Name: .... ( )

ASSUMPTION ENGLISH SCHOOL
MID-YEAR EXAMINATION 2019

CHEMISTRY 6092
BOOKLET A

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LEVEL:	Sec 3 Express	**DATE:**	9 May 2019
CLASS:	Sec 3/2	**DURATION:**	2 hours 30 minutes (for Booklets **A** and **B**)

Additional materials provided: 1 sheet of OAS paper

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.
Write your NAME and INDEX NUMBER at the top of this page and on the OAS paper.
Shade your index number on the OAS paper.

This paper consists of 3 sections.

BOOKLET A:
SECTION A – MULTIPLE CHOICE QUESTIONS (30 marks)
There are 30 questions in this section. Answer **all** questions. For each question, there are four possible answers A, B, C and D. **Choose the correct answer and record your choice in soft or 2B pencil on the OAS paper provided. DO NOT fold or bend the OAS paper.**

BOOKLET B:
SECTION B – SHORT STRUCTURED QUESTIONS (40 marks)
Answer **all** questions. Write your answers in the spaces provided on the question paper.

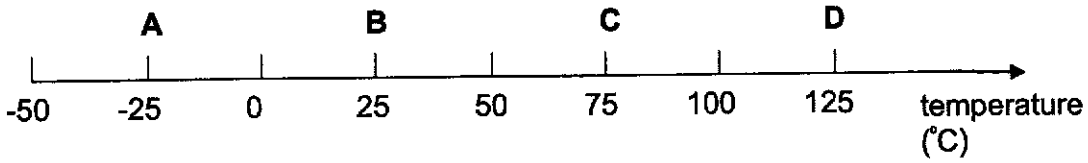
SECTION C – FREE RESPONSE QUESTIONS (30 marks)
Answer all **three** questions, the last question is in the form of an **EITHER / OR**. Write your answers in the spaces provided on the question paper.

At the end of the examination, hand in your OAS paper, Booklets **A** and **B** separately.
A copy of the Periodic Table is printed on the last page of Booklet **B**.

This Question Paper consists of 12 printed pages including this page.
Section A - Multiple Choice Questions (30 marks)

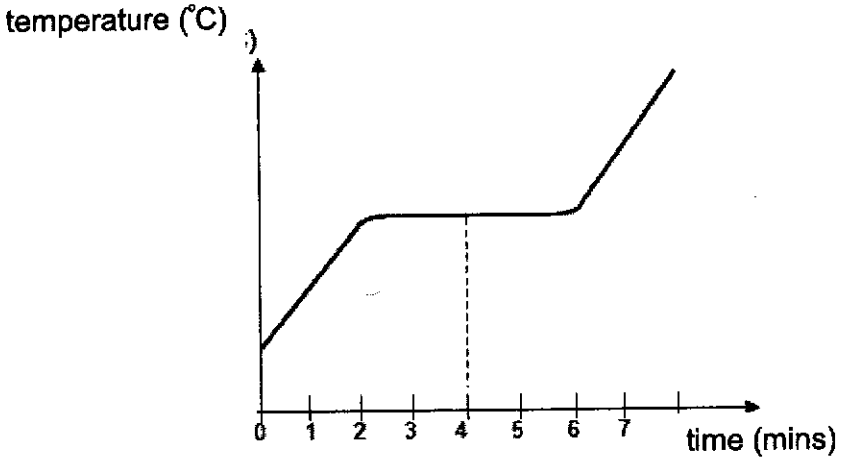
There are **thirty** questions in this section. Answer **ALL** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice on the OAS in soft pencil.

1 Bromine has a melting point of -2 °C and a boiling point of 59 °C.



At which temperature is bromine a liquid?

2 The figure below shows a graph obtained by heating solid **Z** in air.



Which statement is true about the particles of **Z** at the fourth minute?

A All the particles are arranged closely.

B All the particles move freely in all directions.

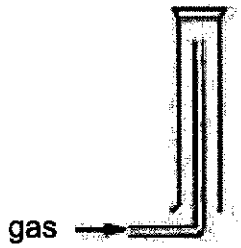
C Some particles are gaining enough energy to overcome attractive forces to be able to slide past each other.

D Some particles slide past each other while some particles move freely in all directions.

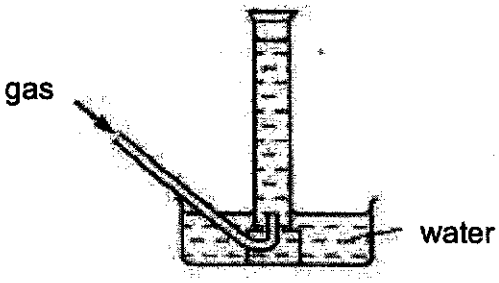
3 The table gives the density and solubility in water of four gases.

gas	density	solubility in water
1	denser than air	insoluble
2	denser than air	soluble
3	less than air	insoluble
4	less than air	soluble

Two methods of collection of gases are shown below.



upward delivery



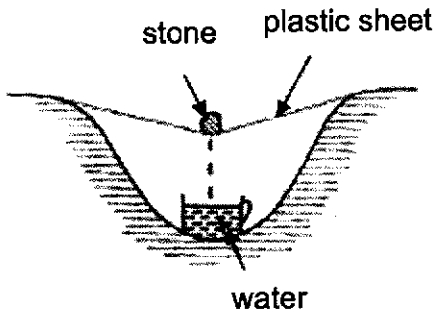
displacement of water

Which row correctly shows whether each of these methods could or could not be used to collect each gas?

		method of collection	
	gas	upward delivery	displacement of water
A	1	no	no
B	2	no	yes
C	3	yes	yes
D	4	yes	yes

4 A desert survival kit contains a plastic sheet and a cup. A hole is dug in the ground and the sheet is stretched over the hole whilst a stone is placed in the middle of the

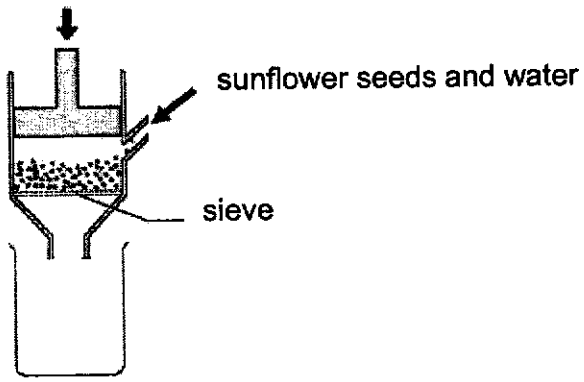
sheet as shown below.



In the heat of the sun, moisture from the ground collects on the underside of the sheet, runs down towards the stone and drips into the cup. The overall process that takes place is an example of .....

A condensation
B distillation
C evaporation
D filtration

5 A student attempted to extract oil from sunflower seeds using a home-made oil press shown in the diagram below. The sunflower seeds were first crushed and then water was added to the oil press to improve the extraction efficiency. A sieve was used in the oil press to prevent the sunflower seeds from dropping into the empty beaker.

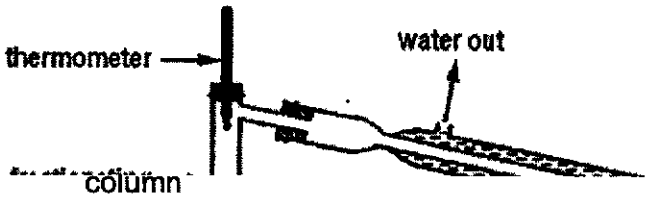


Which method can be used to recover the sunflower oil from the contents in the beaker?

A crystallisation
B filtration
C fractional distillation
D use a separating funnel

6 The apparatus shown is used to distill a mixture of ethanol and water. The boiling point of ethanol is 78 °C.

5



water in

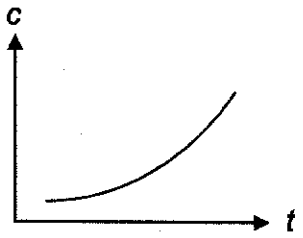
distillation flask

mixture of water and ethanol

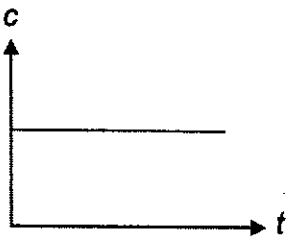
heat

Which graph below shows how the concentration of ethanol (c) in the conical flask changes as time (t) increases?

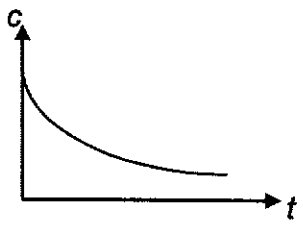
A



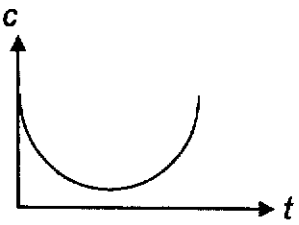
B



C



D



7 Which group of substances contains an element, compound and mixture?

A carbon, zinc, silver chloride

B seawater, carbon dioxide, limestone

C sodium chloride, ammonia, graphite

D water, gold, crude oil

8 Which substance **W**, **X**, **Y** or **Z** is likely to be an element?

A **W** burns in air to form carbon dioxide and water.

B **X** changes colour and loses oxygen rapidly on gentle heating.

C On heating **Y**, a gas is produced, leaving a solid residue.

D **Z** conducts electricity as a solid and when molten.

9 The diagrams below can be used to illustrate the substances **I** to **IV**.

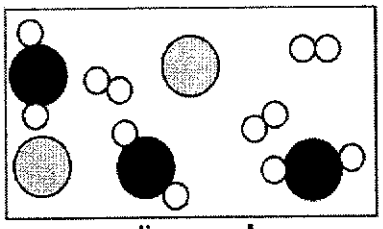


diagram **I**

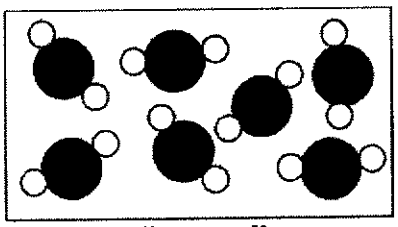


diagram **II**

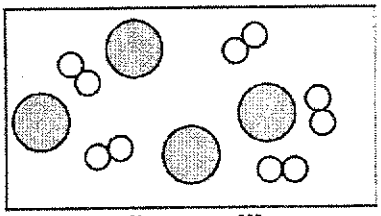


diagram **III**

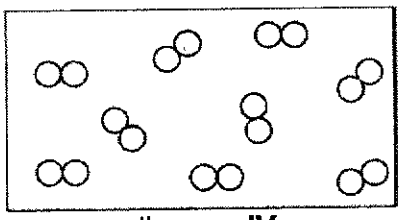


diagram **IV**

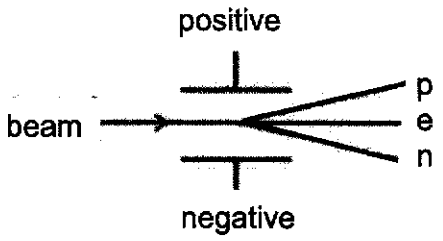
What is the correct order of the diagrams?

	a mixture of elements and compounds	a mixture of elements	molecules of an element	molecules of a compound
A	**I**	**III**	**IV**	**II**
B	**I**	**III**	**II**	**IV**
C	**III**	**I**	**IV**	**II**
D	**III**	**I**	**II**	**IV**

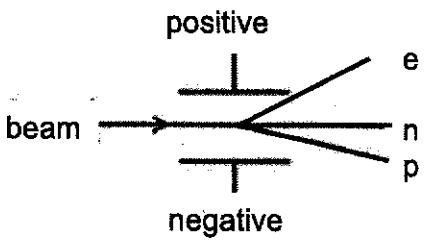
10 A beam of particles containing proton (p), neutron (n) and electron (e) is passed between charged plates.

Which diagram shows how the particles are affected by the plates?

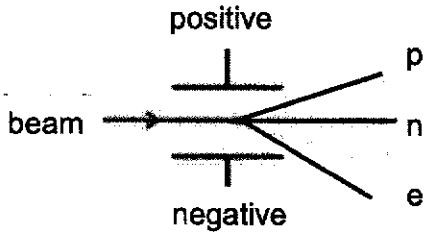
A



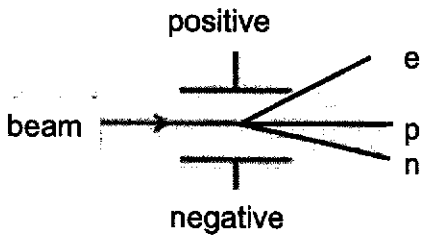
B



C



D



11 Carbon has isotopes with relative atomic masses of 12, 13 and 14.

If ethane, C_2H_6, is formed from these carbon isotopes, which is not a possible relative molecular mass of ethane?

A 30 **B** 32

C 34 **D** 35

12 What is the relative formula mass of a phosphide ion, P^{3-}?

A 15 **B** 18

C 31 **D** 34

13 Which statement correctly describes the formation of sodium sulfide?

A One sulfur atom loses two electrons to two sodium atoms.

B Two sodium atoms lose an electron each to a sulfur atom.

C One sulfur atom shares two electrons with two sodium atoms.

D Two sodium atoms share an electron each with a sulfur atom.

14 Which pair of ions contains the same number of electrons?

A F^- and Cl^-

B Mg^{2+} and N^{3-}

C Be^{2+} and O^{2-}

D Na^+ and Ca^{2+}

15 Four elements **W**, **X**, **Y** and **Z** have consecutive proton numbers. **X** is a noble gas.

Which statement is true?

A The ion of **W** will have the same electronic configuration as the ion of **Z**.

B **W** will form an ion of +1 charge while **Y** will form an ion of –1 charge.

C **Y** and **Z** will combine to form a covalent compound.

D **Y** has more valence electrons than **X**.

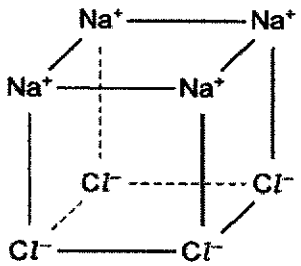
16 An ion X^{2+} has m nucleons and n electrons.

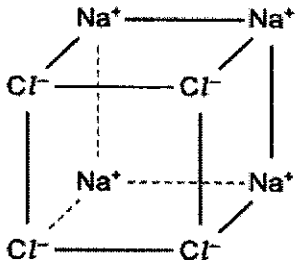
What does atom **X** contain?

	number of protons	number of neutrons	number of electrons
A	n – 2	m – n	n – 2
B	n – 2	m – (n – 2)	n + 2
C	n + 2	m – (n + 2)	n – 2
D	n + 2	m – (n + 2)	n + 2

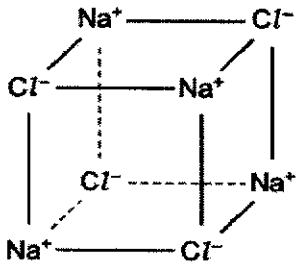
17 Which diagram correctly shows the arrangement of the ions in solid sodium chloride?

A **B**

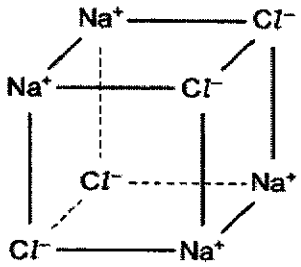




C



D



18 Magnesium silicate, $MgSiO_3$, is often found as an odourless finely divided powder.

What is the chemical formula of sodium silicate?

A $NaSiO_3$ **B** $Na(SiO_3)_2$

C Na_2SiO_3 **D** $Na_2Si_2O_3$

19 Which metal has the strongest metallic bond?

A aluminium **B** magnesium

C potassium **D** sodium

20 Substance **X** has a melting point higher than 500 °C. It conducts electricity when in solid and molten states.

What is **X**?

A copper **B** diamond

C mercury **D** sodium chloride

21 Which ionic equation is correct for the reaction shown below?

$$2\ Na\ (s) + Ca(NO_3)_2\ (aq) \rightarrow 2\ NaNO_3\ (aq) + Ca\ (s)$$

A $2\ Na\ (s) + 2\ NO_3^-\ (aq) \rightarrow 2\ NaNO_3\ (aq)$

B $2\ Na\ (s) + Ca^{2+}\ (aq) \rightarrow 2\ Na^{+}\ (aq) + Ca\ (s)$

C $2\ Na\ (s) + Ca^{2+}\ (aq) + 2\ NO_3^{-}\ (aq) \rightarrow 2\ Na^{+}\ (aq) + 2\ NO_3^{-}\ (aq) + Ca\ (s)$

D $Ca^{2+}\ (aq) + 2\ NO_3^{-}\ (aq) \rightarrow 2\ NO_3^{-}\ (aq) + Ca\ (s)$

22 Which is the correct definition of relative atomic mass?

A The relative atomic mass of any atom is the number of times the mass of one atom of an element is greater than $\frac{1}{12}$ of the mass of one carbon-12 atom.

B The relative atomic mass of any atom is the number of times the mass of one molecule of an element is greater than $\frac{1}{12}$ of the mass of one carbon-12 atom.

C The relative atomic mass of any atom is the number of times the mass of one atom of a substance is greater than $\frac{1}{12}$ of the mass of one carbon-12 atom.

D The relative atomic mass of any atom is the number of times the mass of one molecule of a substance is greater than $\frac{1}{12}$ of the mass of one carbon-12 atom.

23 Which substance has the greatest number of atoms?

A 33 g of CO_2

B 2 g of He

C 27 g of F_2

D 40 g of MgO

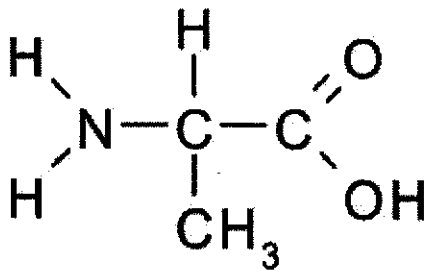
24 Element **Q** forms the nitrate QNO_3 and has an M_r of 101.

What is the M_r of an oxide of **Q**?

A 55 **B** 71

C 94 **D** 110

25 Alanine is an amino acid which is used in the synthesis of proteins. Its structure is shown below.



Which element in alanine is present in the highest percentage by mass?

A carbon **B** hydrogen

C nitrogen **D** oxygen

26 The chemical formulae of two substances, **W** and **X**, are given.

substance	chemical formula
W	$NaAlSi_3O_8$
X	$CaAl_2Si_2O_8$

Which statements are correct?

I **W** and **X** contain the same percentage by mass of oxygen.
II **W** and **X** contain the same number of atoms in 1 mole of the substance.
III **X** has higher M_r than **W**.

A **I** and **II** only **B** **I** and **III** only

C **II** and **III** only **D** **I, II** and **III**

27 What is the concentration of Fe^{3+} ions in 0.01 mol/dm^3 of aqueous $Fe_2(SO_4)_3$?

A 0.01 g/dm^3 **B** 0.02 g/dm^3

C 1.12 g/dm^3 **D** 1.68 g/dm^3

28 A 500 cm^3 of potassium chloride solution at 0.250 mol/dm^3 was left in the open for two days. At the end of the second day, the concentration of the solution was determined to be 0.265 mol/dm^3.

What is the volume of water that had evaporated?

A 12 cm^3 **B** 14 cm^3

C 24 cm^3 **D** 28 cm^3

29 One of the reactions in the manufacture of sulfuric acid is the reaction between sulfur dioxide and oxygen to form sulfur trioxide.

$$2\ SO_2 + O_2 \rightarrow 2\ SO_3$$

What is the mass of sulfur trioxide that can be obtained by reacting 72 dm^3 of sulfur dioxide in excess oxygen?

A 72 g **B** 80 g

C 160 g **D** 240 g

30 Calcium reacts with excess nitric acid, according to the equation shown below.

$$Ca + 2\ HNO_3 \rightarrow Ca(NO_3)_2 + H_2$$

When 6 g of calcium was completely reacted, only 15 g of calcium nitrate was obtained from crystallisation.

What is the percentage yield of calcium nitrate?

A 20% **B** 39%

C 40% **D** 61%

– END OF BOOKLET A –

Name: .... (   )

ASSUMPTION ENGLISH SCHOOL
MID-YEAR EXAMINATION 2019

CHEMISTRY 6092
BOOKLET B

LEVEL: Sec 3 Express **DATE:** 9 May 2019

CLASS: Sec 3/2 **DURATION:** 2 hours 30 minutes (for Booklets **A** and **B**)

Additional materials provided: NIL

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.
Write your NAME and INDEX NUMBER at the top of this page.

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BOOKLET A:
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There are 30 questions in this section. Answer **all** questions. For each question, there are four possible answers A, B, C and D. **Choose the correct answer and record your choice in soft or 2B pencil on the OAS paper provided.**

BOOKLET B:
SECTION B: SHORT-STRUCTURED QUESTIONS (40 marks)
Answer **all** questions in the spaces provided on the question paper.

SECTION C: FREE RESPONSE QUESTIONS (30 marks)
Answer all **three** questions, the last question is in the form of an **EITHER / OR**. Write your answers in the spaces provided on the question paper.

For Examiner's use:	
Section A	/ 30
Section B	/ 40
Section C	/ 30
Total	/ 100

At the end of the examination, hand in your OAS paper, Booklets **A** and **B** separately.
A copy of the Periodic Table is printed on page 22.

This Question Paper consists of 22 printed pages including this page.

SECTION B: SHORT-STRUCTURED QUESTIONS [40 MARKS]

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

1 Paper chromatography can be carried out in two different ways.
In the descending method, solvent flows down the paper as shown in Fig. 1.1.
In the ascending method, solvent travels up the paper as shown in Fig. 1.2.

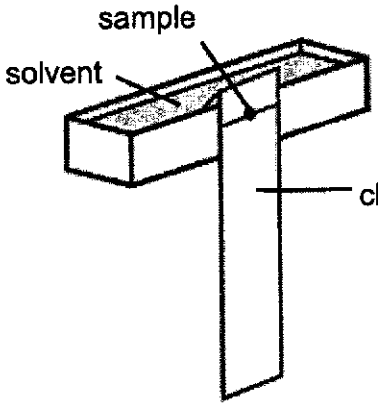


Fig. 1.1

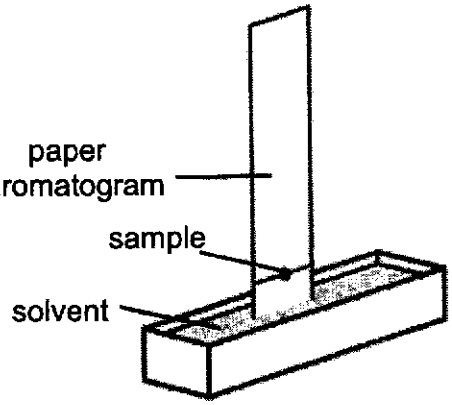


Fig. 1.2

An ink sample was analysed using the two methods. The type of solvent and duration of the experiment were kept constant. The results obtained are shown in Fig. 1.3. A complete separation of the ink is shown in chromatogram **X**. Only the solvent front is shown in chromatogram **Y**.

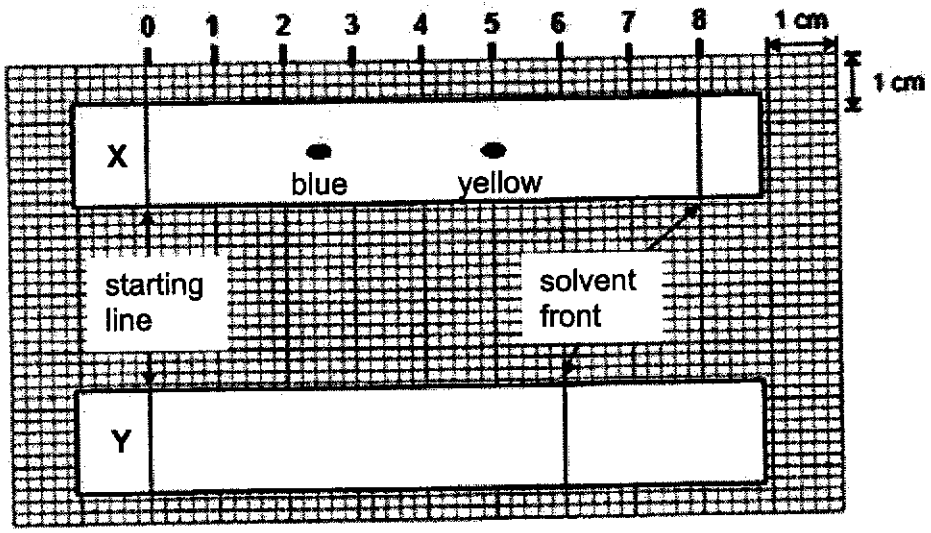


Fig. 1.3

(a) Suggest, with a reason, which chromatogram, **X** or **Y**, is obtained using the descending method.

.....

..... [1]

(b) **(i)** Calculate the R_f values of the blue and yellow dyes in chromatogram **X** giving your answers to 1 decimal place.

Blue dye: ..... Yellow dye: ..... [2]

(ii) Using the rounded off values in part **(b)(i)**, draw and label to show the position of the blue and yellow dyes in chromatogram **Y**. [1]

(c) Which method is better to be used in separating the different dyes in the ink? Explain your answer.

.....

..... [1]

(d) Some chromatogram requires the use of a locating agent.
What is the purpose of the locating agent?

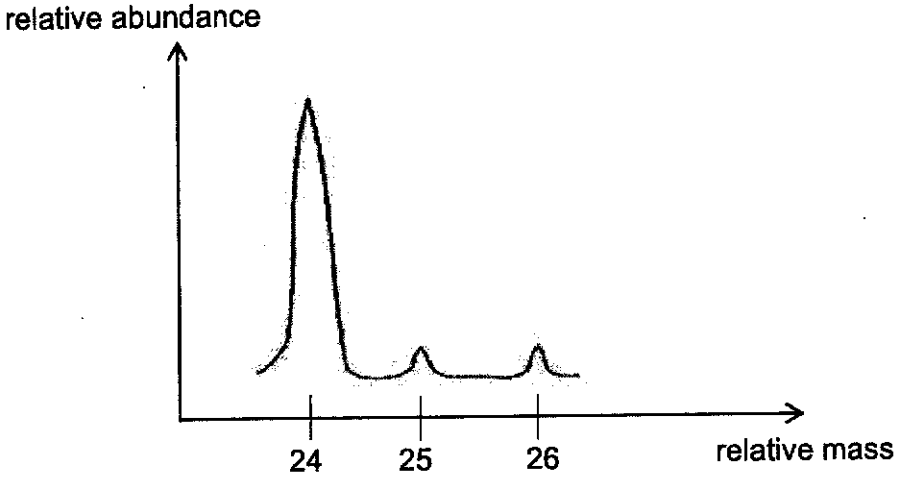
.....

..... [1]

2 The atomic mass spectrum is a printout from the mass spectrometer that contains

information such as the isotopes present in the element, the relative mass of each isotope and the abundance of each isotope.

Study the mass spectrum of a naturally occurring element below and answer the questions.



(a) Define *isotopes*.

.....

..... [1]

(b) State the number of isotopes present in the element.

..... [1]

(c) **(i)** State the relative mass of the isotope that is the most abundant.

..... [1]

(ii) Using your answer in part **(c)(i)**, identify the element.

..... [1]

(d) The results of the mass spectrum were tabulated.

relative mass	24	25	26
abundance (%)	78.99	10.00	11.01

Calculate the relative atomic mass of this element.

[2]

3 Lattice energy is a numerical measure of the amount of energy which is required to break down a solid ionic compound and convert its ions into the gaseous state.

The table below shows the lattice energy of some ionic compounds.

name of ionic compound	lattice energy (kJ/mol)
potassium chloride	715
calcium chloride	796
calcium oxide	3540

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

[2]

(b) (i) By referring to the charges of the ions present in each ionic compound, describe how the value of the lattice energy varies as the charges of the

ions change.

.....

..... [1]

(ii) Explain the trend which is observed in part **(b)(i)**.

.....

.....

..... [2]

4 An element **Y** forms a chloride, YCl_2, which has a melting point of -70 °C and a boiling point of 60 °C.

(a) Deduce

(i) the physical state of YCl_2 at room temperature,

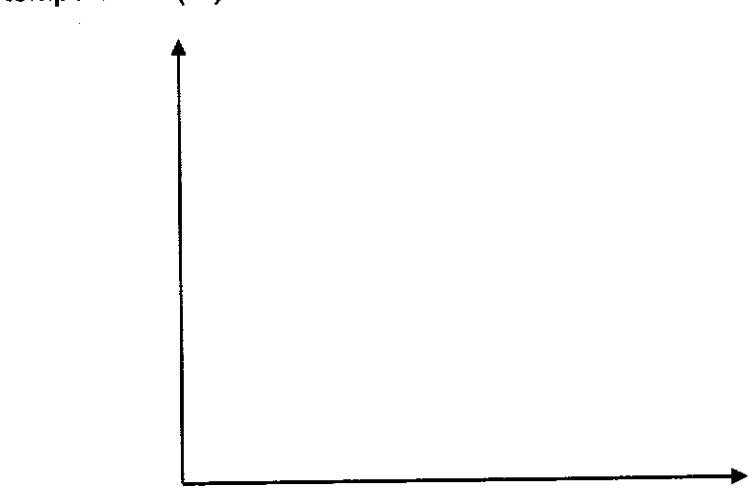
..... [1]

(ii) the type of bonding present in YCl_2, giving a reason for your answer.

.....

..... [2]

(b) On the axes provided below, sketch the cooling curve for a sample of pure YCl_2 when it is cooled from 90 °C to 20 °C. Label all relevant temperatures.



[2]

(c) When YCl_2 reacts with another metal, it forms a new compound which

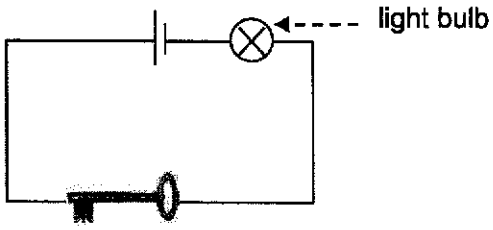
changes directly from the solid to the gaseous state at 68 °C.

Describe how one could obtain the solid form of this new compound from its gaseous form.

.....

..... [1]

5 Christopher wanted to test the electrical conductivity of an iron key. He carefully connected the key to complete a circuit as shown below. The bulb lit up.

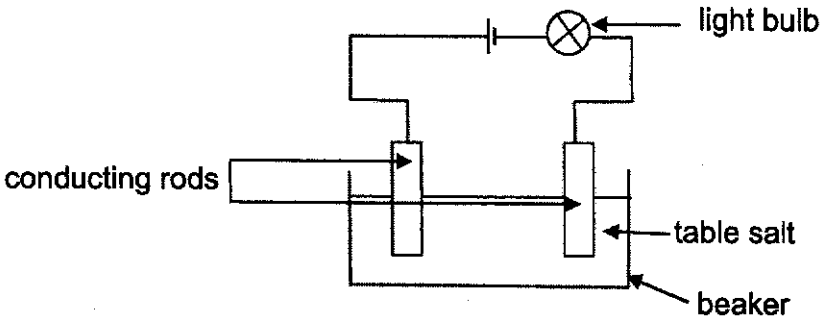


(a) Explain, in terms of structure and bonding, why the bulb lit up.

.....

..... [2]

Christopher then concluded that all solids could conduct electricity. Thus he decided to test the electrical conductivity of table salt (solid sodium chloride) using the set-up as shown in the diagram below. The bulb did not light up.



(b) Explain, in terms of structure and bonding, why the bulb did not light up.

.....

..... [2]

(c) Suggest two ways on how you could modify the experimental set-up to light up the bulb.

.....

..... [2]

6 6 dm^3 of carbonyl sulfide (COS) was combusted in 18 dm^3 of oxygen to form carbon dioxide and sulfur dioxide according to the equation below.
(All volumes of reactants and products are measured at r.t.p)

$$2\ COS\ (g) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 2\ SO_2\ (g)$$

(a) Calculate the number of moles of carbonyl sulfide used.

[1]

(b) Calculate the number of moles of oxygen used.

[1]

(c) Determine the limiting reagent.

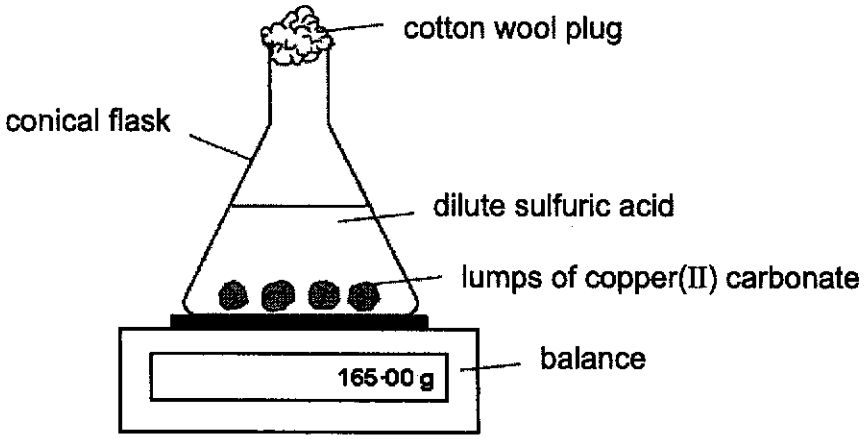
[2]

(d) Calculate the total volume of gases at the end of the reaction.

[3]

7 A student used the apparatus shown below to follow the progress of the reaction between copper(II) carbonate with excess dilute sulfuric acid to form water, carbon

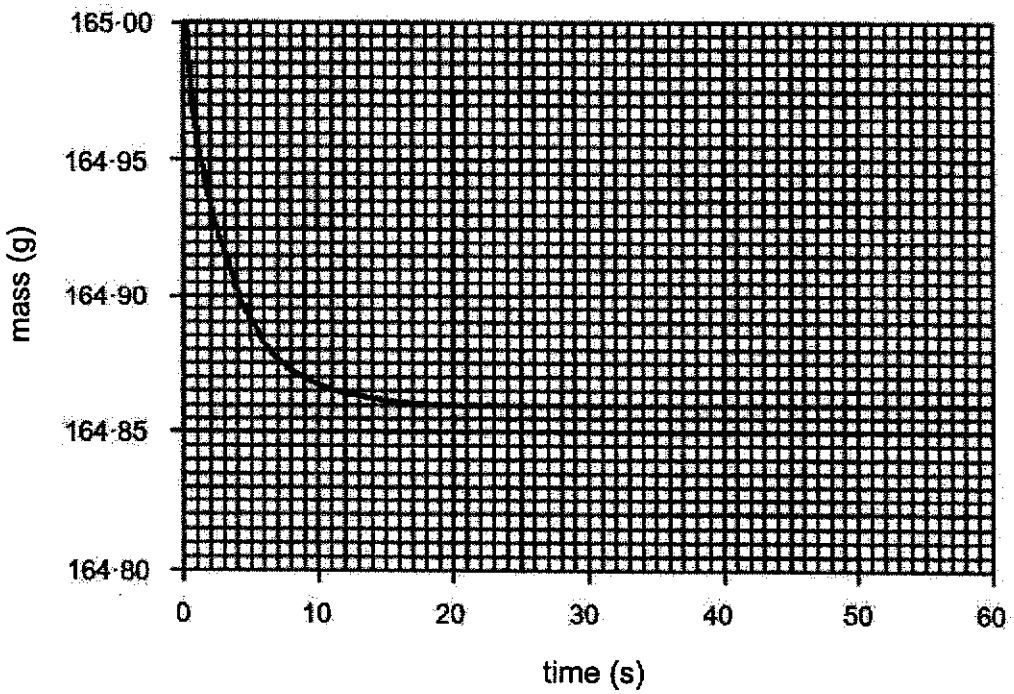
dioxide gas and copper(II) sulfate.



(a) Write a balanced chemical equation for the above reaction.

..... [1]

(b) The experiment was carried out using 0.50 g of impure copper(II) carbonate. The graph below shows the results obtained. The decrease in mass was due to loss of gas produced in the reaction.



Using the data from the graph, calculate the percentage purity of the impure sample. [3]

10

SECTION C: FREE-RESPONSE QUESTIONS [30 MARKS]

Answer **all** the questions in the spaces provided. The last question is in the form of an EITHER / OR and only one of the alternatives should be attempted.

1 Carbon is the name derived from Latin: carbo "coal". It is non-metallic and has four valence electrons available to form covalent chemical bonds. Three isotopes occur naturally, ^{12}C and ^{13}C being stable, while ^{14}C is not.

Carbon is the 15th most abundant element in the Earth's crust, and the fourth most abundant element in the universe by mass after hydrogen, helium, and oxygen. Carbon's abundance, its unique diversity of organic compounds, and its unusual ability to form polymers at the temperatures commonly encountered on Earth enables this element to serve as a common element of all known life. It is the second most abundant element in the human body by mass (about 18.5%) after oxygen.

Allotropy is the existence of an element in two or more forms. Allotropes differ in the arrangement of atoms in crystalline solids or in the occurrence of molecules that contain different number of atoms. The existence of different crystalline forms of an element is the same phenomenon that in the case of compounds is called polymorphism. Diamond, graphite and graphene are some of the carbon allotropes.

The physical properties of carbon vary widely with the allotropic form. For example, graphite is opaque and black while diamond is highly transparent. Graphite is soft enough to write on paper, while diamond is the hardest naturally occurring material known. Graphite is a good electrical conductor while diamond has a low electrical conductivity. As graphene is the world's strongest material, it is used to enhance the strength of other materials. Such graphene enhanced composite materials find their uses in aerospace, building materials, mobile devices and other applications.

The structures of the three allotropes of carbon are shown in Fig 1.1.

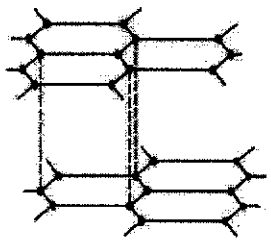
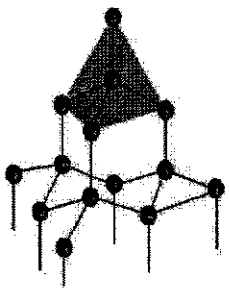
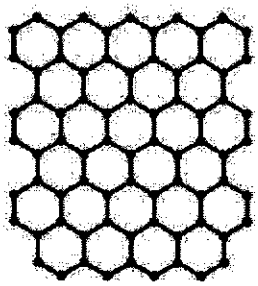
graphite	diamond	graphene
		

Fig. 1.1

When carbon compounds dissolve in water, they break apart into molecules, but not individual atoms. Water is a polar solvent, but covalent compounds are usually nonpolar. This means covalent compounds typically do not dissolve in water, instead making a separate layer on the water's surface. Sugar is one of the few carbon compounds that dissolves in water because it is a polar covalent compound (parts of their molecules have a negative side and a positive side), but it still does not separate into ions the way ionic compounds do in water.

The figures below show how the melting point (Fig. 1.2) and electrical conductivity (Fig. 1.3) of carbon varies as compared to the other elements in Period 2 of the Periodic Table.

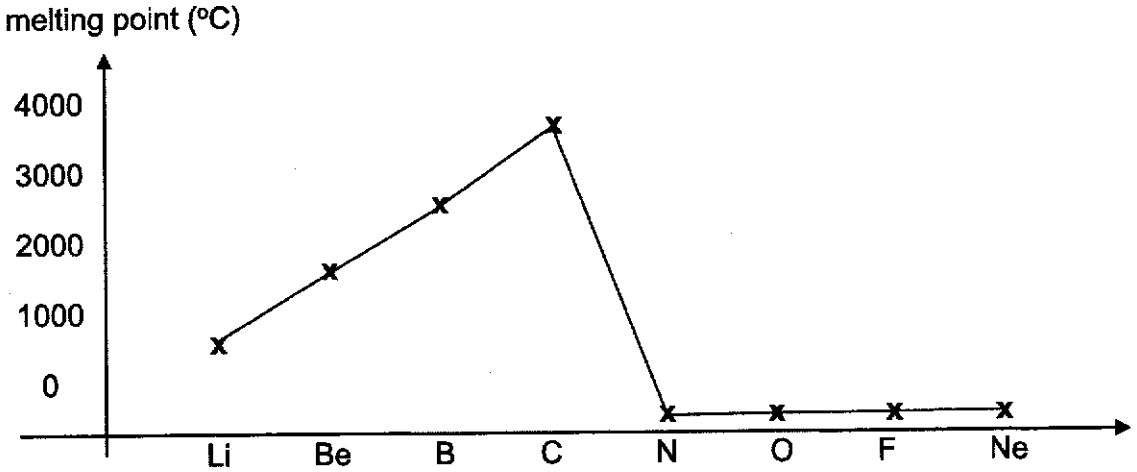


Fig. 1.2

element	Li	Be	B	C	N	O	F	Ne
electrical conductivity (at room temperature and pressure)	good	good	poor	good	does not conduct			

Fig. 1.3

Information adapted from:
https://www.britannica.com/science/allotropy
https://sciencing.com/happens-covalent-compounds-dissolve-water-8575445.html
https://en.wikipedia.org/wiki/Carbon

Answer all questions by referring to the data provided above.

(a) **(i)** Comment on the melting point of carbon compared to the other elements in the period.

..... [1]

(ii) Suggest a possible reason for your answer in part **(a)(i)**.

..... [1]

(b) **(i)** Does the electrical conductivity of carbon fit the general pattern across the period? Justify your answer.

.....

..... [1]

(ii) State and explain which allotrope(s) of carbon is / are represented by the data in Fig. 1.2 and 1.3.

.....

.....

..... [2]

(iii) Using the structure and bonding, explain the electrical conductivity of carbon in part **(b)(ii)**.

.....

..... [1]

(c) Explain, using the structure and bonding, why graphite is slippery.

.....

..... [1]

(d) (i) The table below shows the polarity of some substances.

substance	ammonia	sulfur dioxide	oil	carbon dioxide	sodium chloride
polarity	polar	polar	non-polar	non-polar	polar
solubility in water					

Suggest the solubility of the above five substances in water by writing soluble or insoluble in the last row. [2]

(ii) Suggest a reason for the solubility of ammonia in water.

.....

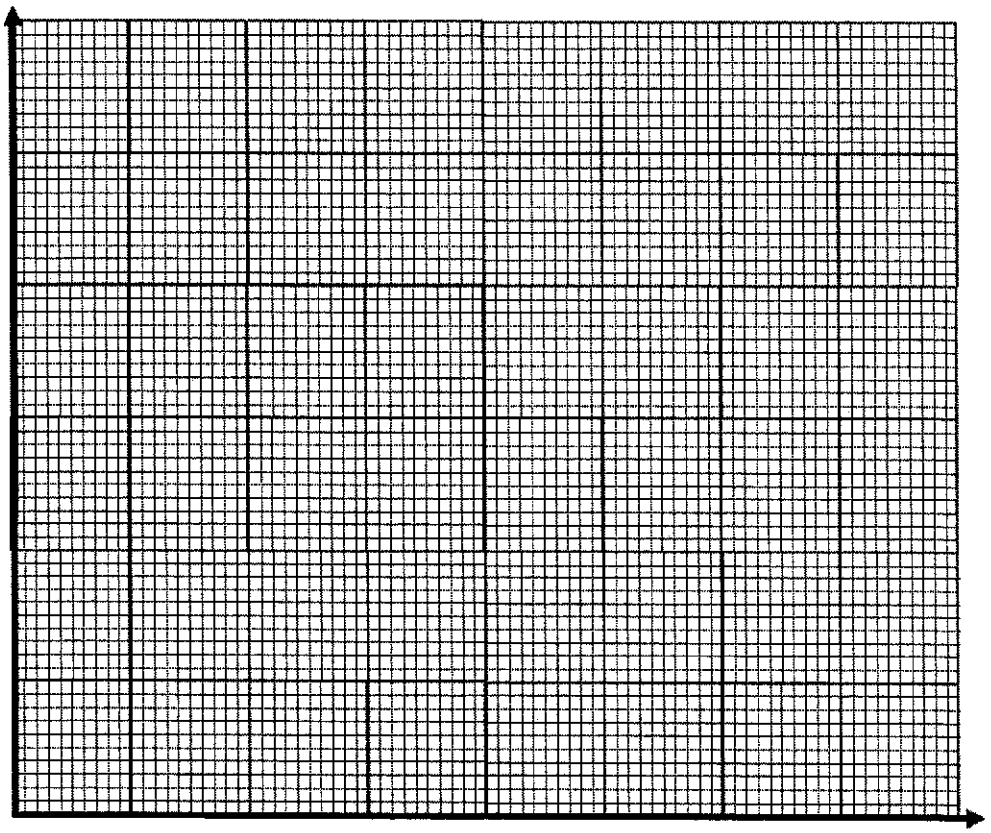
..... [1]

2 In an experiment to investigate the speed of diffusion of gases, a gas was allowed

to pass through a small hole in a metal tube. The time taken for a fixed volume of a gas to diffuse through the hole was then recorded. The experiment was then repeated under the same conditions with different gases, and the results obtained were recorded in the table below.

name	formula	relative molecular mass	time taken (s)
hydrogen	H_2	2	25
helium	He	4	35
carbon monoxide	CO	28	94
nitrogen dioxide	NO_2	46	120

(a) Plot a labelled graph of relative molecular mass against time taken for the diffusion of the gas on the grid below.



[3]

(b) Deduce the relationship between the speed of diffusion of a gas and its

relative molecular mass.

.....

..... [1]

(c) **(i)** Based on your graph in part **(a)**, deduce the time taken for the diffusion of the following gases below.

Nitrogen gas: .....

Carbon dioxide gas: ..... [1]

(ii) Explain your answer in part **(c)(i)**.

.....

.....

.....

..... [2]

(d) State a change to the experiment that can speed the diffusion of gases through the small hole in a metal tube.

.....

..... [1]

(e) **(i)** Draw the electronic structure of helium.

[1]

(ii) Using the electronic configuration of helium, explain why it is unreactive.

.....

..... [1]

EITHER

3 Many daily products contain dissolved chemicals. These chemicals can be harmful when present in high concentrations. For example, too much ammonia in floor cleaners can cause skin irritation. Chemists can check the concentration of these substances by carrying out volumetric analysis (titration).

One such common laboratory experiment would be the neutralisation reaction between sodium hydroxide and sulfuric acid. The equation of the reaction is as follows:

$$2\ NaOH\ (aq) + H_2SO_4\ (aq) \rightarrow Na_2SO_4\ (aq) + H_2O\ (l)$$

(a) Write the ionic equation for this neutralisation reaction.

..... [1]

(b) A student wanted to conduct titration to find out the volume of sulfuric acid needed to neutralise the sodium hydroxide.

She measured exactly 25.0 cm^3 of sodium hydroxide.
One of the titration readings for sulfuric acid was 27.40 cm^3.

Suggest suitable apparatus to measure the volumes of sodium hydroxide and sulfuric acid in this titration experiment.

Sodium hydroxide: .....

Sulfuric acid: ..... [1]

(c) The student carried out four titrations to find out the volume of 0.100 mol/dm^3 sulfuric acid needed to neutralise the sodium hydroxide of unknown concentration. Her results are shown in the table below.

titration	1	2	3	4
volume of sulfuric acid (cm^3)	27.40	28.15	27.05	27.15

(i) Consistent results are within 0.10 cm^3 of each other. Calculate the average volume of sulfuric acid used in the reaction.

[1]

(ii) Calculate the concentration, in mol/dm^3, of sodium hydroxide used in the neutralisation reaction.

[3]

(d) The student did another experiment using 20.0 cm^3 of sodium hydroxide solution with a concentration of 0.18 mol/dm^3. Calculate the mass of sodium hydroxide in 20.0 cm^3 of this solution.

[2]

(e) An indicator is added to the conical flask containing sodium hydroxide before

the titration is carried out.

(i) State the purpose of the indicator.

.....

..... [1]

(ii) The table below shows some information about different types of solutions and their nature.

type of solution	acidic	neutral	alkaline
pH value	less than 7	exactly 7	more than 7
colour in indicator	red	green	blue

Given that sodium hydroxide is alkaline and the products formed in the titration reaction are neutral, suggest the colour change that happens in the conical flask, upon neutralisation.

..... [1]

OR

3 Nitrogen is an unreactive element as it requires a huge amount of energy to break the nitrogen bonds. During a thunderstorm, the energy from the lightning can be used to chemically combine nitrogen and oxygen to form oxides of nitrogen. These several nitrogen oxides have different formulae and properties.

(a) Draw the electronic configuration of nitrogen molecule. Show only valence electrons.

[2]

(b) Using bonding and structure, explain why nitrogen exists as a gas in room temperature and pressure.

.....

.....

..... [2]

(c) The table below shows data from experiments to analyse the mass of nitrogen and oxygen in two samples of oxides. [4]

	mass of nitrogen (g)	mass of oxygen (g)
oxide 1	0.35	0.78
oxide 2	0.35	1.63

Using the above data, find the empirical formulae of both oxides and show that they are the same.

(d) Further experiments showed that oxide 1 has a molecular mass of 46 and oxide 2 has a molecular mass of 92. Find the **molecular formulae** of the two oxides.

[2]

The volume of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

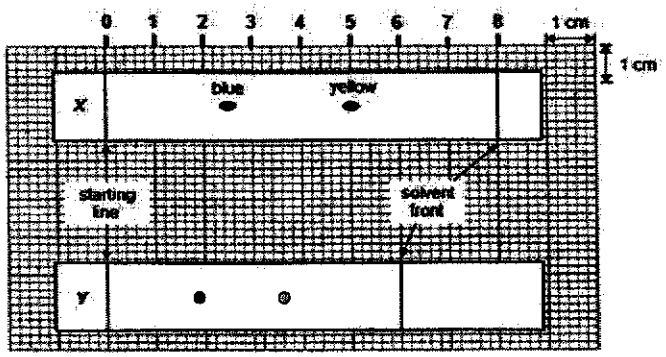
– END OF BOOKLET B –

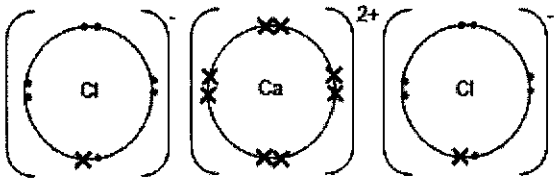
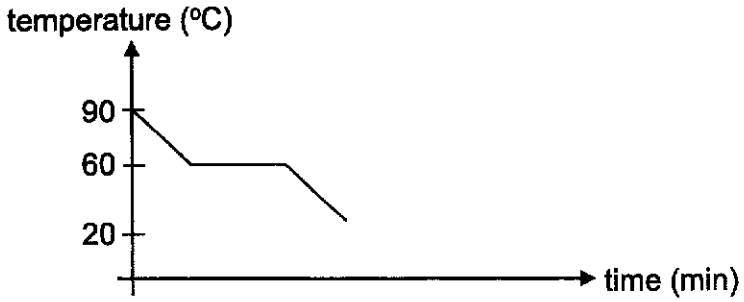
6092 Chemistry Mid-Year Exam 2019 Marking Scheme

SECTION A: MULTIPLE CHOICE QUESTIONS [30 MARKS]

1	2	3	4	5	6	7	8	9	10
B	C	C	B	D	A	D	D	A	B
11	12	13	14	15	16	17	18	19	20
D	C	B	B	A	D	C	C	A	A
21	22	23	24	25	26	27	28	29	30
B	A	A	C	A	C	C	D	D	D

SECTION B: SHORT-STRUCTURED QUESTIONS [40 MARKS]

1a	X. Solvent front travels a greater distance due to pull of gravity.	1
bi	Rf of blue dye = 2.5 / 8 = 0.3125 = 0.3 (1dp) Rf of yellow dye = 5 / 8 = 0.625 = 0.6 (1dp)	1 1
bii	 Diagram III 0.3 = Blue / 6 Blue = 1.9 cm 0.6 = yellow / 6 Blue = 3.6 cm	Correct distance and labelled 1m Allow ecf from bi
c	Descending method. For the same duration of time, the dyes travel further / faster from the starting line. Or dyes do not overlap and can be distinguished clearly. Award 1 mark when reason is correct.	1
d	To make colourless spots visible.	1
2(a)	Atoms of the same element with same number of protons and electrons but different number of neutrons.	1
(b)	3 isotopes	1
(c)(i)	24	1
(c)(ii)	Magnesium/Mg	1

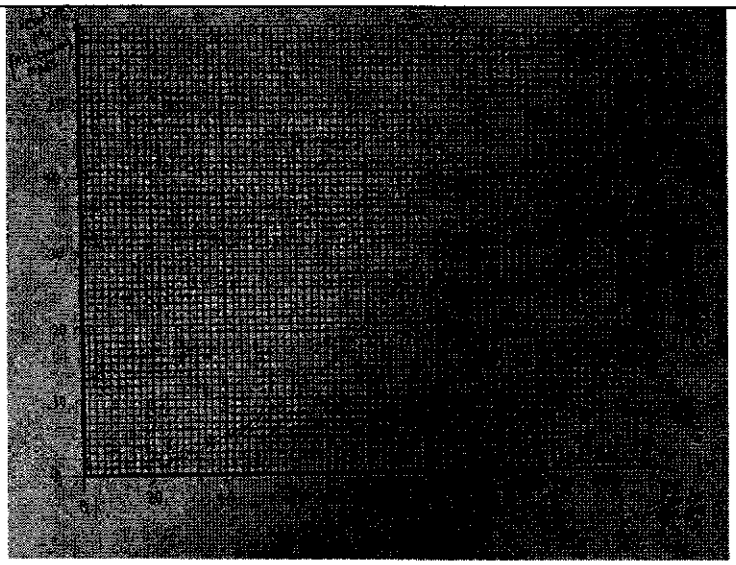
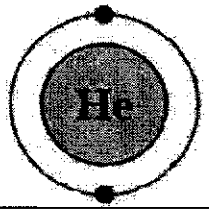
(d)	Average relative mass $= \frac{78.99}{100} \times 24 + \frac{10.00}{100} \times 25 + \frac{11.01}{100} \times 26$ = 18.9576 + 2.5 + 2.8626 = 24.3202 = 24.3 (3sf)	1 mark for working 1 mark for 3sf ans
3(a)		1 mark for correct number of electrons transferred in all ion 1 mark for correct number of electrons in all ions
(b)(i)	The value of the lattice energy increases as the charges of the ions increase. OR The value of the lattice energy decreases as the charges of the ions decrease.	1
(b)(ii)	As the charges of the ions increase, the electrostatic attraction between the ions also increases/gets stronger. It would take more energy to overcome the electrostatic forces of attraction/break up the ionic lattice structure.	1 mark for the relationship 1 mark for explanation
4(a)(i)	Liquid	1
(a)(ii)	YCl_2 is a covalent compound because it has a low melting and boiling point.	1 1
(b)		1 mark for correct curve with one plateau 1 mark for correct labelling of all three temperatures
(c)	An inverted filter funnel is placed over the gaseous compound. As the solid mixture sublimes and the gas/vapour touches the cool surface of the filter funnel, it will turn into solid again.	1 mark for showing ideas of sublimation mentioning heating and cooling

5(a)	Iron is held by strong metallic bonds between iron metal ions and a sea of delocalized electrons in a giant metallic structure. The delocalized electrons move freely within the structure to act as charge carriers to conduct electricity.	1 1
(b)	In solid common salt, sodium and chloride ions are held in fixed positions in a giant lattice structure. Hence there are no mobile ions to act as charge carriers to conduct electricity.	1 1
(c)	Melt the table salt. Dissolve the solid in a beaker of water.	1 1
6(a)	No. of moles of COS used = 6 ÷ 24 = 0.250	1
(b)	No. of moles of O_2 used = 18 ÷ 24 = 0.750	1
(c)	2COS: $3O_2$ If O_2 is LR, no. of moles of COS needed = 2/3 x 0.750 = 0.500 If COS is LR, no. of moles of O_2 needed = 3/2 x 0.250 = 0.375 Thus, carbonyl sulfide is limiting.	 1 1
(d)	No. of moles of O_2 left = 0.750 – 0.375 = 0.375 No. of moles of gases formed = 2 x 0.250 = 0.50 No. of moles of gases at the end = 0.50 + 0. 375 = 0.875 Volume of gases at the end = 0.875 x 24.0 = 21.0 dm^3	 1 1 1
7(a)	$H_2SO_4 + CuCO_3 \rightarrow CuSO_4 + H_2O + CO_2$	1
(b)	No. of mole of CO_2 produced = (165.00 – 164.86) / 44 = 0.003182 mol (4sf) Mass of pure $CuCO_3$ = 0.003182 x 124 = 0.3946 g Percentage purity = 0.3946 / 0.50 x 100 = 78.9 %	 1 1 1

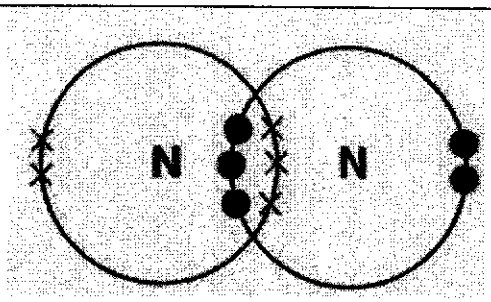
SECTION C: FREE-RESPONSE QUESTIONS [30 MARKS]

<table>
<tr><td>1ai</td><td>It has a high melting point.</td><td>1</td></tr>
<tr><td>aii</td><td>It has a macromolecular/ tetrahedral structure/ strong covalent bonds.</td><td>1</td></tr>
<tr><td>bi</td><td>No.
It is a non-metal and conducts electricity.

Award 1 mark only if reason is correct.</td><td>1</td></tr>
<tr><td>bii</td><td>Graphite and graphene.
It has a high melting point and conducts electricity.</td><td>1
1</td></tr>
<tr><td>biii</td><td>It has one delocalised electron from the unbonded carbon atom in the hexagonal arrangement that acts as a charge carrier to conduct electricity. (1 carbon atom bonded to 3 other carbon atoms)</td><td>1</td></tr>
<tr><td>c</td><td>The layers of hexagonal arrangement of atoms in graphite are able to slide past each other due to weak van der Waals forces, hence is slippery.</td><td>1</td></tr>
<tr><td>di</td><td><table>
<tr><td></td><td>ammonia</td><td>sulfur dioxide</td><td>oil</td><td>carbon dioxide</td><td>sodium chloride</td></tr>
<tr><td>polarity</td><td>polar</td><td>polar</td><td>non-polar</td><td>non-polar</td><td>polar</td></tr>
<tr><td>solubility in water</td><td>soluble</td><td>soluble</td><td>insoluble</td><td>insoluble</td><td>soluble</td></tr>
</table>
All 5 correct – 2 marks
3/4 correct – 1 mark
0/1/2 correct – 0 mark</td><td>2</td></tr>
<tr><td>dii</td><td>As ammonia is polar, parts of the molecules have a negative side and a positive side and hence soluble in water.</td><td>1</td></tr>
</table>

2a		labelled axis with units 1m 4 points plotted 1m curve shown 1m
b	Smaller relative molecular mass, faster speed of reaction or vice versa.	1
ci	Nitrogen: 94 Carbon dioxide: 119 Allow +/- 2s. If students read from the graph accept.	1
cii	N_2 has the same relative molecular mass as CO so the time taken for diffusion will be the same. CO_2 has a relative molecular mass of 44 so time taken for diffusion is slightly shorter than NO_2.	1 1
d	Conduct experiment at a higher temperature.	1
ei		1
eii	Helium has a complete valence shell and does not need to gain, lose or share electrons. Hence it is stable and unreactive.	1

3Either a	$H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$	1
b	Pipette Burette	1
ci	$\frac{27.15+27.05}{2}$ = 27.10	1
cii	Moles $H_2SO_4 = 0.100 \times \frac{27.10}{1000} = 0.00271$ Moles NaOH = 0.00271× 2 = 0.00542 Concentration NaOH = 0.00542/0.025 = 0.217 mol/dm^3 (3 s.f.)	1 1 1
d	Moles of NaOH = (20/1000) × 0.18 = 0.0036 Mass of NaOH = 0.0036 × 40 = 0.144 g	1 1
ei	To show a permanent colour change, indicating complete reaction.	1
eii	Blue to green	1

<table>
<tr><td>3OR
a</td><td> 
</td><td>2
1m – correct bonding electrons
1m – correct non-bonding electrons</td></tr>
<tr><td>b</td><td>The nitrogen molecules are held together in a simple molecular structure by weak van dar waals' forces that require little energy to be overcome.

Hence nitrogen has a low melting point and exists as a gas at room temperature and pressure.</td><td>1
Both structure and VDW must be mentioned

1
Low m.p.</td></tr>
<tr><td>c</td><td>Oxide 1:
<table><tr><td></td><td>Nitrogen</td><td>Oxygen</td></tr><tr><td>Mass</td><td>0.35</td><td>0.78</td></tr><tr><td>Divide by A_r</td><td>0.35/14 = 0.025</td><td>0.78/16 = 0.4875</td></tr><tr><td>Divide by smallest ratio</td><td>0.025/0.025 = 1</td><td>0.4875/0.025 = 1.95
= 2 (nearest whole no)</td></tr></table>Empirical formulae = NO_2

Oxide 2:
<table><tr><td></td><td>Nitrogen</td><td>Oxygen</td></tr><tr><td>Mass</td><td>0.68</td><td>1.63</td></tr><tr><td>Divide by A_r</td><td>0.68/14 = 0.04857</td><td>1.63/16 = 0.101875</td></tr><tr><td>Divide by smallest ratio</td><td>0.04857/0.04857 = 1</td><td>0.101875 / 0.04857 =
2.097
= 2 (nearest whole no)</td></tr></table>Empirical formulae = NO_2</td><td>1

1

1

1</td></tr>
<tr><td>d</td><td>Oxide 1:
n(14 + 2x16) = 46
n = 1
Molecular formulae = NO_2

Oxide 2
n(14 + 2x16) = 92
n = 2
Molecular formulae = N_2O_4</td><td>1

1</td></tr>
</table>