminium and copper helps to satisfy this demand and to build a sustainable future for people and the planet.

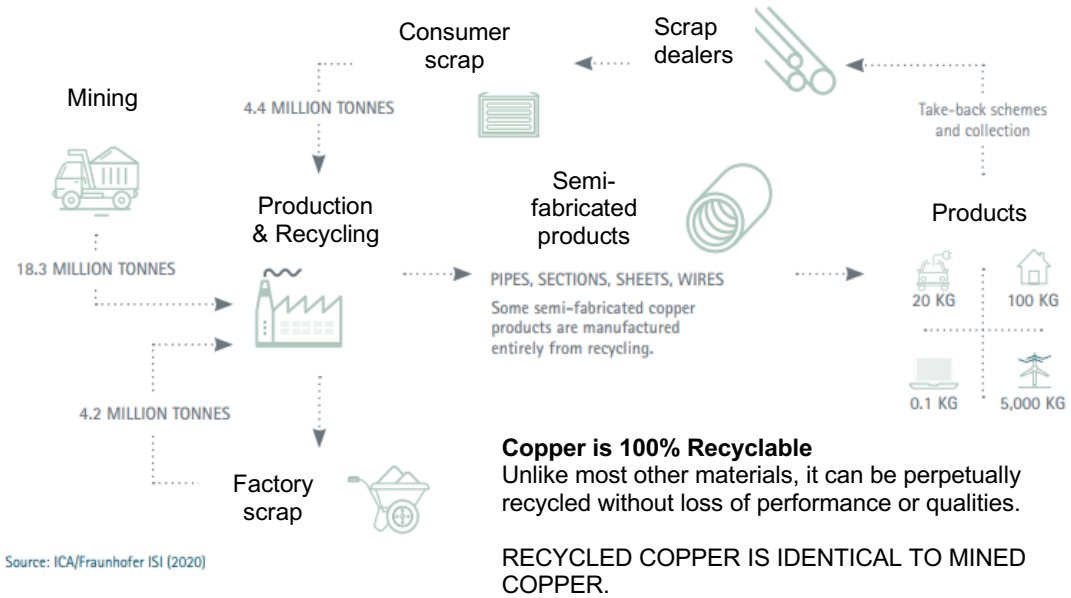
The recycling of aluminium uses only 5% of the energy that is needed to extract aluminium directly from bauxite, ($Al_2O_3 \cdot 2H_2O$). The recycling of 1 kg of used aluminium saves 8 kg of bauxite and 14 kW hours of electricity.

Old aluminium window frames, cans and other aluminium items can be melted down and cooled to form blocks of aluminium ready for sale to manufacturers. Most aluminium is alloyed before cooling by adding metals such as magnesium, copper or iron to form a range of alloys.



Aluminium is used widely in aircraft due to its very low density, but pure aluminium is soft and weak. Alloy 2024 contains around 95% aluminium with 4% copper. They are much stronger and harder than pure aluminium.

The recycling of copper requires less energy than primary production and reduces CO_2 emissions. In addition to its environmental benefits, the recycling of complex copper scrap, such as electronic waste, drives the recovery of many other metals such as gold, silver, tin, lead and zinc.



Nearly 70 % of worldwide copper produced is used for electrical applications and communications. Copper has the highest electrical conductivity of any metal, apart from silver. It also provides light, durable maintenance-free structures that are naturally good looking and long lasting. Other uses of copper include used for coins, sculptures, jewellery, musical instruments, cookware and other consumer goods.

(a) The article discusses the advantages of recycling aluminium compared to extracting aluminium from bauxite.

(i) One advantage of using less bauxite and less electricity is that costs are reduced.

Give **one** other advantage of using less bauxite and **one** other advantage of using less electricity.

……

……

……

…… [2]

(ii) Explain why extracting aluminium from bauxite uses more energy than recycling.

……

…… [1]

(iii) The article states that recycling 1 kg of used aluminium saves 8 kg of bauxite.

Do you agree with the statement? Explain your reasoning.

……

……

……

……

……

…… [2]

(b) Explain why structures made of copper are durable, maintenance-free and long lasting.

……

……

……

…… [1]

(c) Alloy 2024 contains 95 % aluminium and 4 % copper.

Draw a diagram to represent the structure of alloy 2024.

[2]

(d) Describe a test to show that aluminium oxide is amphoteric, whereas copper(II) oxide is not.

…….……..…….....

…….……..……..…...

…….……..……...……...……...

…….……..…….....

……..……..……. [2]

B8 Petrol and diesel are liquid fuels used in the internal combustion engines of motor cars and lorries.

(a) Describe how petrol and diesel are obtained from petroleum.

……

……

……

……

…… [2]

(b) The exhaust gas from an internal combustion engine contains pollutants.

The table shows the mass of pollutants formed when one kilogram of each fuel is burnt.

fuel	mass of pollutant / g				
	carbon monoxide	oxides of nitrogen	sulfur dioxide	volatile organic compounds e.g. unburnt hydrocarbons	particulates
diesel	10	59	3.8	17	18.6
petrol	236	29	0.9	25	0.6

(i) Which pollutant is a poisonous gas formed by the incomplete combustion of the fuels?

..... [1]

(ii) Which fuel contributes the most towards acid rain for each kilogram burnt?

Explain your answer.

.....

.....

..... [2]

(iii) Nitrogen dioxide is formed when nitrogen reacts with oxygen.

Write the chemical equation for this reaction.

……

…… [1]

(iv) Many cars are fitted with catalytic converters. In the catalytic converters, carbon monoxide is oxidised and nitrogen dioxide is reduced to form two gases.

State the use of the catalytic converters and indicate the names of these two gases.

……

……

……

…… [2]

(c) Octane, C_8H_{18}, is a hydrocarbon found in petrol. Complete combustion of one mole of octane releases 5518 kJ of energy.

Calculate the energy released on complete combustion of 1.14 g of octane.

[2]

EITHER

B9 Nickel is a transition element. It is manufactured in a four-stage process from nickel(II) sulfide.

Stage 1 - nickel(II) sulfide is heated in air to form nickel(II) oxide and sulfur dioxide.
Stage 2 - nickel(II) oxide is heated with carbon to give impure nickel.
Stage 3 - impure nickel is reacted with carbon monoxide to make nickel tetracarbonyl, $Ni(CO)_4$.
Stage 4 - nickel tetracarbonyl is decomposed to give pure nickel.

(a) **(i)** Write a balanced equation for the reaction in stage 1.

…… [1]

(ii) Calculate the mass of sulfur dioxide that is formed when 182 kg of nickel sulfide is heated in air.

[2]

(iii) What method can be used to determine if the nickel obtained is pure.

.....

..... [1]

(b) Nickel tetracarbonyl is a liquid with a boiling point of 43 °C.

Suggest, with a reason, the type of bonding in nickel tetracarbonyl.

.....

[2]

…….....

(c) Suggest **one** possible environmental consequence of the manufacture of nickel.

.....

……..... [1]

(d) Give an example of the use of nickel as a catalyst.

..... [1]

(e) In an experiment, small amounts of three metals were added to three aqueous metal nitrate solutions.

Part of the results are shown in the table.

	aqueous zinc nitrate	aqueous nickel(II) nitrate	aqueous copper(II) nitrate
zinc	no reaction	green solution became colourless and zinc is coated with a silver solid	blue solution became colourless and zinc is coated with a pink solid
nickel		no reaction	
copper	no reaction		no reaction

Complete the table by predicting the other three observations.

Write an ionic equation for **one** of the reactions that takes place.

……. [2]

OR

B9 Ethanoic acid is manufactured by reacting methanol with carbon monoxide.

methanol + carbon monoxide → ethanoic acid

(a) **(i)** An industrial process uses 8 tonnes of methanol to produce 4.5 tonnes of ethanoic acid.

Calculate the percentage yield of ethanoic acid.

[2]

(ii) Draw the structural formula and name of the product formed when the methanol reacts with the product ethanoic acid, instead of carbon monoxide.

[2]

(b) One industrial use of ethanoic acid is to remove limescale (calcium carbonate) from steel pipes.

Write the chemical equation for the reaction that occurs when ethanoic acid reacts with calcium carbonate.

..... [2]

(c) Hydrochloric acid is a strong acid, ethanoic is a weak acid.

(i) Describe a **simple** test to show which is the strong acid and which is the weak acid.

……..

……..

……..…

……..

…….. [2]

(ii) Describe the difference between strong and weak acids.

……..

……..

……..…

……..

…….. [1]

(iii) Explain why hydrochloric acid should not be used for removing limescale from steel pipes.

……..

……..

……..…

……..

…….. [1]

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.).

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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
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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 –

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