Name and Index Number: ( )	Class:

SENG KANG SECONDARY SCHOOL
2025 PRELIMINARY EXAMINATION

SCIENCE (CHEMISTRY)

5105/04
5107/04

Secondary 4 Normal (Academic)

4 August 2025

Paper 4

Paper 3 and 4: 1 hour 15 minutes

READ THESE INSTRUCTIONS FIRST

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

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

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

The use of an approved scientific calculator is expected, where appropriate.
In calculations, you should show all the steps in your working, giving your answer at each stage.
You are advised to spend no longer than 30 minutes on Paper 3.
You may proceed to answer Paper 4 as soon as you have completed Paper 3.
A copy of the Periodic Table is printed on page 12.

At the end of the examination hand in your answers to Paper 3 and Paper 4 separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's use	
Section A	/ 22
Section B	/ 8
Total Marks	/ 30

This document consists of **12** printed pages.

Do not turn over the page until you are told to do so.

Section A [22 marks]

Answer **all** questions.

1 Choose from the substances listed to answer the questions.

brass
calcium hydroxide
carbon dioxide
carbon monoxide
chlorine
oxygen
hydrogen
zinc chloride

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

Identify the element or compound that:

(a) relights a glowing splint,

……

(b) contains a halide ion,

……

(c) is a gas formed from the reaction between calcium and water,

……

(d) is a mixture of zinc and another element,

……

(e) has a mass of 14.8 g for every 0.2 mol of the substance.

…… [5]

[Total: 5]

2 A piece of phosphorous is fastened to a copper wire and left for a few days in the apparatus shown in Fig. 2.1.

Phosphorous reacts with oxygen in the air to form phosphorous oxide, causing the water to slowly rise in the test-tube.

The reaction is allowed to proceed, until all of the oxygen has been reacted.

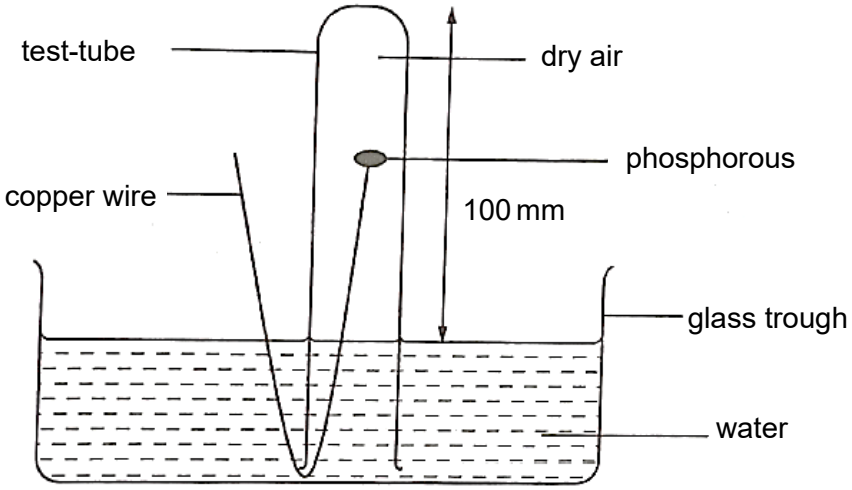


Fig. 2.1

(a) Name **two** gases that are left in the test-tube after a few days.

…… [2]

(b) State the vertical distance travelled by the water in the test-tube.

vertical distance travelled …… mm [1]

(c) The phosphorous oxide that was formed is added to a beaker, as shown in Fig. 2.2.

The beaker contains distilled water and a few drops of Universal Indicator.

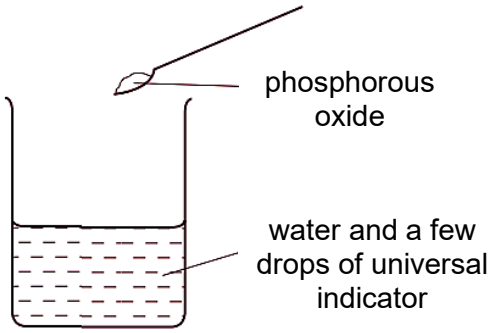


Fig. 2.2

Describe the colour change of Universal Indicator when phosphorous oxide dissolves in distilled water.

colour changes from …….. to …… [1]

[Total: 4]

3 Table 3.1 shows the boiling points of some organic compounds that can be found in crude oil.

Table 3.1

compounds	boiling point / °C
hexane	69
heptane	99
octane	125

(a) State the name of the homologous series to which the organic compounds belong to.

…… [1]

(b) Name a separation technique that could be used to separate a mixture of the compounds found in Table 3.1.

…… [1]

(c) Crude oil, when burnt, releases carbon dioxide into the atmosphere.

Describe a positive test for carbon dioxide gas.

…… [1]

(d) Biofuels are known to be an alternative energy source that could replace crude oil.

(i) Name one example of a biofuel.

…… [1]

(ii) Explain why biofuels are considered more environmentally sustainable compared to crude oil.

……

…… [1]

[Total: 5]

4 A student uses the apparatus shown in Fig. 4.1 to study the reaction between sodium hydroxide and ammonium nitrate.

Ammonia gas is one of the products of the reaction.

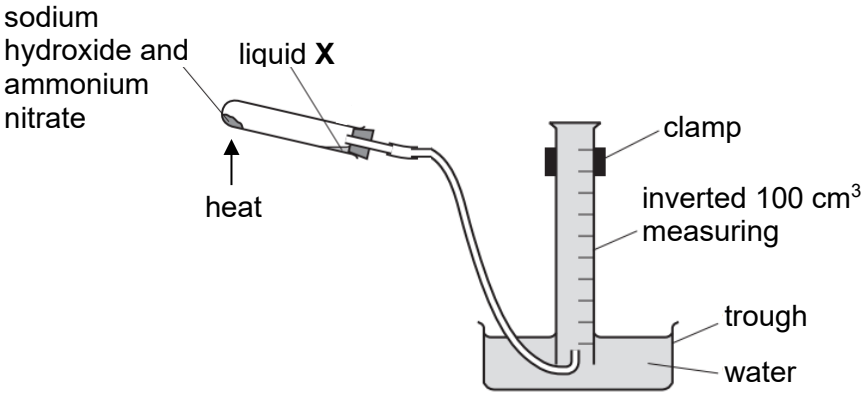


Fig. 4.1

(a) Identify liquid **X**.

……..... [1]

(b) A teacher commented that the set-up in Fig. 4.1 is not suitable for collecting ammonia gas.

Explain why the set-up in Fig. 4.1 is not suitable for collecting ammonia gas and suggest how this should be corrected.

explanation ……

……

correction ……..……

……

…… [2]

(c) The student learnt that ammonia gas can be toxic.

He decides to modify the set-up from Fig. 4.1 to convert ammonia gas to nitrogen gas.

The modified set-up is shown in Fig. 4.2.

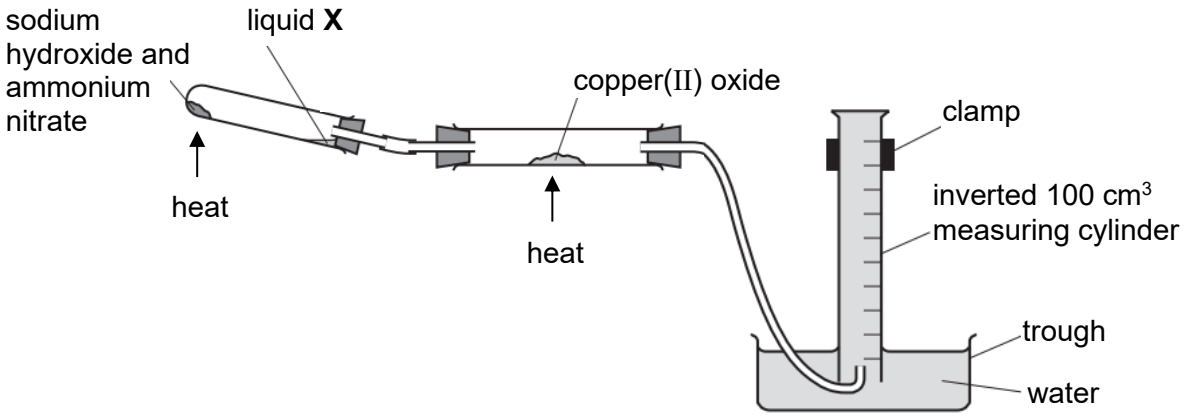


Fig. 4.2

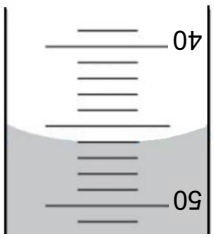
(i) When ammonia gas is passed over hot copper(II) oxide, the reaction produces copper, water and nitrogen.

Balance the chemical equation for this reaction.

…….. CuO + …….. NH_3 → …….. Cu + …….. H_2O + …….. N_2 [1]

(ii) The volume of nitrogen gas produced can be determined by reading the inverted measuring cylinder.

State the volume of nitrogen gas shown in the inverted measuring cylinder.



volume of nitrogen gas = …… cm^3 [1]

(iii) The volume of nitrogen gas is measured and recorded at one-minute intervals.

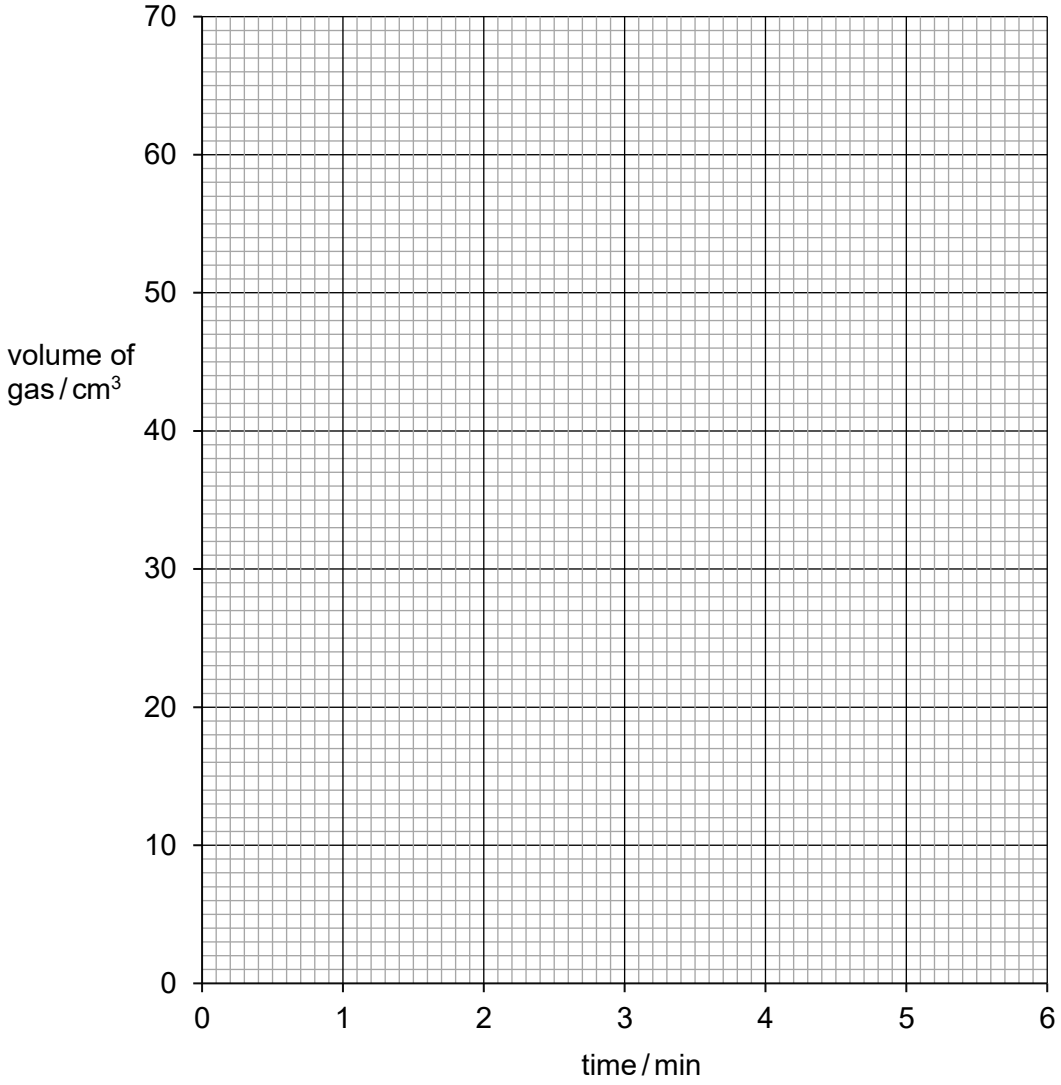
The results obtained by the student are shown in Table 4.3.

Table 4.3

time / min	0	1	2	3	4	5	6
volume of gas / cm^3	0	28	46	55	59	60	60

Using Table 4.3, plot a graph of volume of gas against time, marking each point with a cross (x).

Draw a **curved line** of best fit taking into account all your plotted points. [2]



(iv) Use your graph to estimate the time at which the reaction is completed.

estimated time = …… min [1]

[Total: 8]

Section B [8 marks]

Answer **one** question from this section.

5 Table 5.1 shows information about four non-metallic elements.

All four non-metals are in the same group of the Periodic Table.

Table 5.1

element	melting point / °C	boiling point / °C	density / g / cm^3
V	−307	−188	0.00155
W	−102	−34	?
X	−7	78	3.10
Y	114	184	4.93

The following is known about the non-metals:

- they exist as diatomic molecules;
- they all have 7 valence electrons.

(a) Define the term *diatomic*.

……

…… [1]

(b) State which group of the Periodic Table these elements can be found in.

Group ……. [1]

(c) Predict the density of element **W**.

density ……. g / cm^3 [1]

(d) **(i)** Determine the physical state of element **X** at room temperature and pressure.

…… [1]

(ii) Hence, suggest the name of element **X**.

…… [1]

(e) It is later discovered that each of the elements can react with sodium to form a compound.

For instance, a sample of element **X** can react with sodium to form a compound, Na**X**.

Explain why element Na**X** is able to conduct electricity in aqueous state, but **not** in solid state.

……

……

…… [2]

(f) In an experiment, element **W** is bubbled into an aqueous solution of potassium iodide as shown in Fig. 5.2.

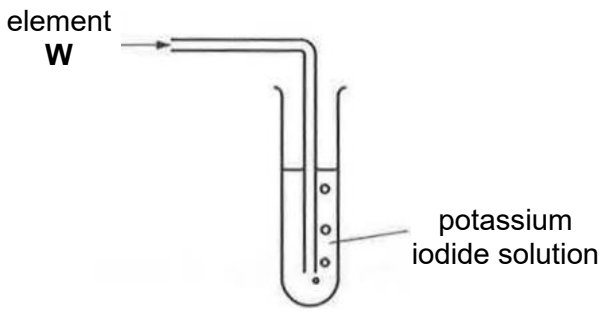


Fig. 5.2

Explain why the solution in the test-tube turns from colourless to yellowish-brown.

……

…… [1]

[Total: 8]

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

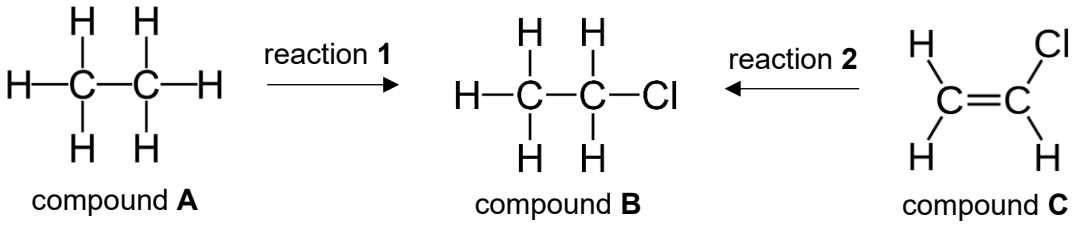


Fig. 6.1

(a) Compounds **A** and **C** undergo different reactions to produce compound **B**.

Fill in Table 6.1 with information about the two reactions to form compound **B**.

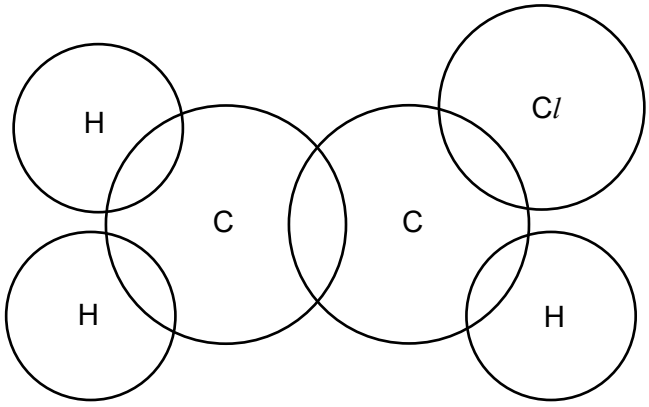
Table 6.1

	reaction **1**	reaction **2**
type of reaction		
name of reactants		

[2]

(b) Complete the dot-and-cross diagram of compound **C**.

Show only the outer shell electrons.



[2]

(c) When multiple units of compound **C** react together, they form a polymer called polyvinyl chloride (PVC).

Draw the structural formula of the polyvinyl chloride.

[1]

(d) Polyvinyl chloride is a non-biodegradable plastic.

If it is incinerated, it causes air pollution, producing toxic hydrogen chloride gas.

Hydrogen chloride gas dissolves in rainwater to cause acid rain.

(i) State the chemical formula of the ion that is responsible for the acidic property of hydrogen chloride.

chemical formula ……. [1]

(ii) Acid rain corrodes limestone (calcium carbonate) structures.

Explain how this happens, in terms of the chemistry involved.

……

……..……..……... [1]

(iii) Describe one **other** environmental problem that is caused by the disposal of non-biodegradable plastics.

……

……... [1]

[Total: 8]

~ END OF PAPER ~

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 x 10^{23} mol