

GAN ENG SENG SCHOOL
End-of-Year Examination 2023



**CANDIDATE
NAME**

CLASS

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**INDEX
NUMBER**

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CHEMISTRY

Paper 1 Multiple Choice

6092/01

11 October 2023
1 hour

Sec 3 Express

Additional Materials: OTAS

Calculators are allowed in the examination.

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and index number on the OTAS.

There are forty questions in this paper. Answer all questions. For each question, there are four possible answers **A**, **B**, **C**, and **D**.

Choose the one you consider correct and record your choice in soft pencil on the separate OTAS.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

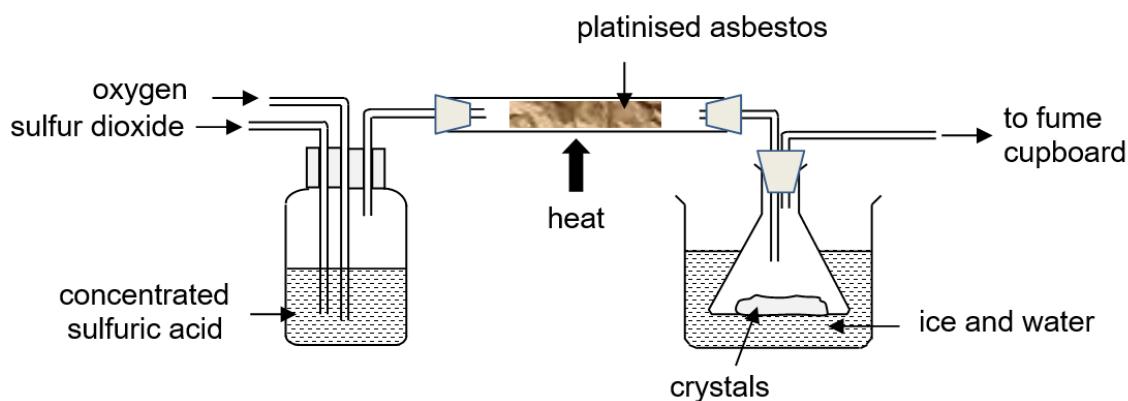
A copy of the Periodic Table is found on page 14.

Total Marks
40

1 Which apparatus is most suitable for measuring 22.15 cm^3 of sodium hydroxide?

- A beaker
- B burette
- C measuring cylinder
- D pipette

2 In the experimental set-up shown below, sulfur dioxide was reacted with oxygen to form sulfur trioxide by passing the mixture through heated platinised asbestos (a substance that speeds up the reaction).



What is the function of concentrated sulfuric acid?

- A to acidify the mixture
- B to act as a drying agent
- C to act as a medium for the two reactant gases to mix
- D to remove impurities

3 The apparatus below shows the method to collect gas X.

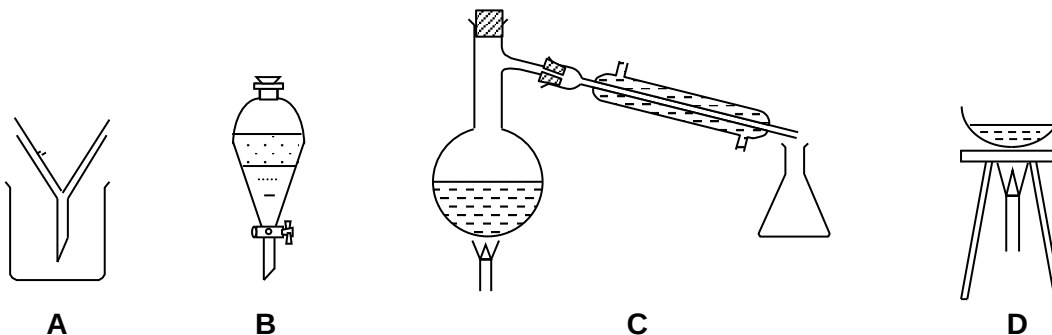


Which properties of gas X can be deduced?

- A denser than air
- B insoluble in water and denser than air
- C less dense than air
- D soluble in water and less dense than air

- 4 A mixture contains solid **Y** mixed with ethanol. Solid **Y** is insoluble in ethanol. Ethanol is an alcohol that has a boiling point of 78 °C and **Y** has a boiling point of 103 °C.

Which of the following apparatus represents the best method used to obtain both solid **Y** and ethanol?



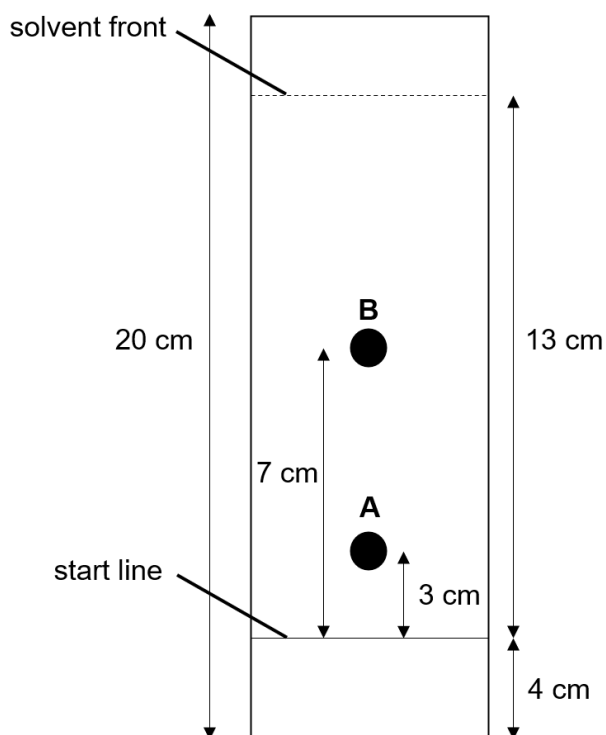
- 5 Megan performed chromatography on some ink samples. The chromatogram below was obtained.



What could Megan have done wrong in her experiment?

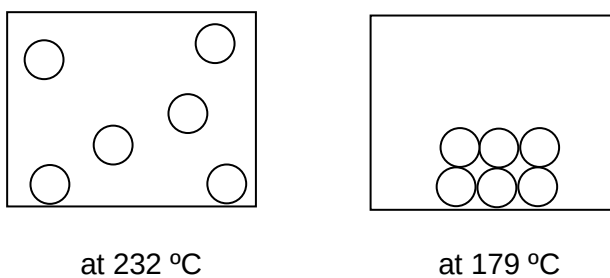
- A** the initial spots of ink were too small
- B** the ink samples were insoluble in the solvent chosen
- C** the starting line was drawn with a pen
- D** the solvent level was above the starting line

- 6 The diagram shows the chromatogram obtained by analysis of a single dye.



Which of the following is the correct R_f value of spot **B**?

- A 0.231
 B 0.350
 C 0.412
 D 0.538
- 7 The diagram below shows the spacing of the particles in a substance **Z** at two different temperatures.



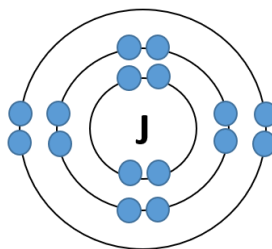
Which of the following could be substance **Z**?

	melting point/ °C	boiling point/ °C
A	- 21	- 9
B	160	210
C	183	253
D	194	229

- 8 Which option correctly describes the locations of the sub-atomic particles in an atom?

	proton	neutron	electron
A	in the nucleus	in the nucleus	orbiting the nucleus
B	in the nucleus	in the nucleus	in the nucleus
C	orbiting the nucleus	in the nucleus	orbiting the nucleus
D	orbiting the nucleus	orbiting the nucleus	in the nucleus

- 9 Isaac drew the electronic structure of the atom of an unknown element **J** as shown below.



Some statements made about the mistakes that Isaac made are shown below.

- I the innermost shell cannot contain four electrons
- II the second shell cannot contain eight electrons
- III the electron pairs in the third shell should be placed at the top and bottom of the shell, instead of the left and right
- IV the third shell must be fully filled with electrons

Which of the above statement(s) correctly describes the mistake(s) Isaac has made?

- A I only
- B I and IV only
- C I, III, and IV only
- D II and III only

- 10 Oxygen reacts with a metal **X** to form an ionic compound **XO**.

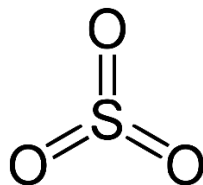
Which statement about oxygen is correct when forming this compound?

- A one atom of oxygen gives away one electron to an atom of **X**
- B one atom of oxygen gives away two electrons to an atom of **X**
- C one atom of oxygen receives one electron from an atom of **X**
- D one atom of oxygen receives two electrons from an atom of **X**

- 11 In which of the following sets do all the particles have the same number of electrons?

- A F^- , Cl^- , Br^-
- B H^+ , He , N^{3-}
- C K^+ , Ca^{2+} , P^{3-}
- D Na^+ , Mg^{2+} , S^{2-}

12 The bonding of sulfur trioxide is shown below.



How many electrons are **not** involved in bonding in each oxygen atom?

- A 2
- B 4
- C 6
- D 8

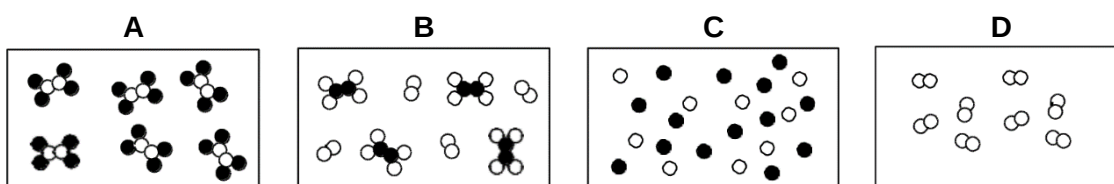
13 Which of the following pairs of elements forms covalent bonds?

- A bromine and calcium
- B phosphorus and oxygen
- C strontium and sulfur
- D zinc and chlorine

14 Which of the following correctly describes metallic bonding?

- A electrostatic forces of attraction between positive metal ions surrounded by a 'sea of delocalised electrons'
- B electrostatic forces of attraction between negative metal ions surrounded by a 'sea of delocalised electrons'
- C intermolecular forces of attraction between positive metal ions surrounded by a 'sea of delocalised electrons'
- D intermolecular forces of attraction between negative metal ions surrounded by a 'sea of delocalised electrons'

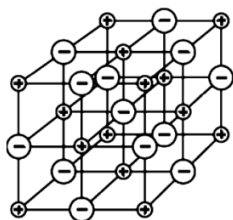
15 Which diagram shows a mixture of an element and a compound?



16 Which physical properties below are true of potassium oxide?

- A hard and brittle
- B hard and malleable
- C soft and brittle
- D soft and malleable

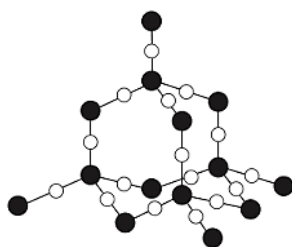
17 Which of the following structures represents lithium bromide?



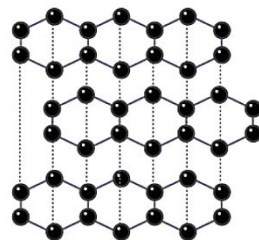
A



B

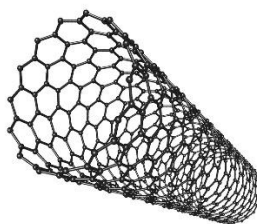


C



D

18 The diagram below shows a carbon nanotube. Carbon nanotubes are made by isolating a single carbon layer from graphite.



How are carbon nanotubes able to conduct electricity?

- A Each carbon atom forms three bonds and carbon ions formed are mobile.
- B One unbonded electron in each carbon atom is delocalised and mobile.
- C Strong covalent bonds between the carbon atoms allow electrons to easily flow through.
- D Weak intermolecular forces of attraction exist between carbon atoms and electrons can overcome these forces of attraction easily.

19 Dimethylglyoxime has the chemical formula $(\text{CH}_3\text{CNOH})_2$. How many atoms does one molecule of dimethylglyoxime contain?

- A 5
- B 8
- C 10
- D 16

- 20 The formula of iridium sulfate is $\text{Ir}_2(\text{SO}_4)_3$ and that of zinc hypochlorite is $\text{Zn}(\text{ClO})_2$.

What is the formula of iridium hypochlorite?

- A $\text{Ir}_2(\text{ClO})_2$
- B $\text{Ir}_2(\text{ClO})_3$
- C IrClO
- D $\text{Ir}(\text{ClO})_3$

- 21 Ammonia can be displaced from its salts.

Which equation is correct?

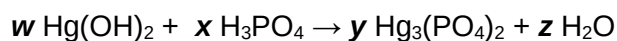
- A $\text{Mg}(\text{OH})_2 (\text{s}) + (\text{NH}_4)_2\text{SO}_4 (\text{aq}) \rightarrow \text{MgSO}_4 (\text{aq}) + 2\text{NH}_3 (\text{g}) + 2\text{H}_2\text{O} (\text{g})$
- B $\text{Mg}(\text{OH})_2 (\text{s}) + \text{NH}_4\text{Cl} (\text{aq}) \rightarrow \text{MgCl} (\text{aq}) + \text{NH}_3 (\text{g}) + \text{H}_2\text{O} (\text{g})$
- C $\text{KOH} (\text{aq}) + 2\text{NH}_4\text{NO}_3 (\text{s}) \rightarrow \text{KNO}_3 (\text{aq}) + 2\text{NH}_3 (\text{g}) + \text{H}_2\text{O} (\text{g})$
- D $\text{KOH} (\text{aq}) + (\text{NH}_4)_2\text{SO}_4 (\text{s}) \rightarrow \text{KSO}_4 (\text{aq}) + 2\text{NH}_3 (\text{g}) + \text{H}_2\text{O} (\text{g})$

- 22 Element E has an electronic structure 2.5.
Element G has an electronic structure 2.8.2.

What would be the chemical formula of the compound formed between E and G?

- A G_2E_3
- B G_2E_5
- C G_3E_2
- D G_5E_2

- 23 Mercury hydroxide reacts with phosphoric acid in the reaction below.



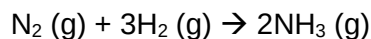
Which values of w , x , y , and z will correctly balance the above equation?

	w	x	y	z
A	2	3	1	4
B	3	3	2	7
C	3	2	1	6
D	6	4	2	11

- 24 Which compound contains the highest percentage of nitrogen by mass?

- A $\text{Al}(\text{NO}_3)_3$
- B Mg_3N_2
- C NO
- D NO_2

- 25 The forward reaction for the Haber process is given below.

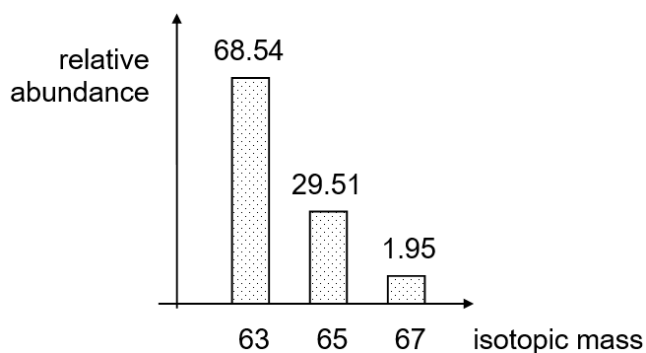


15 cm³ of nitrogen was added to 60 cm³ of hydrogen in a container.

What is the total volume of gas remaining in the container after the reaction is complete?

- A 30 cm³
- B 40 cm³
- C 45 cm³
- D 105 cm³

- 26 A new element was discovered. The relative abundance of its isotopes is shown below.



What is its relative atomic mass?

- A 33.33
 - B 63.67
 - C 63.71
 - D 65.00
- 27 What is the empirical formula for a compound consisting of 4.8 g of carbon and 0.8 g of hydrogen?
- A CH
 - B CH₂
 - C C₂H₃
 - D C₄H₈
- 28 On adding 53 g of impure sodium carbonate, Na₂CO₃ (M_r = 106), to excess hydrochloric acid, 3.0 dm³ of CO₂ was evolved at room temperature and pressure.

What is the percentage purity of sodium carbonate?

- A 25%
- B 50%
- C 75%
- D 100%

29 Which row correctly classifies the nature of these oxides?

	aluminium oxide	nitrogen dioxide	sodium oxide
A	amphoteric	basic	acidic
B	basic	acidic	amphoteric
C	amphoteric	acidic	basic
D	acidic	amphoteric	basic

30 A farmer wishes to grow some ceanothus flowers. The pH of his soil is 5.1. Ceanothus flowers are known to grow best at around pH 7.2.

Which substance should he add to his soil for the ceanothus to grow well?

- A calcium hydroxide
- B citric acid
- C sodium hydroxide
- D water

31 Which particle is found in a solution of oxalic acid, $C_2H_2O_4$?

- A OH^-
- B H_2^+
- C H
- D H^+

32 Which of the following pairs of reagents should be mixed to prepare a sample of lead(II) sulfate salt?

- A lead metal and sulfuric acid
- B lead(II) carbonate and sulfuric acid
- C lead(II) chloride and barium sulfate
- D lead(II) nitrate and sodium sulfate

33 When preparing a salt via titration, the experiment is usually repeated without the addition of an indicator after the volume required for neutralisation has been obtained.

Why is the indicator removed when preparing the salt crystals?

- A The indicator acts as a drying agent and removes moisture from the crystals.
- B The indicator is an impurity and will lead to impure crystals formed.
- C The indicator slows down the process of crystal formation during crystallisation.
- D The indicator will dye and change the original colour of the crystals.

- 34** When sulfur is burned, sulfur dioxide is produced.

How can the identity of sulfur dioxide be confirmed?

	test	observation
A	insert a glowing splint into the gas	the glowing splint rekindles
B	use a piece of damp blue litmus paper	blue litmus paper turns red and is then bleached
C	use a piece of damp red litmus paper	red litmus paper turns blue and is then bleached
D	use a piece of filter paper soaked with acidified potassium manganate(VII)	purple potassium manganate(VII) turns colourless

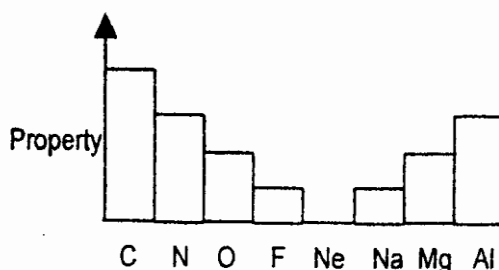
- 35** Separate tests were performed on an unknown solution. The results are shown in the table below.

test	observation
add aqueous sodium hydroxide	green precipitate forms and is insoluble in excess sodium hydroxide
add nitric acid	no observable change
add aqueous sodium hydroxide, aluminium foil and warm	pungent gas evolved which turned moist red litmus paper blue

What is the unknown solution?

- A** ammonium nitrate
- B** iron(II) carbonate
- C** iron(II) nitrate
- D** iron(III) sulfate

- 36** A property of the elements from carbon to aluminium is shown on the chart.



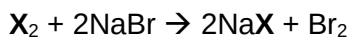
What are the elements arranged according to?

- A** group number
- B** number of electron shells
- C** number of protons
- D** valency

37 Which statement is true for all noble gases?

- A They are coloured elements.
- B They are stable and inert.
- C They have high densities.
- D They have the octet configuration.

38 Halogens can take part in displacement reactions.



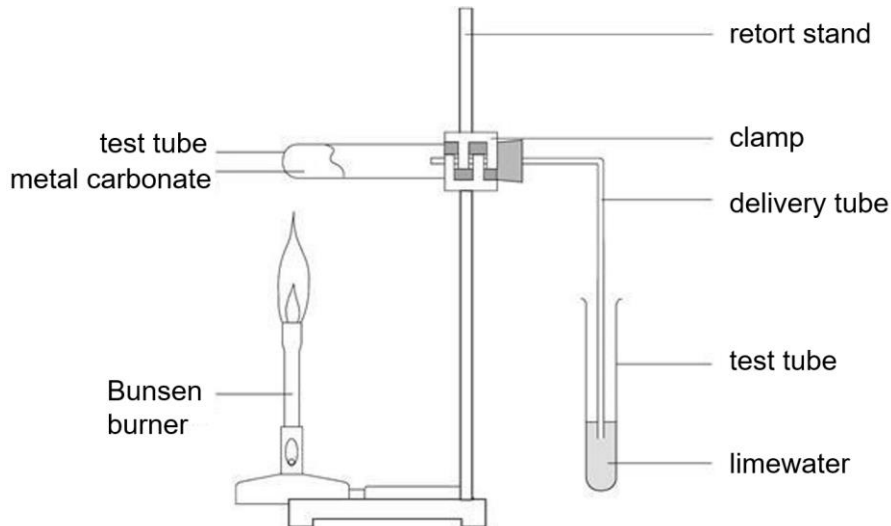
Some halogens are listed below.

- I fluorine
- II chlorine
- III iodine
- IV astatine

Which halogens could X be?

- A I and II
- B I and IV
- C II and III
- D III and IV

39 A metal carbonate was heated as shown in the diagram below.



The metal carbonate was heated strongly for an hour, but the limewater showed no observable change.

Which of the following could the metal carbonate most likely be?

- A calcium carbonate
- B magnesium carbonate
- C sodium carbonate
- D zinc carbonate

40 The table below shows some information on four metals and their compounds.

Metal	adding hydrochloric acid	heating with hydrogen	adding the metal to a solution of the sulfate of J
G	hydrogen evolved	steam produced	no visible change
H	no visible change	steam produced	no visible change
I	hydrogen evolved	no visible change	J formed
J	hydrogen evolved	no visible change	no visible change

What is the order of reactivity of these metals?

	least reactive		→	most reactive	
A	H	I		G	J
B	I	G		J	H
C	H	G		J	I
D	J	G		H	I

END OF PAPER

SECTION A [70 marks]

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

A1 Fig. 1.1 shows part of the Periodic Table.

[illegible]

Fig. 1.1

Select elements from Fig. 1.1 to answer the following questions. You may use each element once, more than once or not at all.

Write down the atomic symbol for an element which

- (a)** has three electrons in its valence shell,

..... [1]

- (b)** is metallic and forms coloured compounds,

..... [1]

- (c) forms a basic oxide,

..... [1]

- (d)** has less than 20 protons and has four electron shells,

..... [1]

- (e) is an inert gas,

..... [1]

- (f)** has a giant covalent structure,

..... [1]

- (g) is a liquid at room temperature,

..... [1]

[Total: 7]

A2 Table 2.1 shows the distribution of some elements in three substances.

Table 2.1

substance	element		
	oxygen	iron	carbon
A	0%	90.4 – 95.6%	4.4 – 9.6%
B	52%	48%	0%
C	66.7%	0%	33.3%

Identify and explain, using data from Table 2.1, which substance is a mixture.

.....

..... [2]

[Total: 2]

A3 Haematite, iron(III) oxide, is an iron ore that can be commonly found around the world.

(a) Haematite can be reduced with carbon to form two products. Write the balanced chemical equation, with state symbols, for this reaction.

..... [2]

(b) The reaction in **(a)** is said to be non-environmentally friendly. Suggest a reason why.

..... [1]

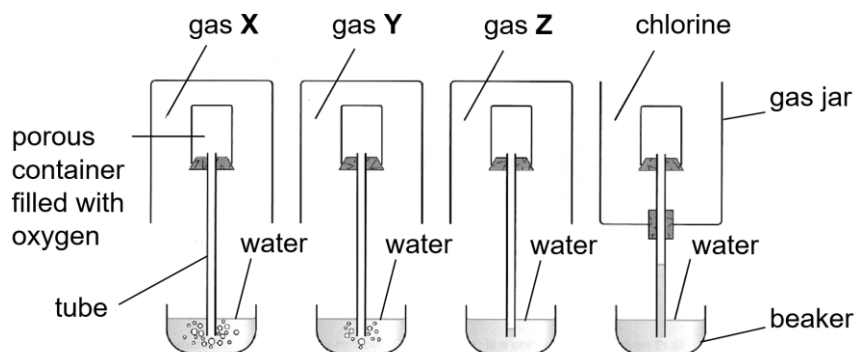
(c) A student, Harini, commented, “Iron(III) oxide can also be obtained in the laboratory via the fast reaction between iron metal and water at 5 °C.” Explain whether she is correct and write the chemical equation for the reaction that occurred, if any.

.....

..... [1]

[Total: 4]

- A4** A student conducted an experiment with the apparatus set-up below. Three unknown gases, **X**, **Y**, **Z** and chlorine gas are compared to oxygen gas. All the porous containers are filled with oxygen gas.



- (a)** Explain why bubbles are observed in the water for the set-ups containing gases **X** and **Y**.

.....

.....

.....

.....

..... [3]

- (b)** No bubbles were observed in the set-up containing gas **Z**. A small amount of water was seen to rise up the tube. Suggest a possible identity of gas **Z**.

..... [1]

- (c)** Suggest why the gas jar containing chlorine was arranged the opposite way from the other gas jars containing gases **X**, **Y** and **Z**.

.....

..... [1]

- (d)** The experiment was conducted at 25 °C. State and explain what would be observed if the experiment was conducted at 50 °C instead.

.....

.....

.....

..... [3]

[Total: 8]

A5 (a) Table 4.1 describes the properties of some sub-atomic particles.

Complete Table 4.1.

Table 4.1

	relative mass	relative charge
proton		
neutron		
electron		

[2]

(b) The symbol of an atom of aluminium is shown below.



(i) State the number of neutrons it has.

..... [1]

(ii) Write the electronic configuration for this atom of aluminium.

..... [1]

(iii) The symbol for another atom of aluminium is ${}_{13}^{26}\text{Al}$.

State and explain the relationship between these two atoms of aluminium.

.....
 [1]

[Total: 5]

- A6** A student, Yu Kai, was conducting an experiment to determine the physical properties of some substances. He recorded his results in Table 5.1 but accidentally spilled some water on a portion of his table.

Table 5.1

substance	melting point/ °C	boiling point/ °C	electrical conductivity	solubility in water
potassium chloride	770	1420		yes
calcium chloride	772	1935		yes
carbon	3550	4830	no	no

- (a)** Draw the 'dot-and-cross' diagram to show the bonding in calcium chloride. Show outer electrons only.

[2]

- (b)** Calcium chloride has a melting point of 772 °C.

- (i)** Explain calcium chloride's high melting point in terms of its structure and bonding.

.....

.....

.....

.....

.....

.....

.....

[3]

- (ii) Suggest and explain why calcium chloride has a higher melting point than potassium chloride.

.....

.....

.....

.....

.....

..... [3]

- (c) Carbon can exist in different forms with different structural arrangements of its atoms.

- (i) State the term used to describe such different forms of carbon.

..... [1]

- (ii) By referring to Table 5.1, suggest and explain which form of carbon Yu Kai likely experimented on.

.....

..... [2]

- (iii) Compare the electrical conductivity between potassium chloride and this form of carbon. Explain your answer.

.....

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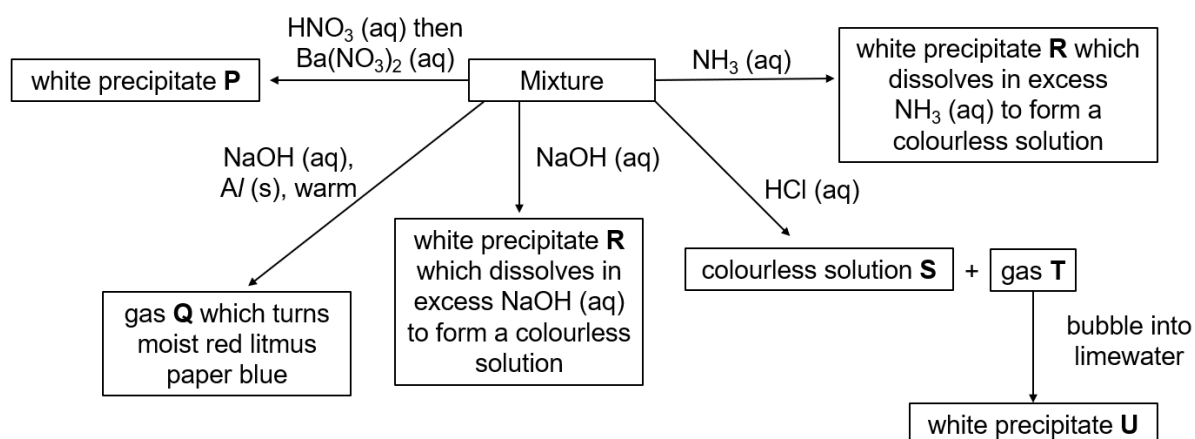
.....

.....

..... [4]

[Total: 15]

- A7** The following reaction scheme describes some of the reaction carried out on an unknown mixture. This mixture contains three different salts.



- (a)** Identify the following substances.

P:

Q:

R:

S:

T:

U: [6]

- (b)** Suggest two of the salts that the mixture contains.

salt 1:

salt 2: [2]

[Total: 8]

A8 Fig. 7.1 shows the heating curve for a substance **X**.

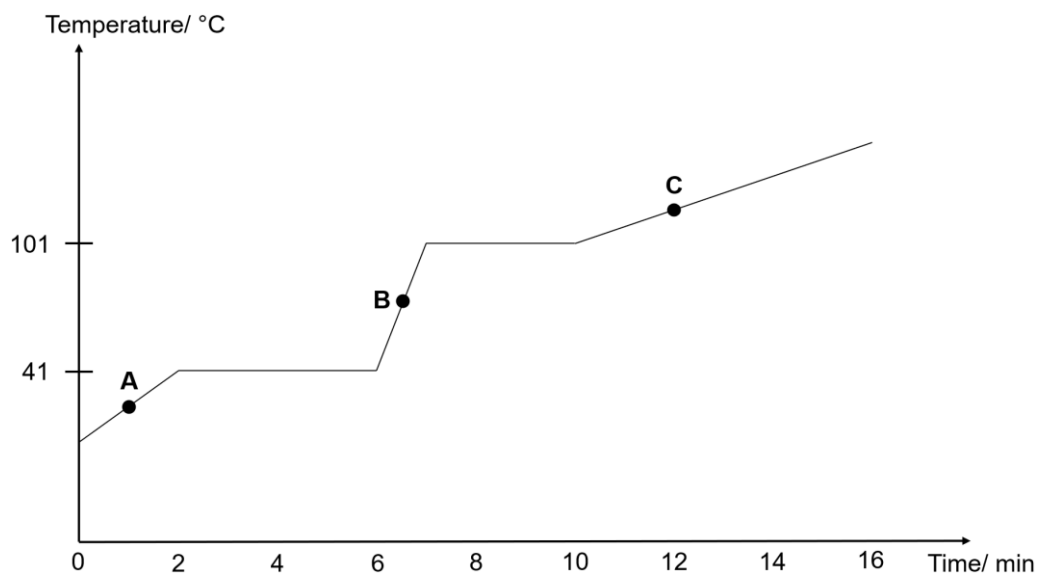


Fig. 7.1

- (a)** Describe, in terms of the kinetic particle theory, the movement and arrangement of the particles of substance **X** at point **A**.

.....

 [2]

- (b)** State how long it took for substance **X** to completely change from a solid into a gas.

..... [1]

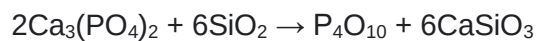
- (c)** Compare the forces of attraction between the particles and the kinetic energy of the particles at point **B** and at point **C**.

.....

 [2]

[Total: 5]

- A9** Wollastonite, CaSiO_3 , can be produced from the reaction between calcium phosphate and silicon dioxide.



100 g of calcium phosphate, $\text{Ca}_3(\text{PO}_4)_2$, was used in this reaction. The actual mass of wollastonite produced was 87 g.

Calculate the percentage yield of wollastonite.

[4]

[Total: 4]

A10 Separation of crude oil for everyday use

How crude oil is separated

Crude oil is a naturally occurring viscous black oil. The raw material is made up of complex organic hydrocarbon structures and is formed from living matter that existed many millions of years ago. In that time, that matter has been processed by geological forces to create its current form of black oil. While it is sometimes found at surface level, crude oil is mostly obtained by drilling for oil in the ground at oil wells on land, and at oil rigs at sea.

In oil industries, crude oil can be separated to obtain all the various petroleum products that we rely on in everyday life. A diagram of this separation technique is shown in Fig. 9.1.

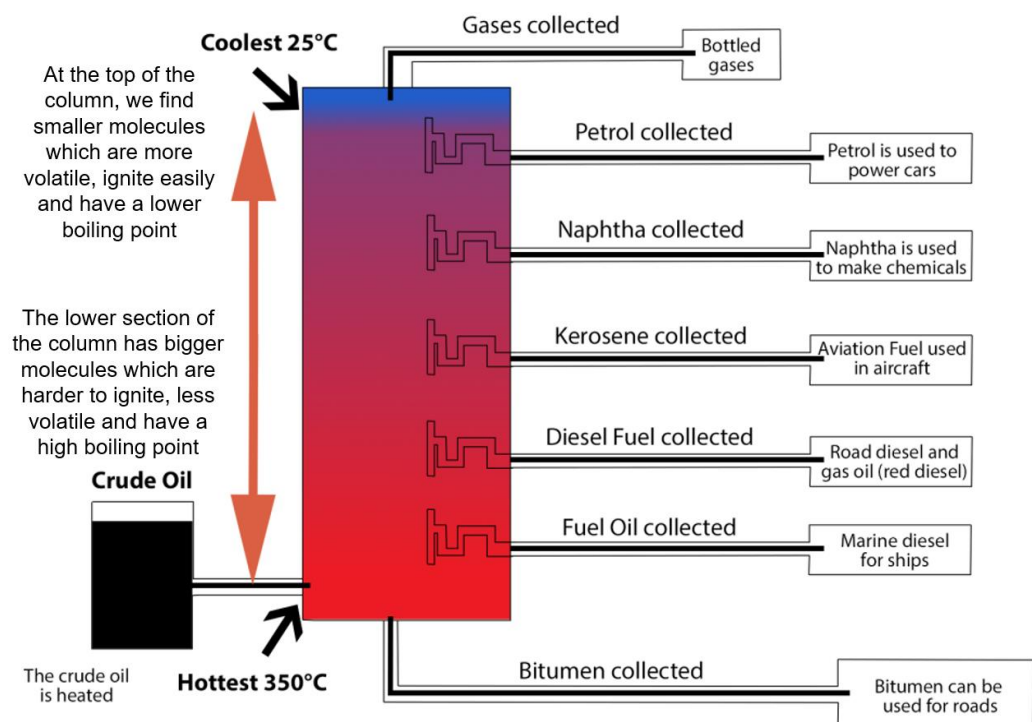


Fig. 9.1

Crude oil is heated and its components turn into vapour. They are subsequently cooled, condensed back into liquids, and collected as different fractions. Each fraction contains different hydrocarbons.

The top of the column gives rise to gases and liquids that have short carbon chains in their composition. While these products are often used as fuels, many have industrial and chemical uses too.

Hydrocarbons like butane, propane and other petroleum gases are formed right at the top of the tower, where it is coolest at a very mild 25°C. The temperature range that forms these gases is between 25°C and 50°C. These gases are the lightest products formed in this separation process and are flammable gases.

These gases, being the lightest products formed and flammable gases too, are then processed into Liquefied Petroleum Gas (LPG), which is usually a mixture of propane and butane. LPG is used for heating applications and for hot air balloons in the case of propane.

The petroleum gases have four or five hydrocarbons in their chain. For these distillates, hydrocarbon chains are made up of three carbon atoms in the case of propane (C_3H_8), and four carbon atoms in the case of butane (C_4H_{10}).

Everyday use of the components of crude oil

Internal combustion engine fuels such as petrol or diesel fuels our cars' engines, gas oil powers machinery and furnaces, kerosene fuels aircraft, and domestic and commercial heating oil keeps our homes and workplaces warm.

In such combustion reactions, hydrocarbons react with oxygen in the air to produce carbon dioxide and water.

- (a) (i) Name the separation technique used to separate crude oil.
 [1]
- (ii) Explain how the physical property of the components of crude oil allows them to be separated by this separation technique.
 [1]
- (iii) Suggest and explain if oil industries can use separating funnels to separate the components of crude oil.
 [1]
- (b) Propene, C_3H_6 , is a hydrocarbon that is a possible by-product of this separation technique.
- (i) Suggest what is meant by the term *hydrocarbon*.
 [1]
- (ii) Draw a 'dot-and-cross' diagram to show the bonding in propene. Show the outer shell electrons only.

[2]

- (iii) Substances that produce ions when dissolved in water are called electrolytes. Electrolytes are used as mediums to conduct electricity in electrolysis reactions.

Suggest and explain whether propene can be used as an electrolyte.

.....

..... [1]

- (iv) Write a balanced chemical equation for the combustion reaction of propene.

..... [1]

- (v) Other than using chromatography, explain how the purity of propene obtained from the separation can be determined.

.....

..... [1]

- (c) Chromatography was performed on a sample of crude oil. The results are shown in Fig. 9.2.

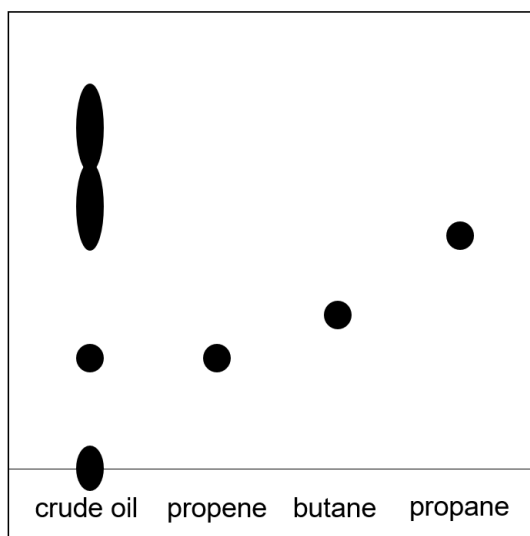


Fig 9.2

State three conclusions that can be drawn by using evidence from Fig 9.2.

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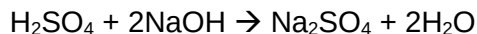
..... [3]

[Total: 12]

SECTION B [10 marks]

Answer **one** question from this section.

- B11** 25.0 cm³ of 0.40 mol/dm³ sulfuric acid was reacted with exactly 35 cm³ of sodium hydroxide.



- (a)** Calculate the concentration of sodium hydroxide used.

[2]

- (b)** Write the ionic equation, with state symbols, for this reaction.

..... [1]

- (c)** Sodium sulfate solution is obtained at the end of the reaction.

- (i)** Describe what would be observed if a few drops of universal indicator were added to the sodium sulfate solution.

..... [1]

- (ii)** Describe the concentration of H⁺ and OH⁻ ions present in the sodium sulfate solution at the end of the reaction.

..... [1]

- (d)** Describe the steps to prepare pure and dry sodium sulfate crystals from sulfuric acid and sodium hydroxide.

[illegible]

[5]

[Total: 10]

B12 30.0 cm³ of 0.80 mol/dm³ nitric acid was reacted with 10 g of magnesium.

(a) Calculate the mass of magnesium nitrate produced.

[3]

(b) A gas was produced in this reaction. Describe the test and observation to confirm the identity of the gas.

.....

.....

[1]

(c) Suggest a change in observation if nitric acid was replaced with ethanoic acid, CH₃COOH, for this reaction. Explain why.

.....

.....

.....

.....

[2]

- (d) Describe the steps to prepare pure and dry magnesium nitrate crystals from nitric acid and magnesium.

[illegible]

[4]

[Total: 10]

END OF PAPER