



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 (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.

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.

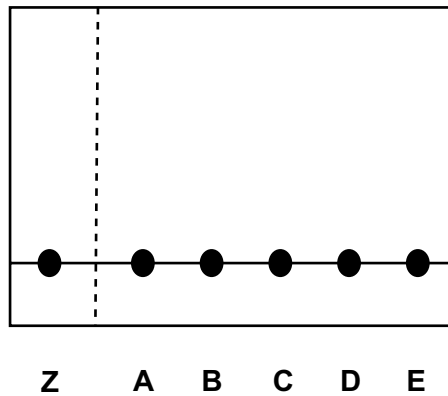


Fig. 1.1

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

The resulting chromatogram is shown in Fig. 1.2.

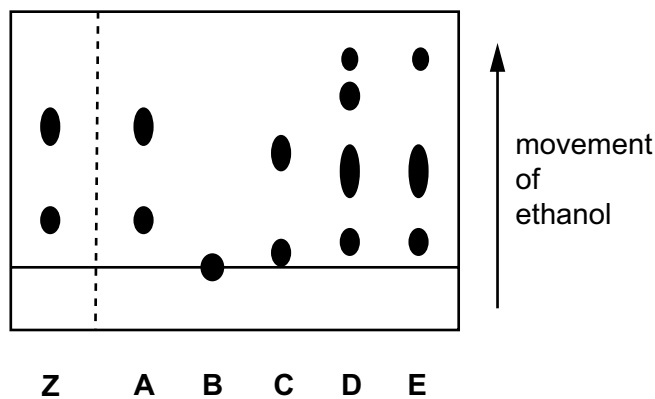


Fig. 1.2

- (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**.

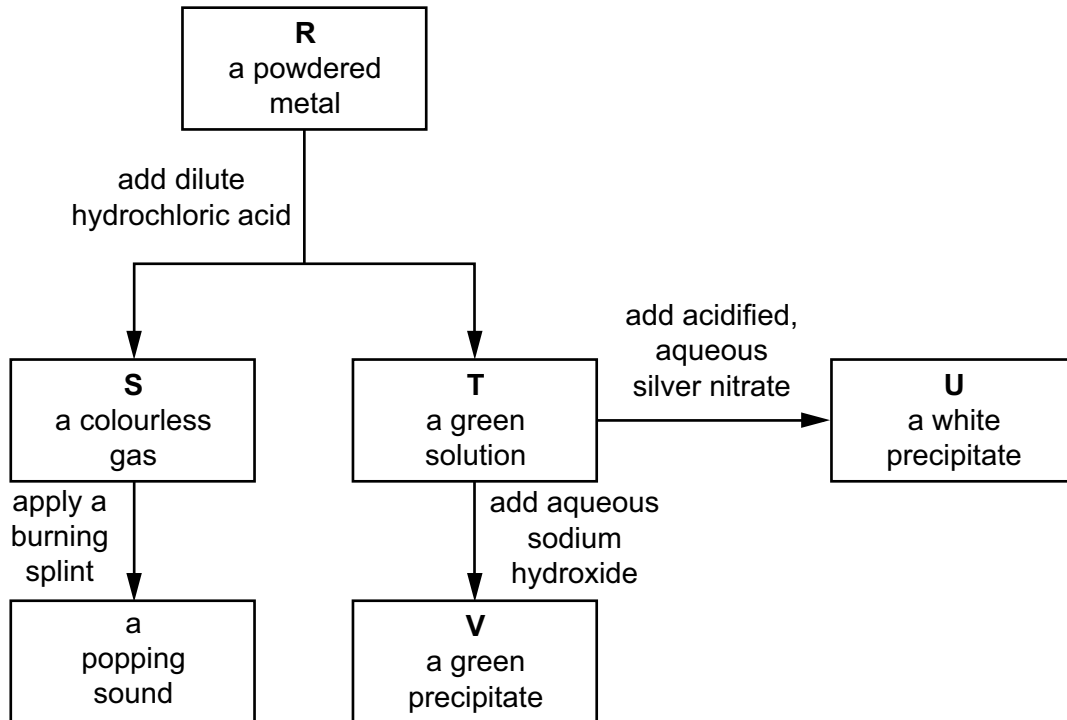


Fig. 3.1

(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.

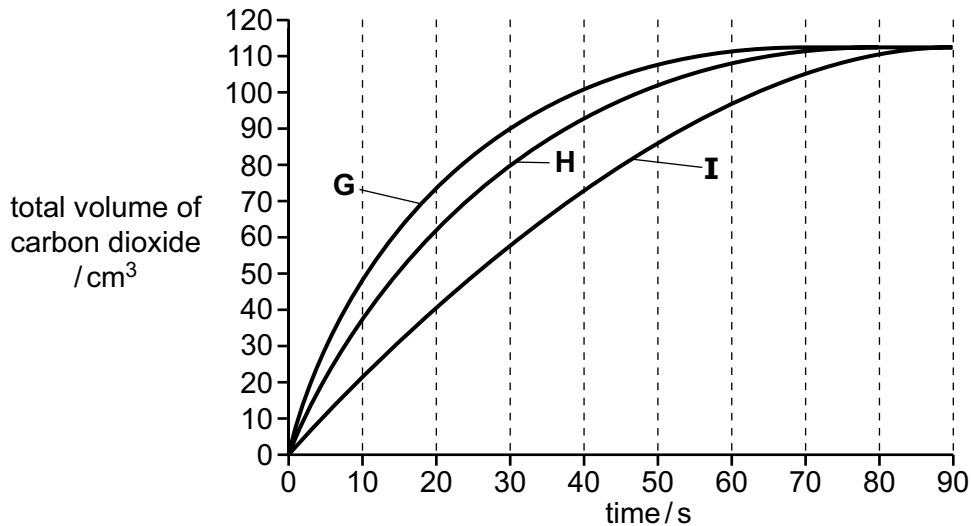


Fig. 4.1

(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.

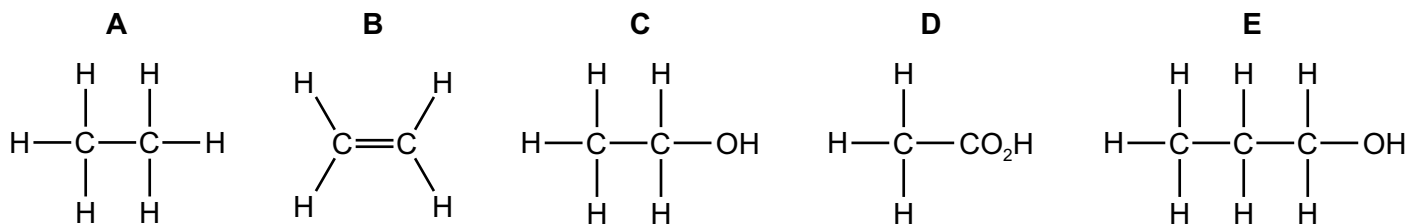


Fig. 6.1

(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.

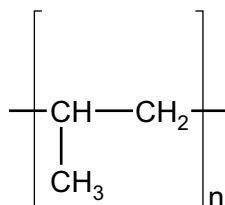


Fig. 6.2

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.

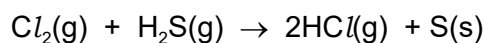
(i) Construct the ionic equation for the reaction of chlorine gas with aqueous iodide ions.

..... [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]

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

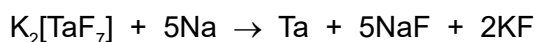
2

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, $\text{Ca}(\text{OH})_2$, 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]

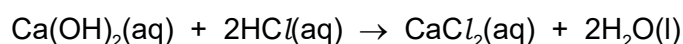
(b) A sample of 0.300 dm^3 of aqueous calcium hydroxide is added to an excess of hydrochloric acid.

(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								
		1	proton (atomic) number atomic symbol name relative atomic mass																								
		1	H hydrogen 1																								
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18												
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20	Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40												
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36										
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59	Cu copper 64	Zn zinc 65	Ga gallium 70	Ge germanium 73	As arsenic 75	Se selenium 79	Br bromine 80	Kr krypton 84										
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54										
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106	Ag silver 108	Cd cadmium 112	In indium 115	Sn tin 119	Sb antimony 122	Te tellurium 128	I iodine 127	Xe xenon 131										
55	56	57–71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86										
Cs caesium 133	Ba barium 137	lanthanoids	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium —	At astatine —	Rn radon —										
87	88	89–103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118										
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Nh nihonium —	Fl flerovium —	Mc moscovium —	Lv livermorium —	Ts tennessine —	Og 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, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$.