MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION
General Certificate of Education Ordinary Level

CANDIDATE NAME									
CENTRE NUMBER	S					INDEX NUMBER			

0123456789

SCIENCE (PHYSICS, CHEMISTRY) 5086/03

Paper 3 Chemistry **For examination from 2024**

SPECIMEN PAPER

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number and name 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.
DO **NOT** WRITE ON ANY BARCODES.

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 21.
A copy of the Periodic Table is printed on page 22.

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

Singapore Examinations and Assessment Board

Cambridge Assessment International Education

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Section A

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

1 Fig. 1.1 shows a piece of chromatography paper with five spots of coloured dyes, **A**, **B**, **C**, **D** and **E**.

Spot **Z** is a coloured dye that contains poisons and should not be used in foods.

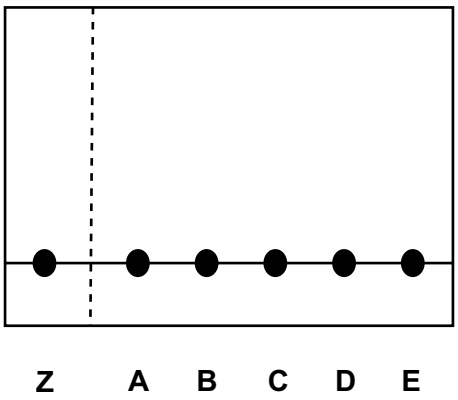

Fig. 1.1

The coloured dyes are separated into their components using chromatography using an ethanol solvent.

The resulting chromatogram is shown in Fig. 1.2.

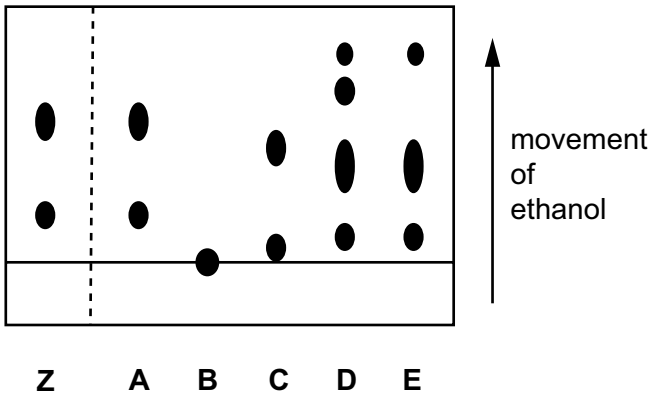

Fig. 1.2

(a) State which of the coloured dyes, **A**, **B**, **C**, **D** or **E**, is insoluble in ethanol.

..... [1]

(b) State which of the coloured dyes, **A**, **B**, **C**, **D** or **E**, is a mixture of only three components.

..... [1]

(c) State which of the coloured dyes, **A**, **B**, **C**, **D** or **E**, should not be used to colour food.

..... [1]

(d) Which two of the coloured dyes, **A**, **B**, **C**, **D** and **E**, contain the same three components?

..... and ..... [1]

[Total: 4]

2 Sulfur dioxide and carbon dioxide are both gases found in the atmosphere.

(a) Sulfur dioxide is an atmospheric pollutant.

(i) State a major source of atmospheric sulfur dioxide.

..... [1]

(ii) Describe one effect of atmospheric sulfur dioxide on the environment.

.....

..... [1]

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

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

.....

.....

.....

.....

.....

..... [3]

(ii) The percentage by volume of carbon dioxide in the atmosphere is slowly increasing.

Explain a possible effect of this increase.

.....

.....

..... [2]

[Total: 7]

3 Fig. 3.1 describes some of the substances that result from the reactions of a metal **R**.

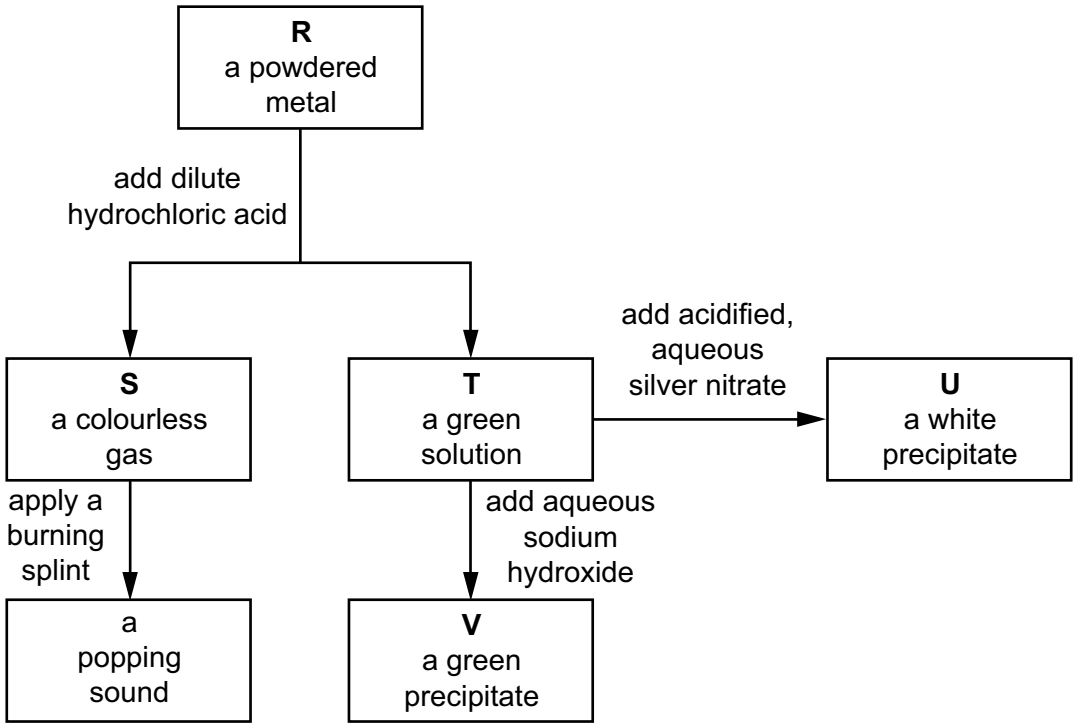

Fig. 3.1

(a) Identify **R**, **S**, **T**, **U** and **V**.

R .....

S .....

T .....

U .....

V .....

[5]

(b) Write a balanced chemical equation, with state symbols, for any **one** of the reactions in Fig. 3.1.

..... [3]

[Total: 8]

4 Indigestion tablets react with sulfuric acid to form carbon dioxide gas.

The rate of reaction is found by measuring the total volume of carbon dioxide formed at regular intervals.

In an investigation, ten tablets are added to an excess of sulfuric acid at a fixed temperature **G**.

The experiment is repeated two more times but at different temperatures, **H** and **I**. All other conditions are kept constant.

Fig. 4.1 shows the results of these three experiments.

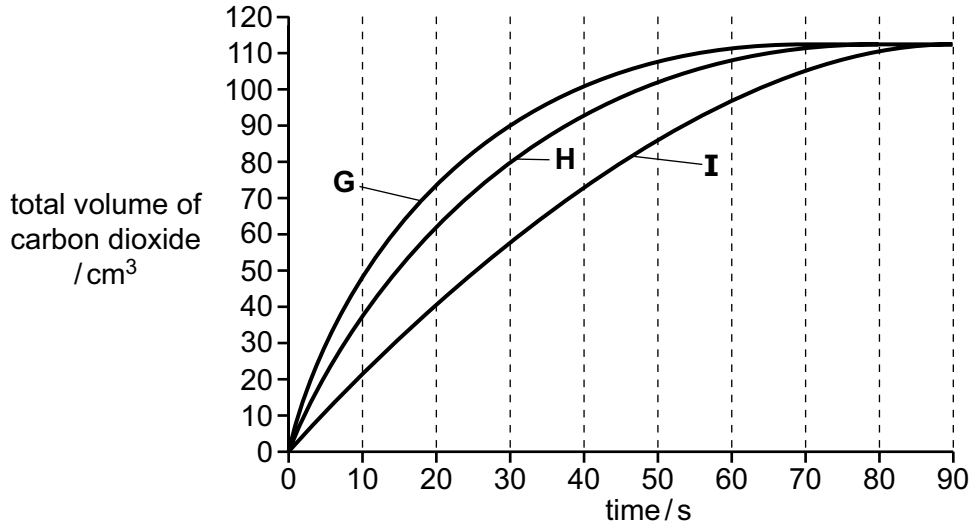

Fig. 4.1

(a) State which temperature, **G**, **H** or **I**, is the highest.

Use information from Fig. 4.1 to explain your answer.

highest temperature .....

explanation .....

.....

.....

[2]

(b) The experiment with acid at temperature **I** is repeated.

In this experiment, **five** tablets instead of ten tablets are used.

Predict the shape of the curve expected in this experiment by drawing it on Fig 4.1. [2]

(c) The experiment with acid at temperature **I** is repeated. In this experiment, the ten tablets added were finely powdered.

Deduce and explain the effect of this change on the rate of reaction.

.....

.....

.....

..... [2]

[Total: 6]

5 Table 5.1 contains information about seven different particles.

The letters are **not** the chemical symbols.

Table 5.1

	J	**K**	**L**	**M**	**N**	**O**	**P**
nucleon number	3	10	11	14	19	23	35
proton number	2	5	5	7	10	11	17
number of electrons	2	5	5	7	10	10	18

(a) State which particle, **J**, **K**, **L**, **M**, **N**, **O** or **P** from Table 5.1:

(i) has only one neutron

..... [1]

(ii) is a positive ion

..... [1]

(iii) is an atom of an element in Group 15.

..... [1]

(b) Two of the particles in Table 5.1 are isotopes of the same element.

(i) Define the term isotopes.

.....

.....

..... [2]

(ii) Identify the two particles that are isotopes of the same element.

..... and ..... [1]

[Total: 6]

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6 The structures of some organic compounds are shown in Fig. 6.1.

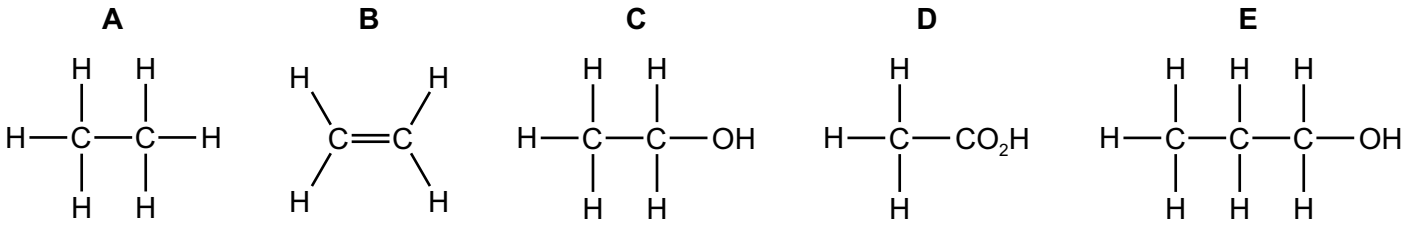

Fig. 6.1

(a) Identify which one of these compounds is a carboxylic acid.

..... [1]

(b) Compound **B** is an unsaturated hydrocarbon.

(i) State the meaning of the term unsaturated.

.....

..... [1]

(ii) State the meaning of the term hydrocarbon.

.....

..... [1]

(iii) Describe a chemical test for an unsaturated hydrocarbon.

test .....

result .....
[2]

(c) The structure of an addition polymer is shown.

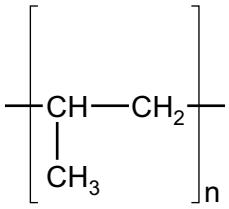

Fig. 6.2

Give the name and structure of the monomer used to make this polymer.

name .....

structure

[2]

(d) Poly(ethene) is another addition polymer.

Describe one physical method and one chemical method used to recycle poly(ethene).

physical method .....

.....

chemical method .....

.....

[2]

[Total: 9]

7 Chlorine and iodine are in Group 17 of the Periodic Table.

(a) Name one **other** element in Group 17.

..... [1]

(b) Aqueous chlorine is an oxidising agent.

Chlorine gas is bubbled into aqueous potassium iodide.

(i) Construct the ionic equation for the reaction of chlorine gas with aqueous iodide ions.

..... [1]

(ii) Describe the colour change that happens during the reaction.

..... [1]

(c) Chlorine reacts with hydrogen sulfide to form hydrogen chloride gas as shown in the equation.

$$Cl_2(g) + H_2S(g) \rightarrow 2HCl(g) + S(s)$$

Calculate the volume of chlorine needed to form 3000 dm^3 of hydrogen chloride gas.

All gas volumes are measured at room temperature and pressure.

volume of chlorine = ... dm^3 [2]

[Total: 5]

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8 Carbon dioxide, CO_2, and calcium chloride, $CaCl_2$, have different structures and bonding.

(a) Carbon dioxide has a relative molecular mass of 44.

Define the term relative molecular mass.

.....

.....

..... [2]

(b) Carbon dioxide and calcium chloride have different arrangement of electrons.

(i) State the electronic configuration of carbon and of calcium.

carbon .....

calcium .....
[2]

(ii) Draw a 'dot-and-cross' diagram to show the arrangement of the outer shell electrons in a molecule of carbon dioxide.

[2]

(iii) Draw a 'dot-and-cross' diagram to show the arrangement of the outer shell electrons in calcium chloride.

[2]

(c) Liquid (molten) calcium chloride conducts electricity but solid calcium chloride does **not**.

Explain this difference in electrical conductivity.

.....

.....

..... [1]

(d) Explain why carbon dioxide does **not** conduct electricity in any physical state.

.....

..... [1]

[Total: 10]

[Turn over

Section B

Answer **one** question from this section.

9 Tantalum, Ta, has physical properties similar to most other metals.

(a) State three physical properties typical of metals.

1 .....

2 .....

3 .....
[3]

(b) Tantalum is manufactured by converting its ore into potassium heptafluorotantalate, $K_2[TaF_7]$.

This compound is then reacted with sodium to make tantalum as shown in the equation.

$$K_2[TaF_7] + 5Na \rightarrow Ta + 5NaF + 2KF$$

(i) The reaction is exothermic.

Suggest what would be observed in the reaction.

..... [1]

(ii) State if the sodium has been oxidised, reduced or neither oxidised nor reduced.

Explain your answer.

.....

.....

..... [2]

(iii) Calculate the mass of one mole of potassium heptafluorotantalate, $K_2[TaF_7]$.

[Relative atomic masses: A_r: F, 19; K, 39; Ta, 181]

mass = ... g [1]

(iv) Calculate the mass of sodium needed to extract 2000 g of tantalum from potassium heptafluorotantalate.

mass = ... g [2]

(c) Both carbon and zinc react with tantalum oxide to form tantalum.

State what this indicates about the relative chemical reactivity of tantalum.

..... [1]

[Total: 10]

10 Calcium is a metal in Group 2 of the Periodic Table.

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

Colourless aqueous calcium hydroxide, $Ca(OH)_2$, 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.

Suggest a pH value for aqueous calcium hydroxide.

..... [1]

(iv) Describe one **other** way in which the pH of aqueous calcium hydroxide is measured.

.....

.....

..... [2]

(b) A sample of 0.300 dm^3 of aqueous calcium hydroxide is added to an excess of hydrochloric acid.

(i) The concentration of the aqueous calcium hydroxide is 0.150 mol/dm^3.

Calculate the number of moles of calcium hydroxide in the sample.

number of moles = ... mol [1]

(ii) The equation for the reaction between aqueous calcium hydroxide and hydrochloric acid is shown.

$$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

Deduce the number of moles of hydrochloric acid that react with the calcium hydroxide.

number of moles = ... mol [1]

(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]

[Total: 10]

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