Name: _____ Index Number:_____ Class: _____

TEMASEK SECONDARY SCHOOL
Preliminary Examination 2022
Secondary 4 Express

CHEMISTRY **6092/02**

Paper 2 (Section A) **Total duration for Sections A and B: 1 hour 45 minutes**

Question and Answer Booklet

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.

Hand in this booklet at the end of the paper.

Write your name, index number and class in all the work you hand in.
Write in dark blue or black pen.

Answer all questions in the spaces provided on the question paper.

At the end of the examination, submit **Section A and B separately**.

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 14.

FOR EXAMINER'S USE	
Section A	/50

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

A1 All nitrates of Group II metal undergo thermal decomposition to form metal oxide, nitrogen dioxide and oxygen.

(a) Describe a test to confirm that decomposition has taken place.

……

……

……[2]

(b) Table 1.1 shows the temperature at which each metal nitrate salt decomposes.

Table 1.1

metal nitrate salt	Temperature at which metal nitrate salt decomposes/ °C
magnesium nitrate	330
calcium nitrate	500
strontium nitrate	570
barium nitrate	650

(i) Using Table 1.1, deduce the order of reactivity of the four metals.

most reactive …….

…….

…….

least reactive ……. [1]

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

……..……..

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……..……....[2]

A2 Fig. 2.1 shows a mixture of the gases, methane, ammonia and water vapour in a flask. The electrodes provide electric sparks which causes chemical reactions to occur.

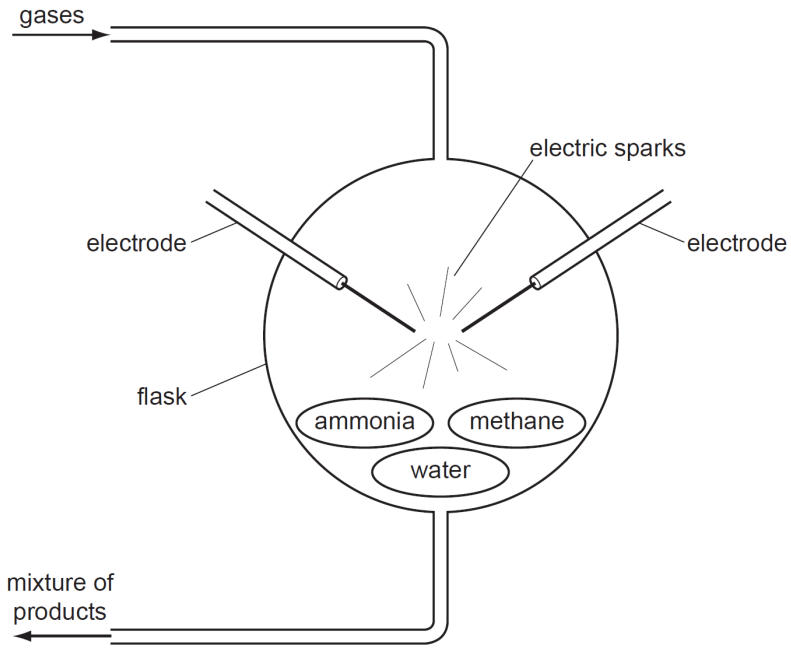

Fig. 2.1

(a) The substances present at the start of the experiment are compounds consisting of small molecules.

Explain what is meant by *molecule*.

……

……..……[1]

(b) After one week, the experiment produced a mixture of products. The mixture of products can be analysed using paper chromatography.

Four known compounds, glycine, alanine, cysteine and lactic acid, were added to the chromatogram for comparison. The chromatogram is shown in Fig. 2.2.

Fig. 2.2 is not drawn to scale.

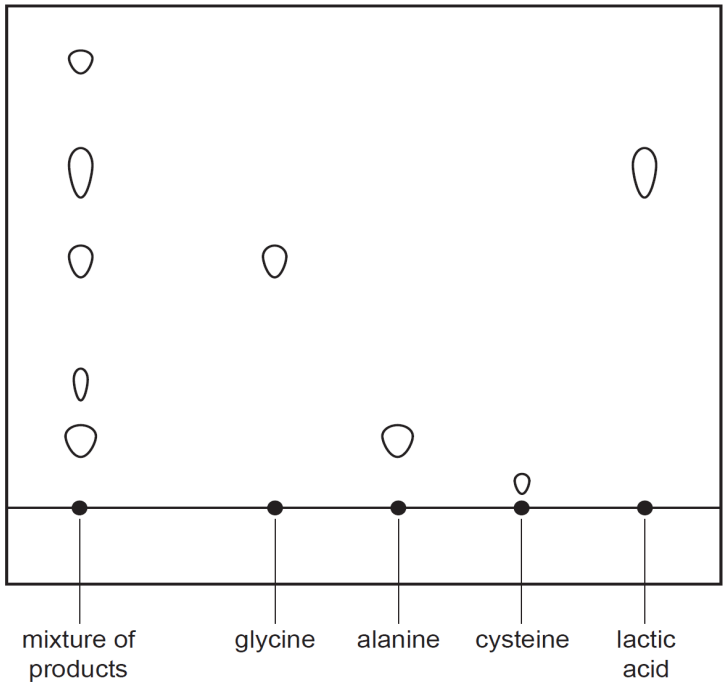

Fig. 2.2

(i) From Fig. 2.2, deduce the identities of the substances present in the mixture of products.

Explain your answer.

……

……

……[2]

(ii) The solvent front of the chromatogram is 140 mm away from the start line. It is also known that the R_f value of lactic acid ranges from 0.67 to 0.78.

Calculate the range of distances travelled by lactic acid in in the chromatogram.

…… mm [2]

A3 Titanium is a transition metal used in the aerospace industry.
It can be extracted by heating titanium(IV) chloride to 2000°C with sodium.

$$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$$

(a) At room temperature and pressure, titanium(IV) chloride exists as a liquid.

Explain why you would not expect titanium(IV) chloride to exist as a liquid at room temperature and pressure.

……

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……

……[2]

(b) 40 kg of titanium chloride was added to 20 kg of sodium.

Explain why titanium chloride is the limiting reactant. All workings must be shown.

[3]

A4 Aqueous solutions of **barium nitrate, copper(II) sulfate, potassium hydroxide and sodium carbonate** are stored in four bottles labelled A, B, C and D, but not necessarily in this order.

Table 4.1 shows the observations based on the following procedures.

Table 4.1

procedure	observations
Mix A with B, followed by dilute hydrochloric acid	The solution remains colourless. Effervescence seen when dilute hydrochloric is added.
Mix A with C, followed by dilute hydrochloric acid	A green precipitate is observed. Effervescence seen and the precipitate is soluble in dilute hydrochloric acid.
Mix C with D, followed by dilute hydrochloric acid	A white precipitate is formed in a blue solution. The white precipitate remains when dilute hydrochloric acid is added.

Using Table 4.1, identify solutions A, B, C and D.

A ……..

B ……..

C ……..

D ……..

[4]

A5 A student investigated the reaction between excess zinc and dilute hydrochloric acid.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

The experiment was conducted twice with the same mass of zinc and same volume, but different concentrations of acid.

(a) Fig. 5.1 shows how volume of hydrogen gas produced changes with time.

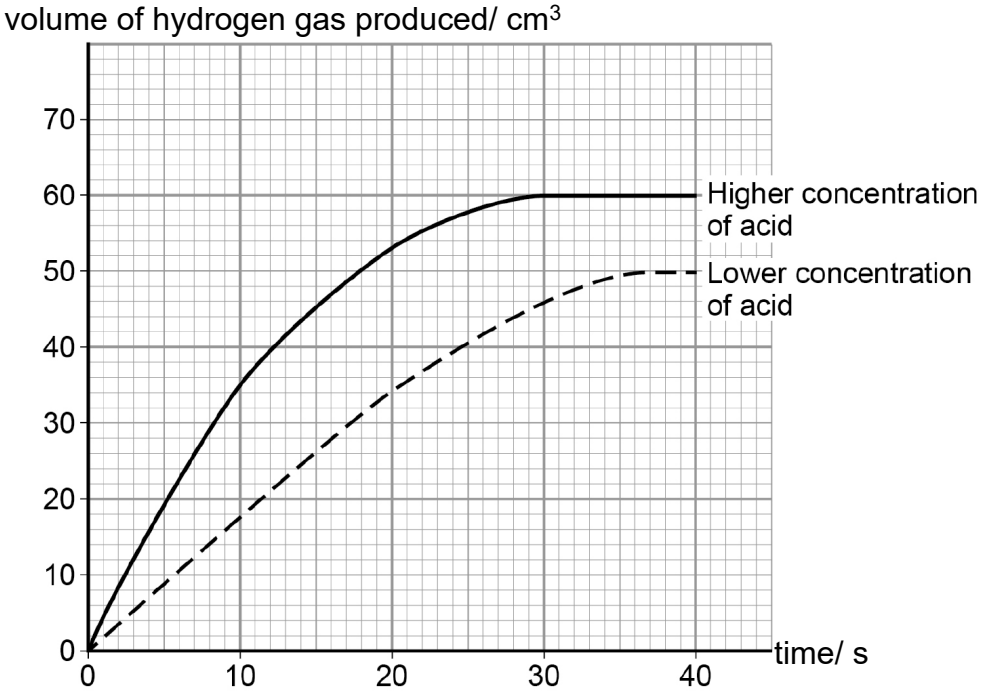

Fig. 5.1

Describe and explain the difference in the shape of the graphs shown in Fig. 5.1.

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……[2]

(b) Another set of experiments was conducted using the same number of moles of zinc, magnesium and aluminium with excess hydrochloric acid.

Fig. 5.2 shows the results for this set of experiments.

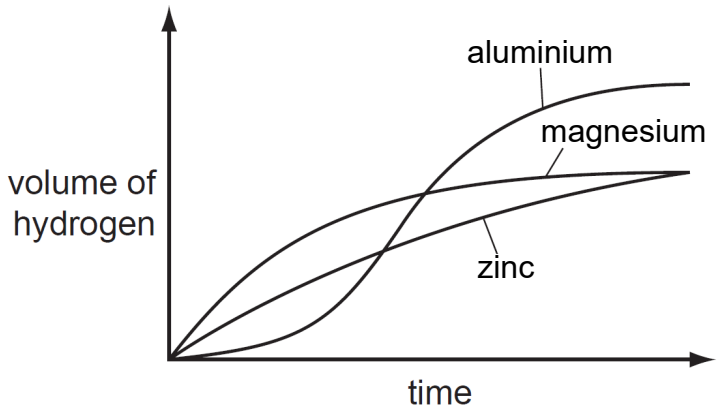

Fig. 5.2

(i) Explain why the volume of hydrogen produced by zinc and magnesium is the same, but that of aluminium is much higher.

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……

……

……[2]

(ii) Compare the speed of reaction for the reaction between aluminium and acid and that of zinc and acid.

Explain your answer.

……

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……

……[2]

A6 To reduce emission of pollutants during the production of electricity, some countries are starting to burn natural gas instead of coal in power stations.

Table 6.1 shows the amount of pollutants formed by each type of fuel.

Table 6.1

type of fuel	**mass of pollutant formed per MJ of electrical energy/ g (1 MJ = 10^6 J)**	
	SO_2	**NO_2**
coal	0.31	0.64
natural gas	0.0015	0.11

The chemical equations of complete combustion of coal and natural gas are shown.

$$\text{coal: } C + O_2 \rightarrow CO_2 \quad \Delta H = -890 \text{ kJ/ mol}$$

$$\text{natural gas: } CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \quad \Delta H = -394 \text{ kJ/ mol}$$

(a) Using Table 6.1, state the advantages of using natural gas instead of coal in power stations.

……

……

……[2]

(b) Calculate the energy released by the complete combustion of 48.0 cm^3 of natural gas.

[2]

(c) Some claim that speed of combustion of natural gas can be increased by reducing the volume of the reaction vessel. All other reaction conditions remain the same.

Do you agree? Explain your answer using collision theory.

……...

……...

……...

……...

……[3]

(d) In terms of bond breaking and bond making, explain why the combustion of coal is exothermic.

……..

……..

……[2]

(e) State and explain whether the combustion of coal is a redox reaction.

……..

……..

...……[2]

A7 Fig. 7.1 shows an experimental set-up to study the effect of graphite and copper electrodes in the electrolysis of dilute aqueous copper(II) sulfate.

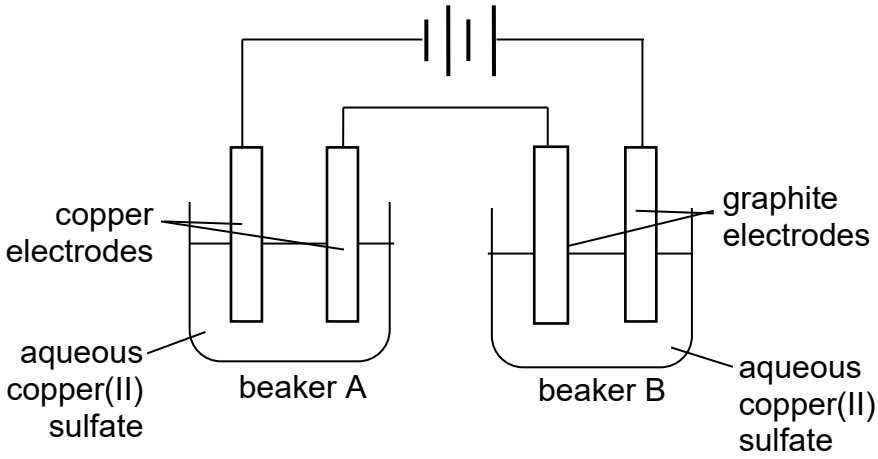


Fig. 7.1

(a) With the aid of half equations, describe one difference in the observation at the anodes in both beakers.

……..

……..

……..

……..

……..[3]

(b) The experiment is repeated by replacing the dilute copper(II) sulfate solution in beaker B with concentrated potassium chloride solution. A few drops of Universal Indicator are also added to beaker B.

Describe two observations in beaker B. Explain your answer.

……..

……..

……..

……[3]

A8 **(a)** It is believed ancient civilisations generate electricity using clay jars, filled with vinegar solution, with an iron rod placed in a copper cylinder.

Fig. 8.1 shows a representation of the ancient electric cell.

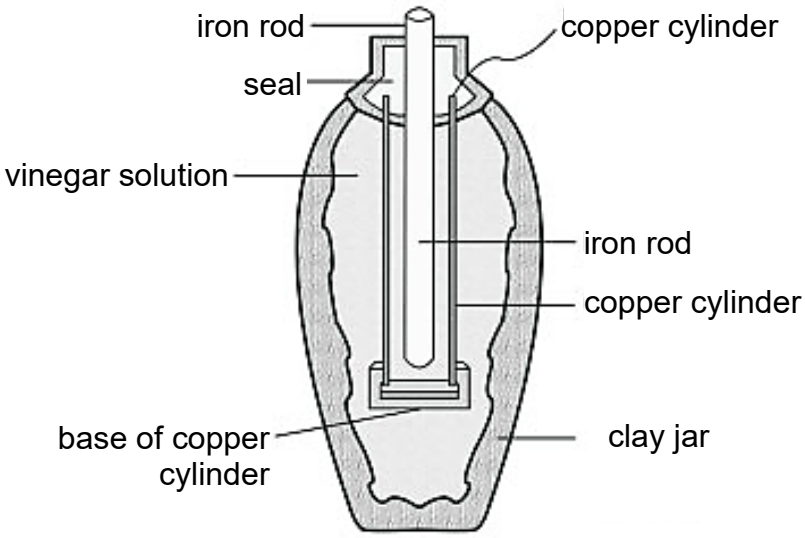


Fig. 8.1

(i) Using Fig. 8.1, state the electrolyte and metals acting as the positive and negative electrode.

electrolyte: ……

positive electrode: ……

negative electrode: …… [2]

(ii) Suggest the observation in the copper cylinder when the electric cell is used. Explain your answer.

……

……

……[2]

(iii) Suggest another metal that can be used in place of iron to increase the amount of electrical energy produced by the electric cell.

……[1]

(b) A modern version of the electric cell is the methanol fuel cell. Electrical energy and heat are produced from a reaction between methanol and oxygen.

The following ionic equations take place at the respective electrodes.

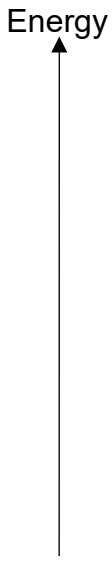
Anode: $CH_3OH\ (aq) + H_2O\ (l) \rightarrow 6\ H^+\ (aq) + CO_2\ (g) + 6e^-$
Cathode: $O_2\ (g) + 4H^+\ (aq) + 4e^- \rightarrow 2\ H_2O\ (l)$

(i) Write a chemical equation for the overall reaction.

……[1]

(ii) Using your answer in **(b)(i)**, draw an **energy level diagram** for the overall reaction.

Your diagram should label the enthalpy change of reaction, ΔH.



[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		**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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