CHUA CHU KANG SECONDARY SCHOOL

O LEVEL PRELIMINARY EXAMINATION 2024
Secondary Four Express

Marks: **65**

CANDIDATE NAME			
CLASS		INDEX NUMBER	

SCIENCE (CHEMISTRY) **5086/5088/03**

Paper 3 **22 August 2024**

Candidates answer on Question Paper. **1 hour 15 minutes**

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
You may use an HB pencil for any diagrams, graphs or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer **one** question.
Write your answers in the spaces provided on the question paper.

A copy of the Data Sheet is printed on page 16.
A copy of the Periodic Table is printed on page 17.

The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **17** printed pages.

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Vetters: Ms Ang Jia Wei, Mdm Izzati, Mr Alwin Njoo

[Turn over

Section A

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

1 Choose from the substances listed to answer the questions.

acidified potassium manganate(VII)
ammonia
bromine
carbon dioxide
ethane
ethene
hydrogen
methane
silver chloride
potassium sulfate

Each substance may be used once, more than once or not at all.

Identify the substance which:

(a) is a gas that turns damp blue litmus paper red

……. [1]

(b) oxidises ethanol to ethanoic acid

……. [1]

(c) forms a white precipitate with barium nitrate solution

……. [1]

(d) is the main constituent of natural gas.

……. [1]

[Total: 4]

2 **(a)** Magnesium reacts with sulfuric acid to produce magnesium sulfate and hydrogen gas.

Fig. 2.1 shows an incomplete reaction pathway diagram for this reaction.

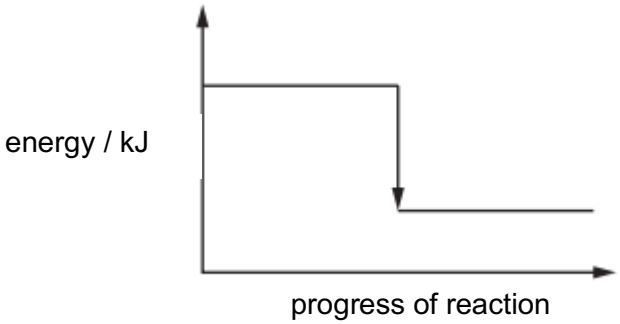


Fig. 2.1

(i) Complete Fig. 2.1 by writing these formulae on the diagram:

- $Mg + H_2SO_4$
- $MgSO_4 + H_2$ [1]

(ii) Explain how Fig. 2.1 shows that the reaction is exothermic.

……..

…… [1]

(b) Magnesium is a reactive metal that can react with steam.

(i) Name the products of this reaction.

…… [1]

(ii) Table 2.1 shows some information about the reaction of four metals with steam.

Table 2.1

metal	reaction with steam when metal is cold
beryllium	reacts slowly
chromium	reacts slowly only when metal is very hot
magnesium	reacts rapidly
silver	no reaction

Arrange the four metals in order of their reactivity, starting with the least reactive metal first.

…… [1]

[Total: 4]

3 Atoms of non-metallic elements can combine with other atoms to form many different compounds.

(a) One of such compounds, ammonia is a non-conductor of electricity and has a low melting point.

(i) Name the type of bonding present in ammonia.

…… [1]

(ii) Draw a 'dot and cross' diagram to show the arrangement of electrons in a molecule of ammonia in the space given.

Show only the outer shell electrons.

[Proton numbers: H, 1; N, 7]

[2]

(b) Another compound, magnesium chloride, has a high melting point and is a conductor of electricity when molten.

Explain the following statements:

(i) Magnesium chloride has a high melting point.

……..

……..

……..

…… [2]

(ii) Magnesium chloride is a conductor of electricity when molten.

……..

…… [1]

[Total: 6]

4 In recent years there are great concerns in the rise of carbon dioxide and air pollutants, such as nitrogen monoxide and carbon monoxide, in the atmosphere.

(a) State the percentage by volume of nitrogen in clean dry air.

…… % [1]

(b) Describe how nitrogen monoxide is formed in a car engine.

……

…… [1]

(c) Carbon monoxide is also formed in a car engine.

State **one** effect of carbon monoxide in the air on health.

……

…… [1]

(d) The percentage by volume of carbon dioxide in the atmosphere is regulated by the carbon cycle.

Describe how the percentage by volume of carbon dioxide is regulated by the carbon cycle.

……

……

……

……

……

…… [3]

[Total: 6]

5 Table 5.1 lists the number of protons, neutrons and electrons in several different particles.

Table 5.1

particle	number of protons	number of neutrons	number of electrons
C	1	0	1
D	3	3	2
E	7	7	7
F	8	9	8
G	8	10	8
H	9	10	10

Which of the particles, **C**, **D**, **E**, **F**, **G** and **H** in Table 5.1, fit each of the following descriptions?

Each letter may be used once, more than once or not at all.

(a) an atom with a mass number of 18 ..... [1]

(b) an atom with 5 electrons in its outer shell ..... [1]

(c) an ion of a metal ..... [1]

(d) are isotopes of the same element ..... and ..... [1]

(e) a negatively charged ion ..... [1]

[Total: 5]

6 A student has a mixture of solid ionic compounds.

The student adds the mixture to a beaker with water and stirs the contents of the beaker.

The beaker contains a colourless solution and an insoluble black solid.

(a) Draw a diagram to show how the student separates the colourless solution and the black solid.

Label the black solid and the colourless solution in your diagram.

[2]

(b) Fig. 6.1 and Fig. 6.2 describe some of the tests carried out on the colourless solution and the black solid respectively.

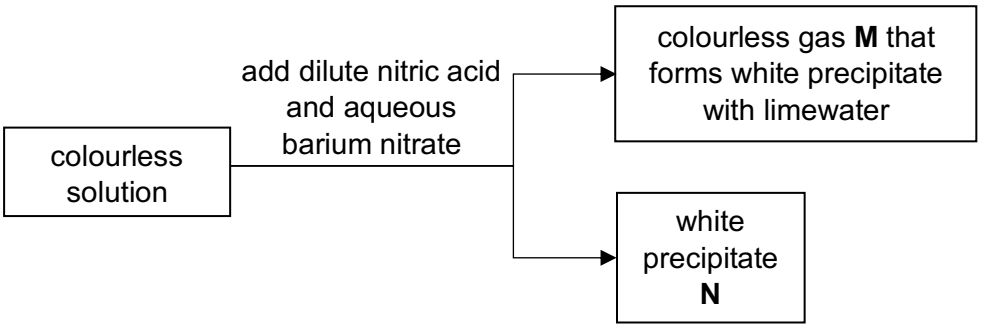


Fig. 6.1

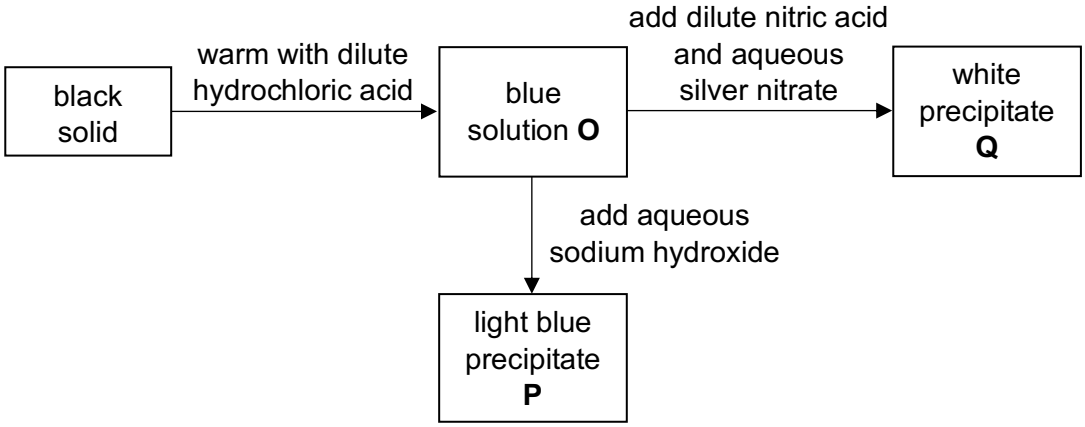


Fig. 6.2

Suggest the identity of substances **M**, **N**, **O**, **P** and **Q**.

M ……

N ……

O ……

P ……

Q …… [5]

(c) Write a balanced chemical equation, including state symbols, for any **one** of the reactions shown in Fig. 6.1 or Fig. 6.2.

…… [3]

[Total: 10]

7 Table 7.1 shows some information about the homologous series of carboxylic acids.

Table 7.1

name	structure	boiling point / °C
methanoic acid	HCOOH	101
ethanoic acid	CH_3COOH	118
propanoic acid	CH_3CH_2COOH	141
butanoic acid	$CH_3CH_2CH_2COOH$	164
pentanoic acid	$CH_3CH_2CH_2CH_2COOH$	186

(a) One of the characteristics of a homologous series is that it has a general formula.

(i) Deduce the general formula for the homologous series of carboxylic acids.

……..……..……..…….……..... [1]

(ii) Describe two other characteristics of a homologous series.

1 ……..

…….

2 ……..

..…….. [2]

(b) An aqueous solution of methanoic acid is a weak acid.

Define the term acid.

……..……..……..…….……....

……..……..……..…….……..... [1]

(c) Ethanoic acid is a liquid at room temperature.

Describe the changes in the arrangement and movement of the molecules of ethanoic acid when it is heated from room temperature to 120 °C.

……..……..……..…….……....

……..……..……..…….……....

……..……..……..…….……....

……..……..……..…….……....

……..……..……..…….……..... [3]

(d) A solution of propanoic acid has a concentration of 125 g/dm^3.

(i) Calculate the relative molecular mass of propanoic acid.

[Relative atomic masses: A_r: H, 1; C, 12; O, 16]

relative molecular mass = …… [1]

(ii) Calculate the concentration of the solution in mol/dm^3.

concentration = ……. mol/dm^3 [1]

(iii) Another solution of propanoic acid is made by diluting 1.0 mol to make 2 dm^3 of solution.

What is the concentration of this solution in mol/dm^3?

concentration = ……. mol/dm^3 [1]

[Total: 10]

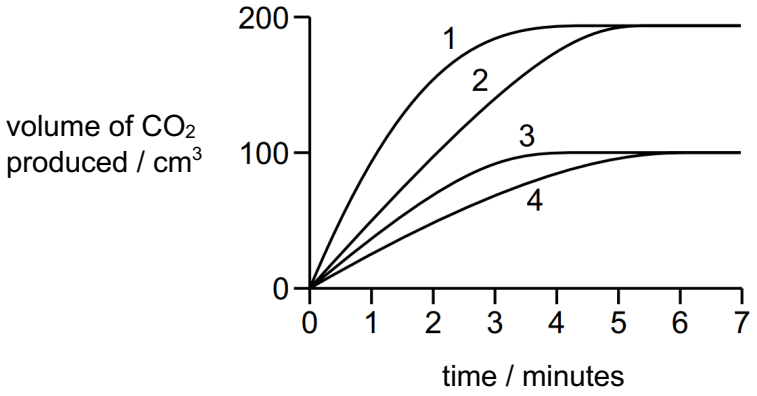
8 In four separate experiments, 1, 2, 3 and 4, excess marble chips containing $CaCO_3$ were added to aqueous nitric acid. The volume of carbon dioxide gas formed is measured at regular intervals. The chemical equation of the reaction is as follows:

$$CaCO_3 + 2\ HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$$

In all four experiments the same volume of nitric acid is used.

The concentration, or temperature, or both concentration and temperature of the nitric acid, are changed.

The results of the experiments are shown on the graph.



(a) Explain how speed of reaction will be affected if powdered marble was used instead of marble chips.

……

……

……

…… [2]

(b) Use the graph and your knowledge of reacting particles to explain the following statements.

(i) The temperature of the acid in experiment 4 is lower than in experiment 3.

……

……

……

…… [2]

(ii) A lower concentration of acid is used in experiment 3 than in experiment 1.

……

……

……

……

……

…… [3]

(c) 100 cm^3 of carbon dioxide gas was collected in experiment 4.

(i) Calculate the mass of marble chips used in experiment 4.

mass of marble chips …… g [2]

(ii) Hence, or otherwise, calculate the mass of marble chips used in experiment 2.

mass of marble chips …… g [1]

[Total: 10]

Section B

Answer **one** question from this section.

9 **(a)** The Periodic Table lists the elements in groups and periods.

With reference to electronic structure, explain this using calcium as an example.

……

……

…… [2]

(b) A sample of calcium is added to cold water.

Colourless aqueous calcium hydroxide and a colourless gas are formed.

(i) Name the gas formed in the reaction.

…… [1]

(ii) Aqueous calcium hydroxide is an alkali.

State the formula of the ion that causes the solution to be alkaline.

…… [1]

(iii) A pH meter is used to measure the pH of aqueous calcium hydroxide.

Describe another test that could be carried out to show that calcium hydroxide is alkaline.

……

……

…… [2]

(c) Potassium also reacts with cold water.

Compare the observations of the reaction of calcium and cold water with the reaction of potassium and cold water.

In your answer you should include at least one similarity and at least one difference.

……

……

……

……

……

…… [3]

(d) Calcium and argon have very different chemical reactivities.

Explain these differences.

……

…… [1]

[Total: 10]

10 (a) Naphtha is a fraction of crude oil. Naphtha is processed by cracking in an oil refinery.

One of the molecules in naphtha is a saturated hydrocarbon X containing 5 carbon atoms. When this molecule is cracked it produces propane, C_3H_8 and one other hydrocarbon Y.

(i) Explain why cracking of naphtha is an important process in oil refinery.

……..

……..

…… [2]

(ii) Draw the full structural formula for hydrocarbon X and Y.

hydrocarbon X	hydrocarbon Y

[2]

(iii) Describe one test that could be used to distinguish between a sample of hydrocarbon X and Y. Name the reagent used and the result obtained.

reagent ……...

result with hydrocarbon X …….

……..

result with hydrocarbon Y …….....

…… [2]

(iv) Hydrocarbon Y is used to make the addition polymer Z.

Draw the full structural formula of two repeating units in polymer Z.

Show **all** bonds.

[2]

(b) Margarine is made from liquid vegetable oil.

Hydrogen is bubbled through the vegetable oil at 140 °C in the presence of nickel catalyst. After some time, the oil starts to solidify producing polyunsaturated margarine.

(i) Explain the meaning of polyunsaturated.

……..

…… [1]

(ii) Explain what happens to the chemical structure of the oil as the margarine is formed.

……..

…… [1]

[Total : 10]

Data Sheet

Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
zinc hydroxide	white

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											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 –

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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}