



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

CANDIDATE
NAME

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CENTRE
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INDEX
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SCIENCE (CHEMISTRY, BIOLOGY)

5088/03

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.

This document consists of **19** printed pages and **3** blank pages.



Singapore Examinations and Assessment Board



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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.

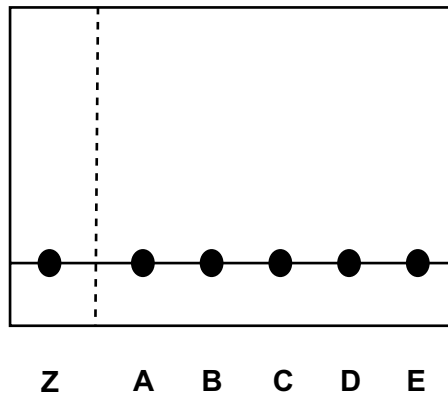


Fig. 1.1

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

The resulting chromatogram is shown in Fig. 1.2.

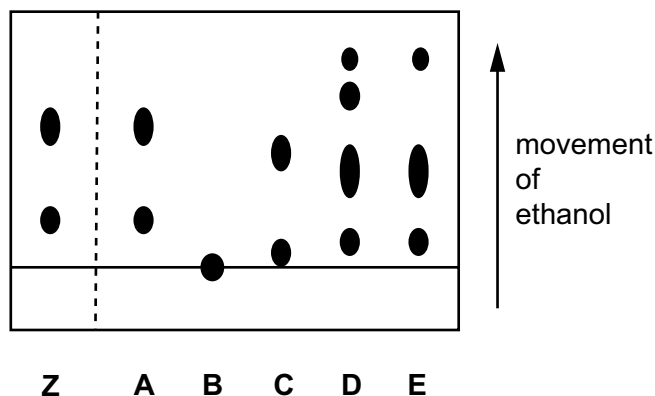


Fig. 1.2

- (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**.

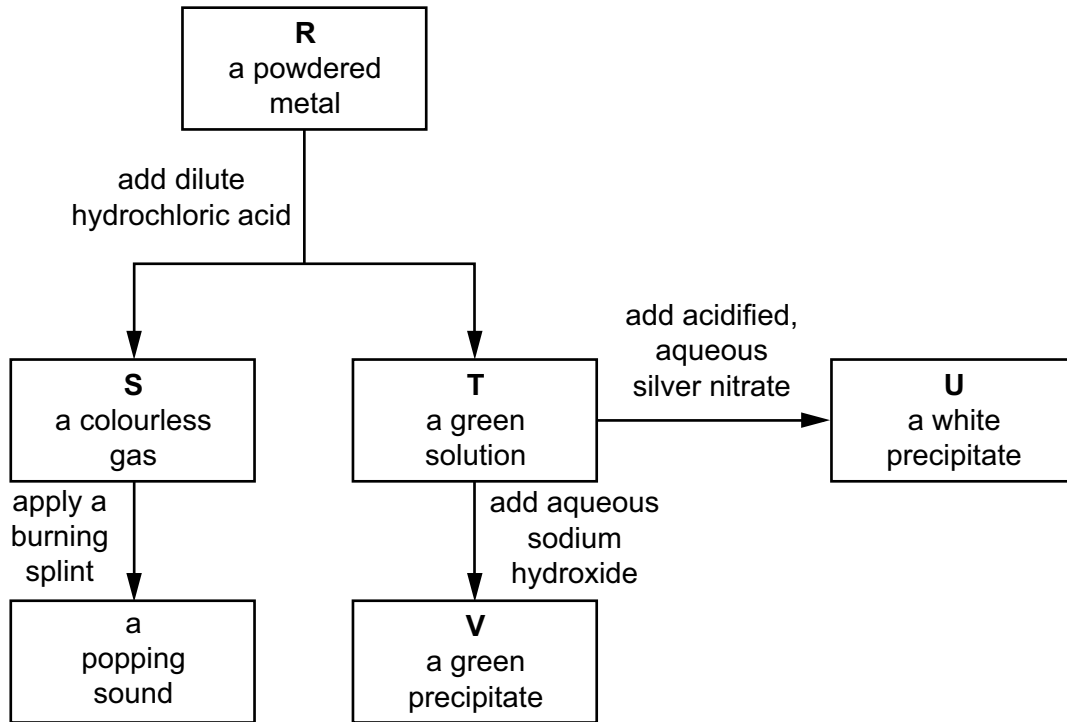


Fig. 3.1

(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.

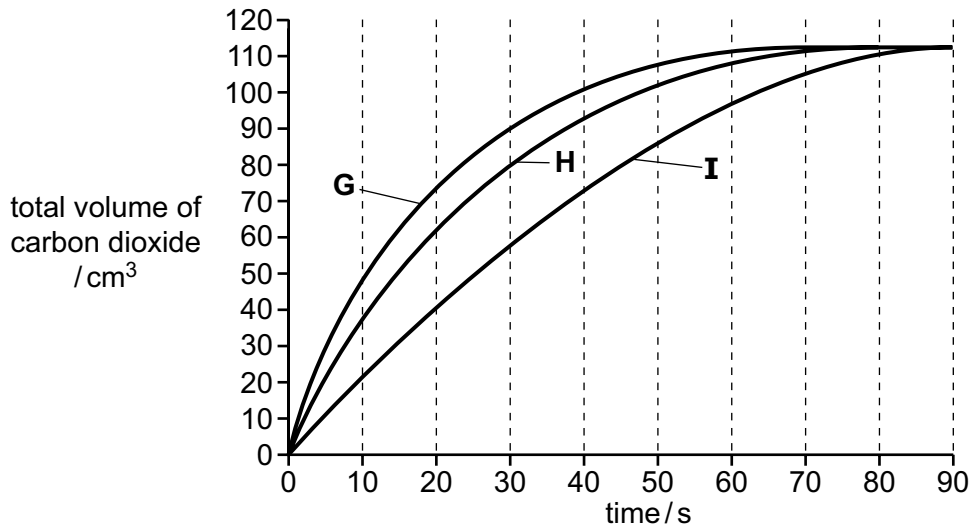


Fig. 4.1

(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.

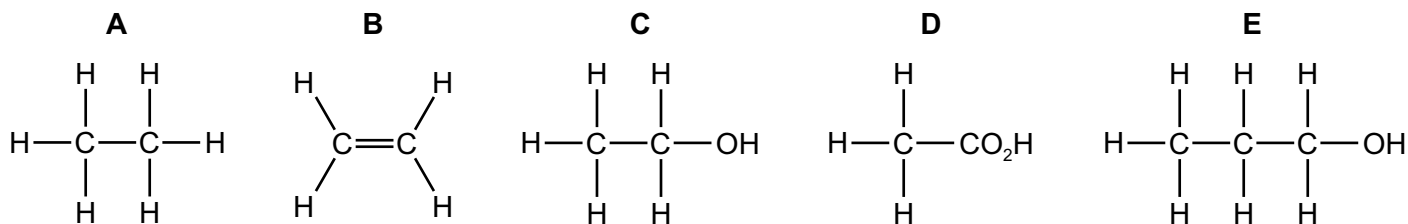


Fig. 6.1

(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.

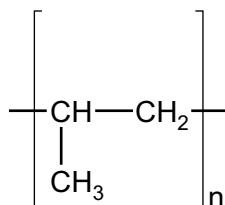


Fig. 6.2

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.

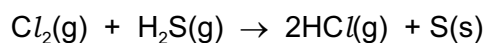
(i) Construct the ionic equation for the reaction of chlorine gas with aqueous iodide ions.

..... [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.



Calculate the volume of chlorine needed to form 3000 dm³ of hydrogen chloride gas.

All gas volumes are measured at room temperature and pressure.

volume of chlorine = dm³ [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]

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

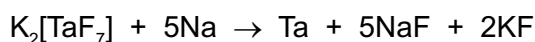
2

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.



(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 2000g 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]

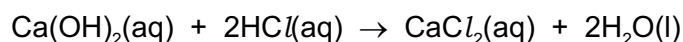
(b) A sample of 0.300 dm^3 of aqueous calcium hydroxide is added to an excess of hydrochloric acid.

(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.



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]

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 |

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The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-------|---|---|---|---|---|---|---|---|---|---|----|----|----|-----------|-----------|------------|-------------|------------|-----------|--|--|--|--|--|--|--|
| 1 | 2 | Key | | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 | | | | | | | |
| | | proton (atomic) number atomic symbol name relative atomic mass | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 5 | 6 | 7 | 8 | 9 | 10 | | | | | | | |
| | | | | | | | | | | | | | | B | C | N | O | F | He | | | | | | | |
| | | | | | | | | | | | | | | boron | carbon | nitrogen | oxygen | fluorine | helium | | | | | | | |
| | | | | | | | | | | | | | | 11 | 12 | 14 | 16 | 19 | 4 | | | | | | | |
| | | | | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 20 | | | | | | | |
| | | | | | | | | | | | | | | Al | Si | P | S | Cl | Ne | | | | | | | |
| | | | | | | | | | | | | | | aluminium | silicon | phosphorus | sulfur | chlorine | argon | | | | | | | |
| | | | | | | | | | | | | | | 27 | 28 | 31 | 32 | 35.5 | 40 | | | | | | | |
| | | | | | | | | | | | | | | 31 | 32 | 33 | 34 | 35 | 36 | | | | | | | |
| | | | | | | | | | | | | | | Ga | Ge | As | Se | Br | Kr | | | | | | | |
| | | | | | | | | | | | | | | gallium | germanium | arsenic | selenium | bromine | krypton | | | | | | | |
| | | | | | | | | | | | | | | 70 | 73 | 75 | 79 | 80 | 84 | | | | | | | |
| | | | | | | | | | | | | | | 49 | 50 | 51 | 52 | 53 | 54 | | | | | | | |
| | | | | | | | | | | | | | | In | Sn | Sb | Te | I | Xe | | | | | | | |
| | | | | | | | | | | | | | | indium | tin | antimony | tellurium | iodine | xenon | | | | | | | |
| | | | | | | | | | | | | | | 115 | 119 | 122 | 128 | 127 | 131 | | | | | | | |
| | | | | | | | | | | | | | | 81 | 82 | 83 | 84 | 85 | 86 | | | | | | | |
| | | | | | | | | | | | | | | Tl | Pb | Bi | Po | At | Rn | | | | | | | |
| | | | | | | | | | | | | | | thallium | lead | bismuth | polonium | astatine | radon | | | | | | | |
| | | | | | | | | | | | | | | 204 | 207 | 209 | — | — | — | | | | | | | |
| | | | | | | | | | | | | | | 113 | 114 | 115 | 116 | 117 | 118 | | | | | | | |
| | | | | | | | | | | | | | | Nh | Fl | Mc | Lv | Ts | Og | | | | | | | |
| | | | | | | | | | | | | | | nihonium | flerovium | moscovium | livermorium | tennessine | oganesson | | | | | | | |
| | | | | | | | | | | | | | | — | — | — | — | — | — | | | | | | | |
| | | | | | | | | | | | | | | — | — | — | — | — | — | | | | | | | |

| | | | | | | | | | | | | | | | |
|-------------|------------------------|----------------------|---------------------------|------------------------|-----------------------|-----------------------|-----------------------|-------------------------|----------------------|-------------------------|------------------------|---------------------|------------------------|------------------------|-----------------------|
| lanthanoids | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 |
| | La lanthanum 139 | Ce cerium 140 | Pr praseodymium 141 | Nd neodymium 144 | Pm promethium — | Sm samarium 150 | Eu europium 152 | Gd gadolinium 157 | Tb terbium 159 | Dy dysprosium 163 | Ho holmium 165 | Er erbium 167 | Tm thulium 169 | Yb ytterbium 173 | Lu lutetium 175 |
| actinoids | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |
| | Ac actinium — | Th thorium 232 | Pa protactinium 231 | U uranium 238 | Np neptunium — | Pu plutonium — | Am americium — | Cm curium — | Bk berkelium — | Cf californium — | Es einsteinium — | Fm fermium — | Md mendelevium — | No nobelium — | 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, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$.