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

CANDIDATE NAME: Suggested Answers [Overmugged - Shannon]

CENTRE NUMBER: S

INDEX NUMBER

* 4 9 8 2 8 7 7 9 0 6 *

SCIENCE (PHYSICS, CHEMISTRY)

5086/03

Paper 3 Chemistry

October/November 2024

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, tables 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 19.
A copy of the Periodic Table is printed on page 20.

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

DC (DE/SW) 331933/4

[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.

calcium carbonate

calcium chloride

carbon monoxide

chlorine

neon

nickel

oxygen

potassium iodide

potassium nitrate

water

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

Identify the substance which:

(a) relights a glowing splint

oxygen

..... [1]

(b) reacts with a mixture of warm aqueous sodium hydroxide and aluminium to give a gas that turns damp red litmus paper blue

potassium nitrate

..... [1]

(c) is an unreactive element.

neon

..... [1]

[Total: 3]

2 Complete Table 2.1 with the method of separation used to produce a sample of **each** of the components in the named mixtures.

Table 2.1

mixture	method of separation
coloured inks	chromatography / paper chromatography
crude oil	fractional distsillation
salt and water	simple distillation
sand and water	filtration

crystallisation and evaporation to dryness is incorrect

[4]

3 A bromide ion has the formula shown.

$$^{79}_{35}Br^{-}$$

Complete Table 3.1 to show how many of each type of particle this bromide ion contains.

Table 3.1

particle	number
proton	35
neutron	44
electron	36

[3]

4 Aqueous calcium hydroxide is an alkaline solution.

Dilute hydrochloric acid is an acidic solution.

(a) State the formula of the ion present in all alkaline solutions.

OH^- [1]

(b) State the formula of the ion present in all acidic solutions.

H^+ [1]

(c) Using a pH meter, the pH of aqueous calcium hydroxide is determined to be 9.

Describe one **other** method to determine the pH of aqueous calcium hydroxide. Suggest the observed result.

method Add a few drops of universal indicator.

observation The universal indicator will turn from green to blue. [2]

(d) State **one** use for calcium hydroxide in farming.

Neutralise the acid in the soil due to acid rain / Increase the pH of the soil. [1]

(e) Aqueous calcium hydroxide and dilute hydrochloric acid are used to produce gases.

Complete Table 4.1 to identify the gas produced in each reaction.

Table 4.1

reaction	gas produced
aqueous calcium hydroxide and ammonium chloride	ammonia / NH_3
dilute hydrochloric acid and calcium carbonate	carbon dioxide / CO_2

[2]

[Total: 7]

5 One of the characteristics of the homologous series of alcohols is that its members have the same general formula.

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

1 Similar chemical properties

2 Gradual change in physical properties.

Same functional group. [2]

(b) Complete Table 5.1 about some alcohols.

Table 5.1

name	molecular formula	structure
methanol	CH_4O	CH_3OH
ethanol	C_2H_6O	CH_3CH_2OH
propanol	C_3H_8O	$CH_3CH_2CH_2OH$

C_2H_5OH is incorrect

[3]

(c) Deduce the general formula for the homologous series of alcohols.

$C_nH_{2n+1}OH$ [1]

(d) Aqueous ethanol is manufactured by the fermentation of glucose.

State **two** conditions needed for fermentation.

1 37°C / room temperature

2 Absence of oxygen / No oxygen

[2]

(e) Vinegar is an aqueous solution of ethanoic acid.

(i) Name a substance required to convert ethanol into ethanoic acid.

Oxygen / Acidified Potassium manganate(VII) [1]

(ii) The structure of alcohols contains the –OH group.

Ethanoic acid is a carboxylic acid.

Use the structure of ethanoic acid to explain why it is a carboxylic acid.

It contains the -COOH group.

[1]

[Total: 10]

6 Fig. 6.1 describes the reaction of solid **R** with acid **S** to form solution **T** and hydrogen.

It also shows some of the reactions of solution **T**.

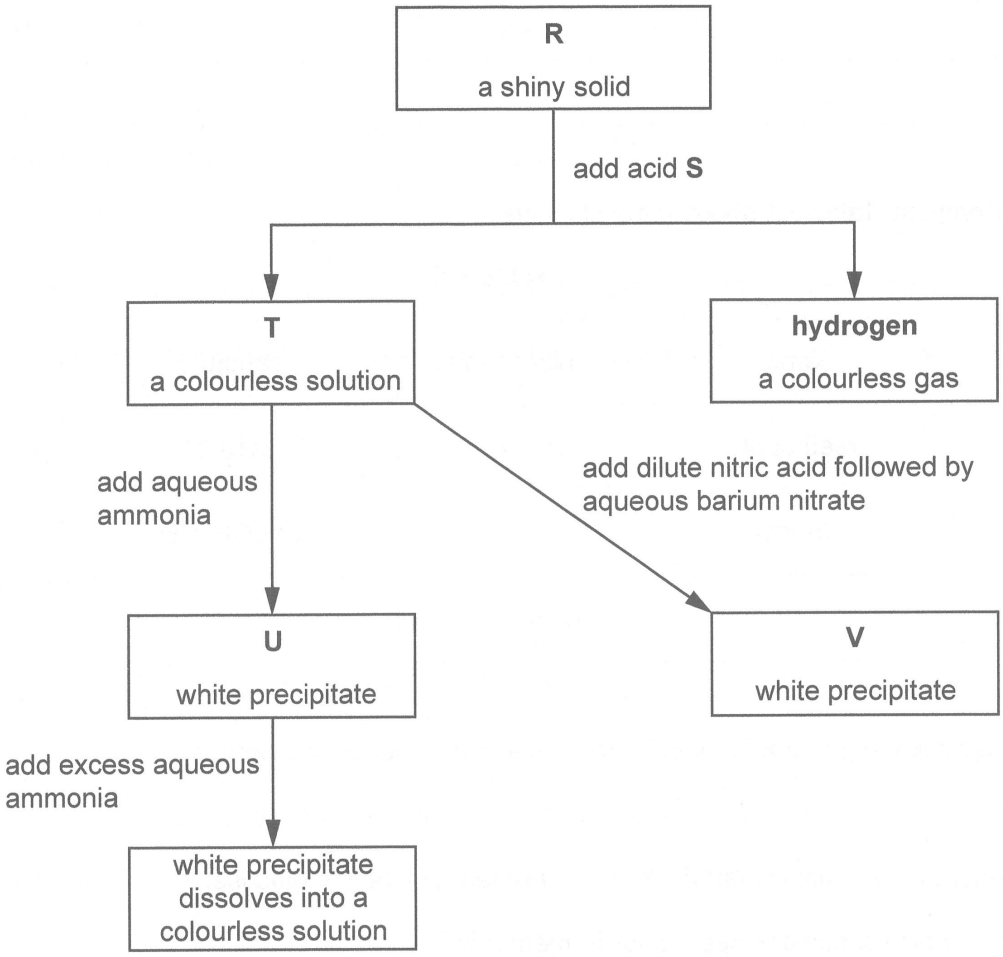


Fig. 6.1

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

R zinc Zn

S sulfuric acid H_2SO_4

T zinc sulfate $ZnSO_4$

U zinc hydroxide $Zn(OH)_2$

V barium sulfate $BaSO_4$

[5]

(b) Write a balanced chemical equation, including state symbols, for any of the reactions shown in Fig. 6.1.

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$ [3]

$ZnSO_4(aq) + Ba(NO_3)_2(aq) \rightarrow Zn(NO_3)_2(aq) + BaSO_4(s)$ [Total: 8]

7 In 1950, carbon dioxide contributed 0.031% by volume of clean dry air. The percentage is now 0.041%.

(a) State **one** effect on the environment of this change to the percentage of carbon dioxide in the air.

Higher percentage of carbon dioxide will lead to global warming / increase in Earth's average temperature. [1]

(b) Briefly describe how the carbon cycle regulates the amount of carbon dioxide in the atmosphere.

Carbon dioxide is produced during respiration and combustion of carbon-containing fuels. However, carbon dioxide is absorbed during photosynthesis of plant growth. Hence, the amount of carbon dioxide remains about the same. [2]

[Total: 3]

8 Calcium, iron, magnesium and silver are all metals.

(a) Describe **two** general physical properties of metals.

1 High melting point and boiling point

2 Malleable / Ductile

Good conductor of electricity.

Higher melting point and boiling point is accepted as question stated general.

[2]

(b) State the name of the type of mixture that contains a metal with other elements.

Alloy [1]

(c) Describe how the order of reactivity of calcium, iron, magnesium and silver is experimentally determined.

Add hydrochloric acid into a conical flask and add calcium powder into it.

Immediately connect a gas syringe and measure the volume of gas produced in 30 seconds.

Repeat steps 1 and 2 using the same mass of metal powder for the other three metals and use the same concentration and volume of hydrochloric acid.

The more reactive the metal, the higher the volume of gas (hydrogen) produced in 30 seconds.

Note:

The size of the metal used can affect the rate of reaction. Hence, it is important to standardise the size (powder).

Reaction between steam and calcium is quite dangerous. I am not sure if Cambridge will award full credit but you are likely to get marks for the idea. [4]

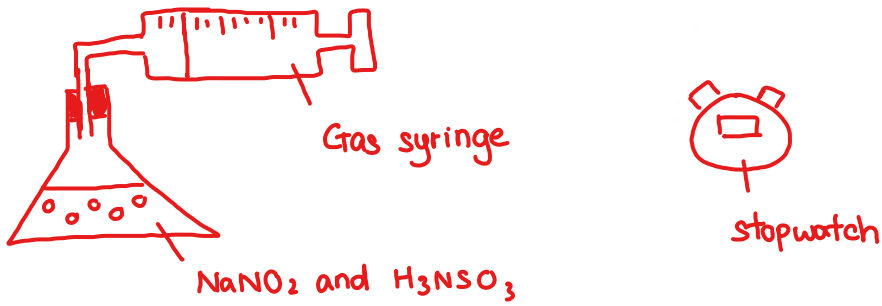
[Total: 7]

9 Sodium nitrite, $NaNO_2$, reacts with sulfamic acid, H_3NSO_3, as shown in the equation.

$$NaNO_2(aq) + H_3NSO_3(aq) \rightarrow N_2(g) + NaHSO_4(aq) + H_2O(l)$$

(a) The rate of this reaction is determined by measuring the volume of nitrogen produced every 10 s.

Draw a labelled diagram of the assembled apparatus required to measure the volume of nitrogen produced.



[2]

(b) Describe **two** changes to the conditions and explain how they increase the rate of this reaction.

Use ideas about particles in your answer.

Increase the temperature of sodium nitrite and sulfamic acid. At higher temperature, the reactant particles have higher kinetic energy and collide with each other more often. This leads to higher frequency of effective collision and faster rate of reaction.

Use higher concentration of sulfamic acid. When concentration increases, there are more reactant particles per unit volume. This leads to higher frequency of effective collision and faster rate of reaction. [3]

(c) Describe and explain how you would identify when this reaction is completed.

There will be no more effervescence/bubbles observed.

[OR] Volume of gas syringe does not increase further. [1]

(d) In one experiment, 0.97 g of sulfamic acid is reacted with excess sodium nitrite.

(i) Calculate the amount, in moles, of sulfamic acid, H_3NSO_3, used in the experiment.

[A_r: H, 1; N, 14; S, 32; O, 16]

mol of H_3NSO_3 = $\frac{0.97}{3+14+32+3(16)}$

= 0.01 mol

1 mark for correct Mr calculation / working.

1 mark for correct final answer

amount = 0.01 mol [2]

(ii) Deduce the amount, in moles, of nitrogen formed in the reaction.

Calculate the volume of nitrogen, measured at room temperature and pressure, formed in the reaction.

[One mole of any gas at room temperature and pressure has a volume of 24 dm^3.]

H_3NSO_3 : N_2

1 : 1

0.01 : 0.01

0.01 × 24 = 0.24 dm^3

amount = 0.01 mol

volume = 0.24 dm^3

[2]

[Total: 10]

Section B

Answer **one** question from this section.

Write your answers in the spaces provided.

10 Ethene is a covalent compound with a simple molecular structure shown in Fig. 10.1.

Fig. 10.1 shows the structure of ethene.

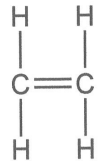


Fig. 10.1

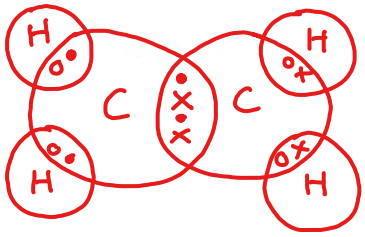
(a) Describe what is meant by a covalent bond.

A covalent bond is a chemical bond formed due to the sharing of electrons between two atoms.

..... [1]

(b) Draw a 'dot-and-cross' diagram to show the bonding in an ethene molecule.

Show only the outer shell electrons.



o : e⁻ of H

• : e⁻ of C₁

x : e⁻ of C₂

Can use same symbol for C as well.

[2]

(c) Suggest **two** physical properties of ethene.

1 Low melting point and boiling point .....

2 Cannot conduct electricity in any states .....

[2]

(d) Ethene is an unsaturated hydrocarbon.

(i) Explain why ethene is unsaturated.

It contains carbon-carbon double bond.

..... [1]

(ii) State the name of a reagent used to test for unsaturated hydrocarbons.

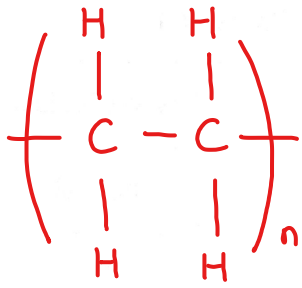
Aqueous bromine / Bromine solution / Bromine water

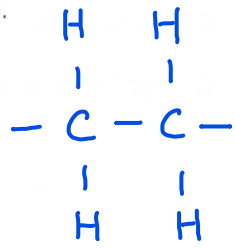
..... [1]

(e) A plastic is made of poly(ethene) molecules.

Poly(ethene) is an addition polymer made from ethene monomers.

(i) Draw the structure of poly(ethene).





1 mark if this is seen in your answer

[2]

(ii) Describe **one chemical** method of recycling plastics.

Plastics can be cracked to form shorter chain alkanes and alkenes.

..... [1]

[Total: 10]

11 Sodium is a reactive metal and chlorine is a reactive non-metal.

(a) Explain why sodium is a metal and chlorine is a non-metal. Answer in terms of electronic configuration.

Sodium atom and chlorine atom has an electronic configuration of 2.8.1 and 2.8.7 respectively.

Since sodium atom will gain electron while chlorine atom will lose electrons instead of gaining electrons, sodium is a metal and chlorine is a non-metal.

New Syllabus LO:

[2]

Relate metallic properties to number of valence electrons and tendency to lose electrons.

(b) Sodium has an oxide, Na_2O.

Chlorine has an oxide, Cl_2O_7.

Complete Table 11.1 about these oxides.

Table 11.1

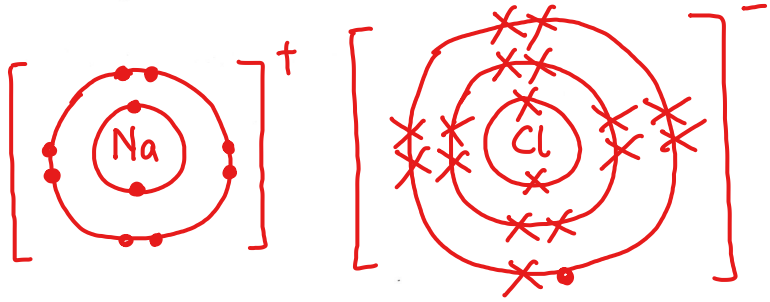
oxide	type of oxide
CO	neutral
Cl_2O_7	acidic
Na_2O	basic

[2]

(c) Sodium reacts with chlorine to form the ionic compound sodium chloride.

(i) Draw a 'dot-and-cross' diagram to show the arrangement of all the electrons in sodium chloride. [Proton numbers: Na, 11; Cl, 17]

Include the charge on each ion.



[2]

(ii) Explain why sodium chloride conducts electricity when molten but **not** when solid.

The electrostatic forces of attraction between oppositely charged ions are weaker in the molten state and there are mobile ions to act as charge carriers.

[1]

(iii) The reaction between sodium and chlorine is exothermic.

State the meaning of the term exothermic.

Exothermic means heat is released/lost to the surrounding.

..... [1]

(d) Fluorine is a halogen in the same group as chlorine.
Fluorine reacts with iodide ions as shown in the equation.

$$F_2 + 2I^- \rightarrow I_2 + 2F^-$$

Explain why this reaction involves both oxidation and reduction.

Use ideas about electron transfer in your answer.

I^- is oxidised as it lost electrons to form I_2.

F_2 is reduced as it gained electrons to form F^-.

..... [2]

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