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**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.

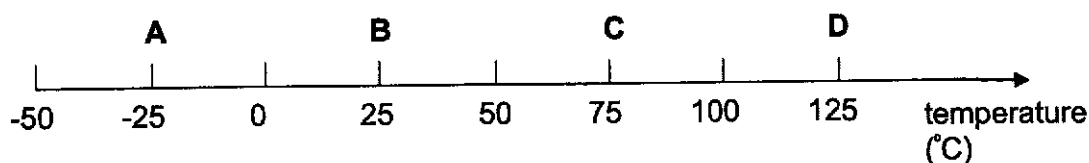
At the end of the examination, hand in your OAS paper, Booklets A and B separately.
A copy of the Periodic Table is printed on the last page of Booklet B.

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

2

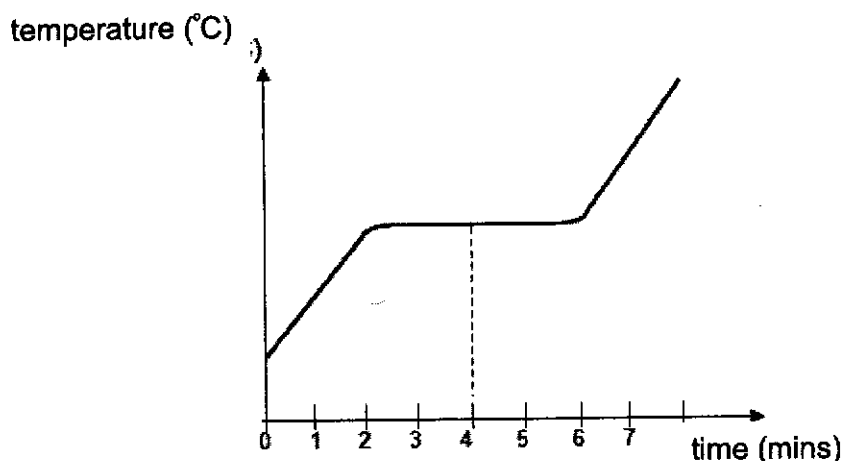
There are **thirty** questions in this section. Answer **ALL** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice on the OAS in soft pencil.

- 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?

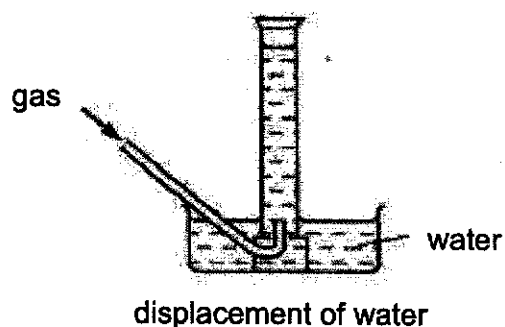
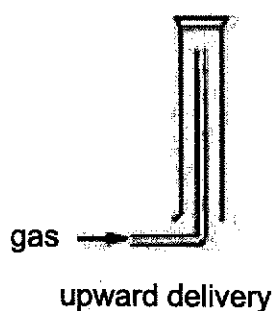
- A All the particles are arranged closely.
- B All the particles move freely in all directions.
- C Some particles are gaining enough energy to overcome attractive forces to be able to slide past each other.
- D Some particles slide past each other while some particles move freely in all directions.

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

3

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.



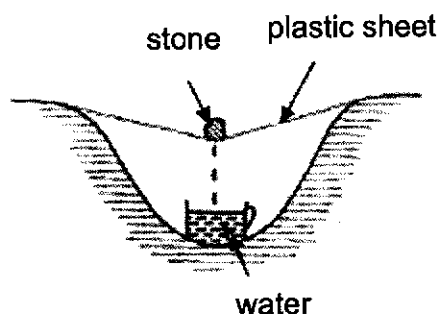
Which row correctly shows whether each of these methods could or could not be used to collect each gas?

	gas	method of collection	
		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

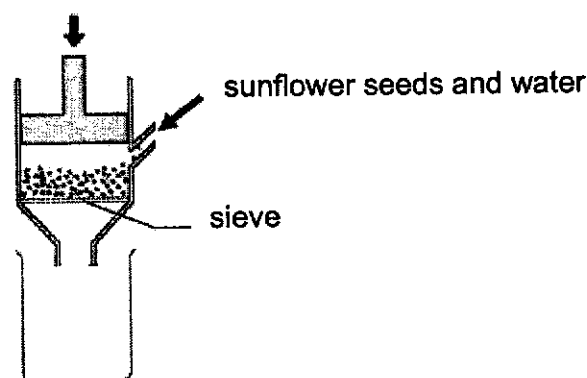
4

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

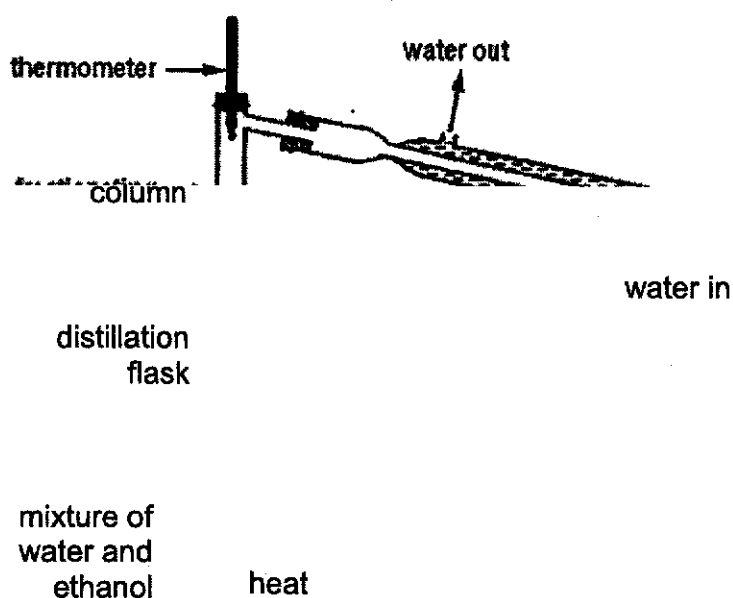
- | | |
|-----------------------|-----------------------|
| A condensation | B distillation |
| C evaporation | D filtration |
- 5** A student attempted to extract oil from sunflower seeds using a home-made oil press shown in the diagram below. The sunflower seeds were first crushed and then water was 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.



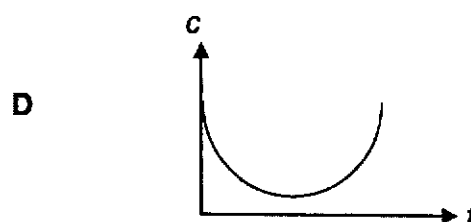
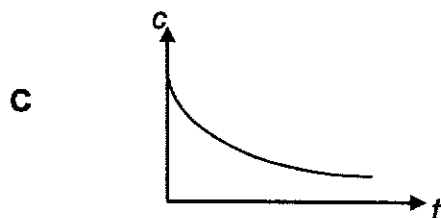
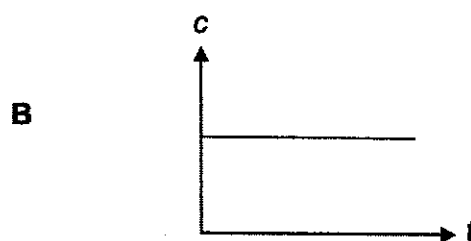
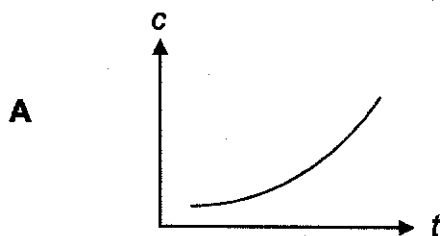
Which method can be used to recover the sunflower oil from the contents in the beaker?

- | | |
|----------------------------------|----------------------------------|
| 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



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



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

A carbon, zinc, silver chloride

6

- 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**.

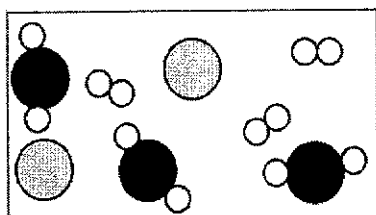


diagram I

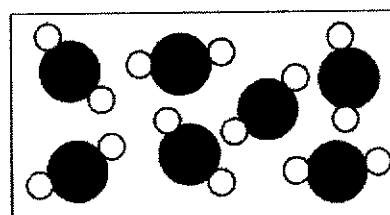


diagram II

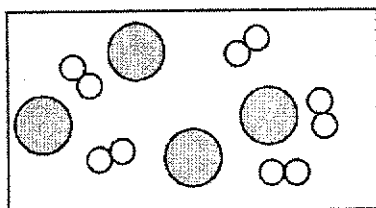


diagram III

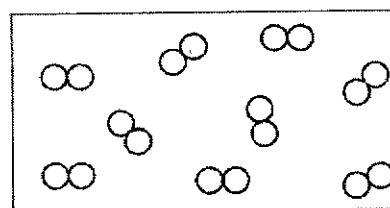


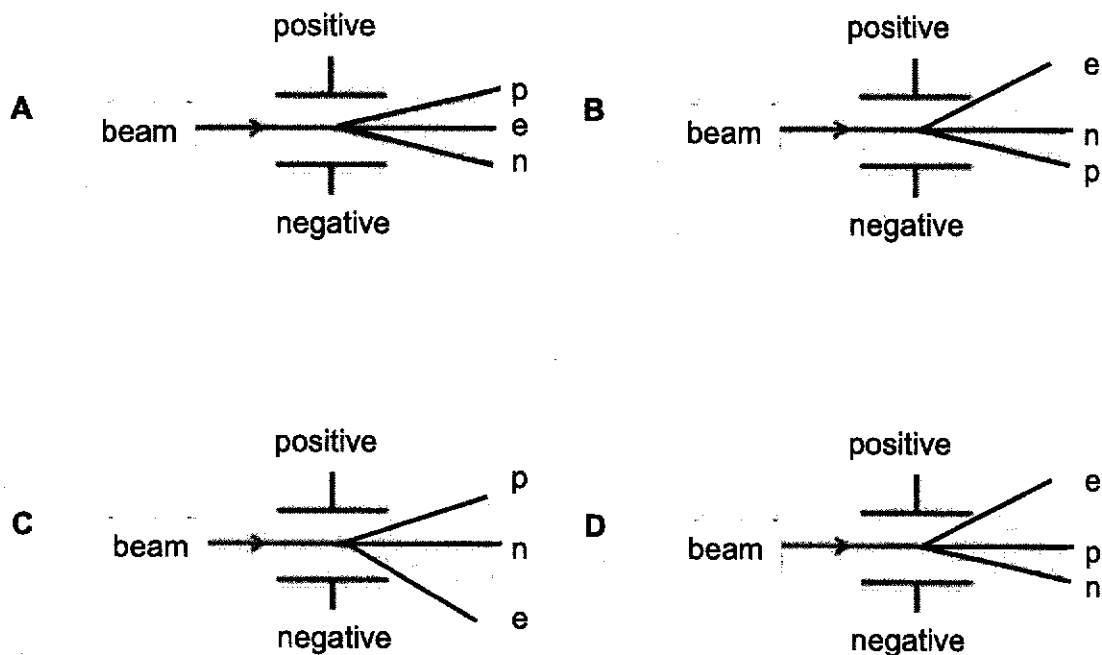
diagram IV

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?



- 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.

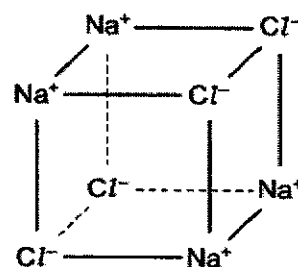
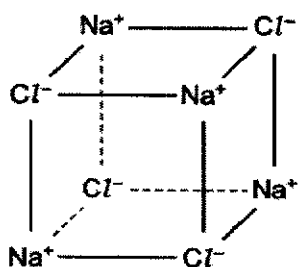
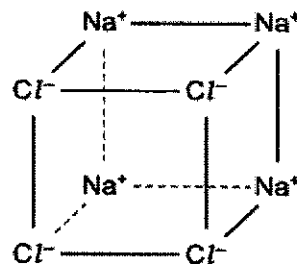
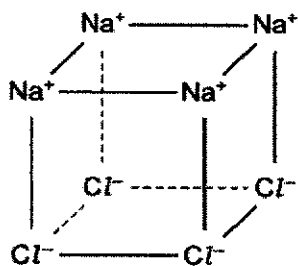
What does atom **X** contain?

	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

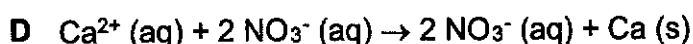
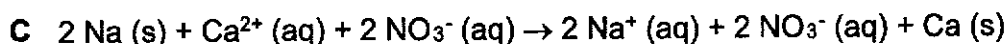
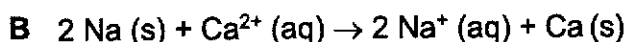


- D** $\text{Na}_2\text{Si}_2\text{O}_3$

- ## D sodium

- D** sodium chloride

- A** $2 \text{Na (s)} + 2 \text{NO}_3^- \text{(aq)} \rightarrow 2 \text{NaNO}_3 \text{(aq)}$



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 **QNO₃** and has an *M_r* of 101.

What is the M_r of an oxide of Q?

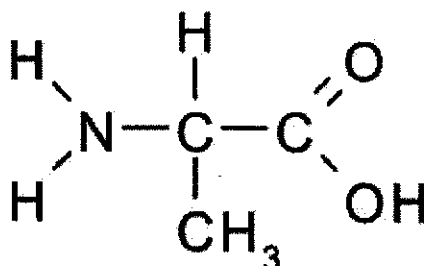
A 55

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	$\text{NaAlSi}_3\text{O}_8$
X	$\text{CaAl}_2\text{Si}_2\text{O}_8$

Which statements are correct?

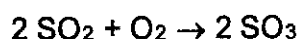
- I **W** and **X** contain the same percentage by mass of oxygen.
 II **W** and **X** contain the same number of atoms in 1 mole of the substance.
 III **X** has higher M_r than **W**.
- A I and II only
B I and III only
C II and III only
D I, II and III
- 27 What is the concentration of Fe^{3+} ions in 0.01 mol/dm^3 of aqueous $\text{Fe}_2(\text{SO}_4)_3$?
- 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 cm³ of potassium chloride solution at 0.250 mol/dm³ 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/dm³.

What is the volume of water that had evaporated?

- A** 12 cm³
- B** 14 cm³
- C** 24 cm³
- D** 28 cm³

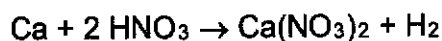
- 29** One of the reactions in the manufacture of sulfuric acid is the reaction between sulfur dioxide and oxygen to form sulfur trioxide.



What is the mass of sulfur trioxide that can be obtained by reacting 72 dm³ 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.



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**



ASSUMPTION ENGLISH SCHOOL ASSUMPTION ENGLISH SCHOOL ASSUMPTION ENGLISH SCHOOL ASSUMPTION ENGLISH SCHOOL
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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: 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.

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.

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.

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.

For Examiner's use:

Section A	/ 30
Section B	/ 40
Section C	/ 30
Total	/ 100

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.

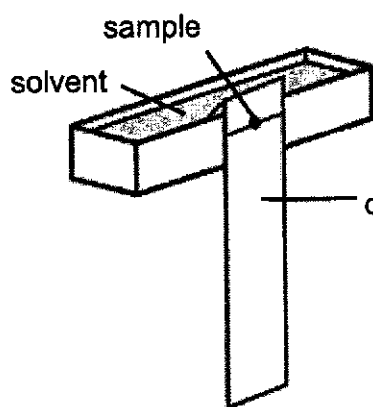


Fig. 1.1

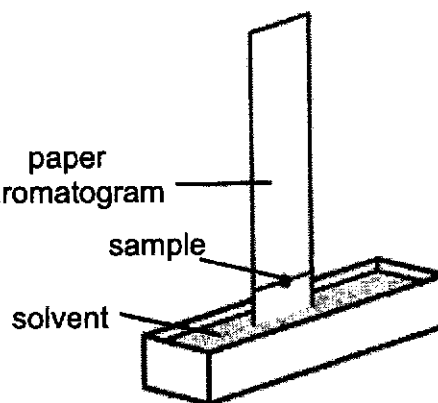


Fig. 1.2

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.

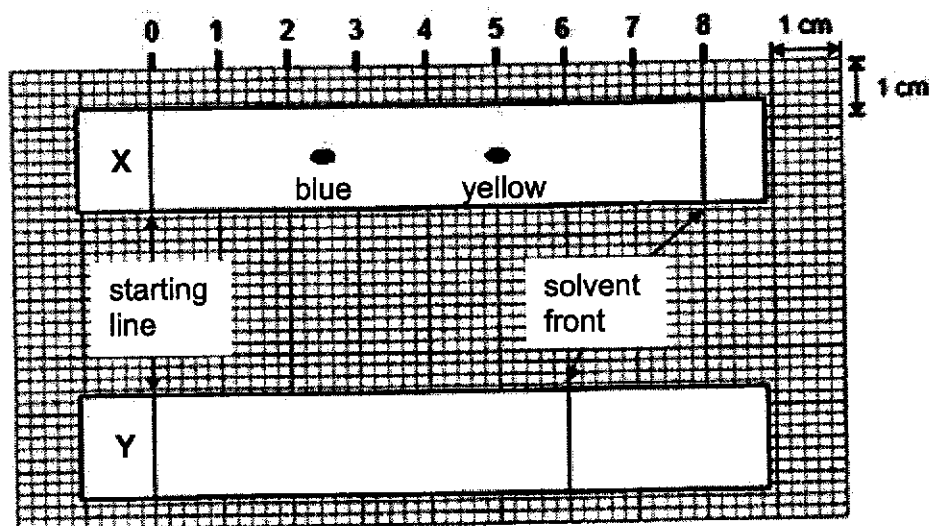


Fig. 1.3

- (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]

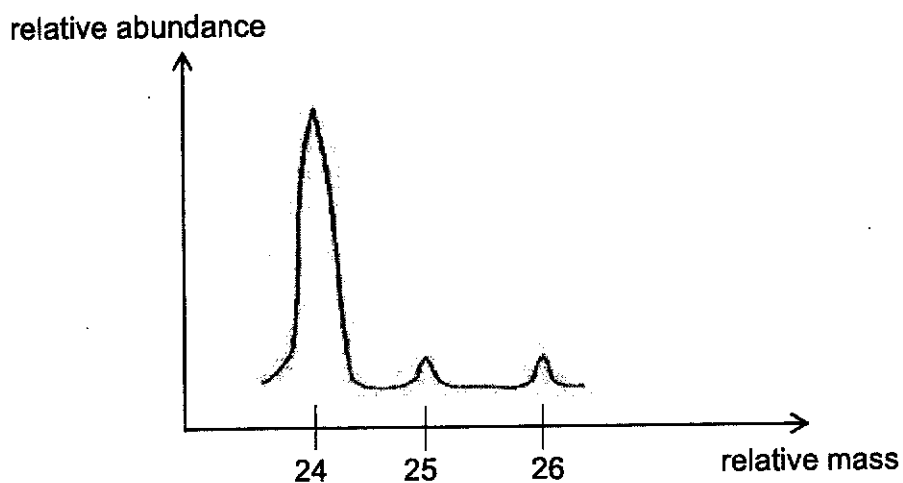
- (d) Some chromatogram requires the use of a locating agent. What is the purpose of the locating agent?

.....
 [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, $YC{l}_2$, which has a melting point of $-70\text{ }^{\circ}\text{C}$ and a boiling point of $60\text{ }^{\circ}\text{C}$.

(a) Deduce

(i) the physical state of $YC{l}_2$ at room temperature,

..... [1]

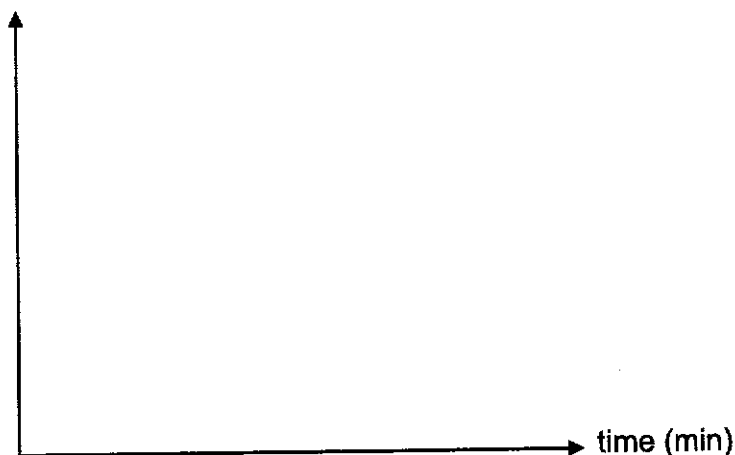
(ii) the type of bonding present in $YC{l}_2$, giving a reason for your answer.

.....

..... [2]

- (b) On the axes provided below, sketch the cooling curve for a sample of pure $YC{l}_2$ when it is cooled from $90\text{ }^{\circ}\text{C}$ to $20\text{ }^{\circ}\text{C}$. Label all relevant temperatures.

temperature ($^{\circ}\text{C}$)



[2]

- (c) When $YC{l}_2$ reacts with another metal, it forms a new compound which

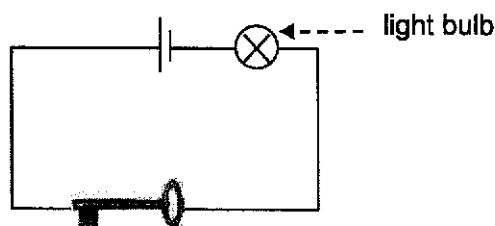
changes directly from the solid to the gaseous state at 68°C .

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.

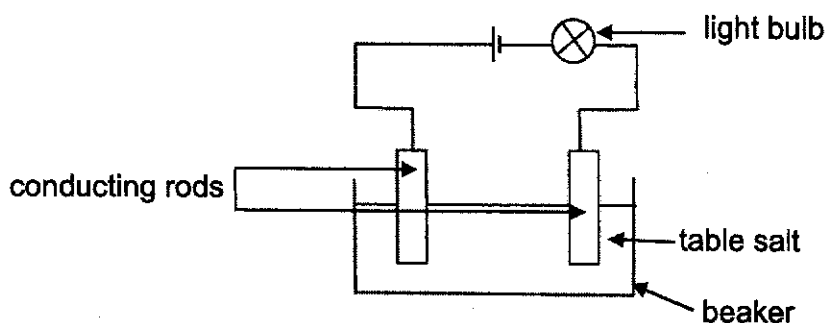


- (a) Explain, in terms of structure and bonding, why the bulb lit up.

.....

[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.

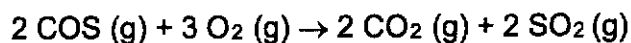
.....

[2]

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

[2]

- 6 6 dm³ of carbonyl sulfide (COS) was combusted in 18 dm³ 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)



- (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.

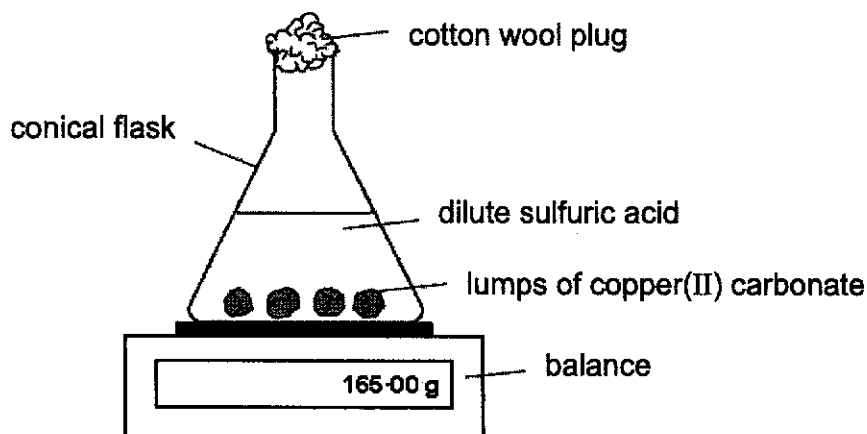
[2]

- (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

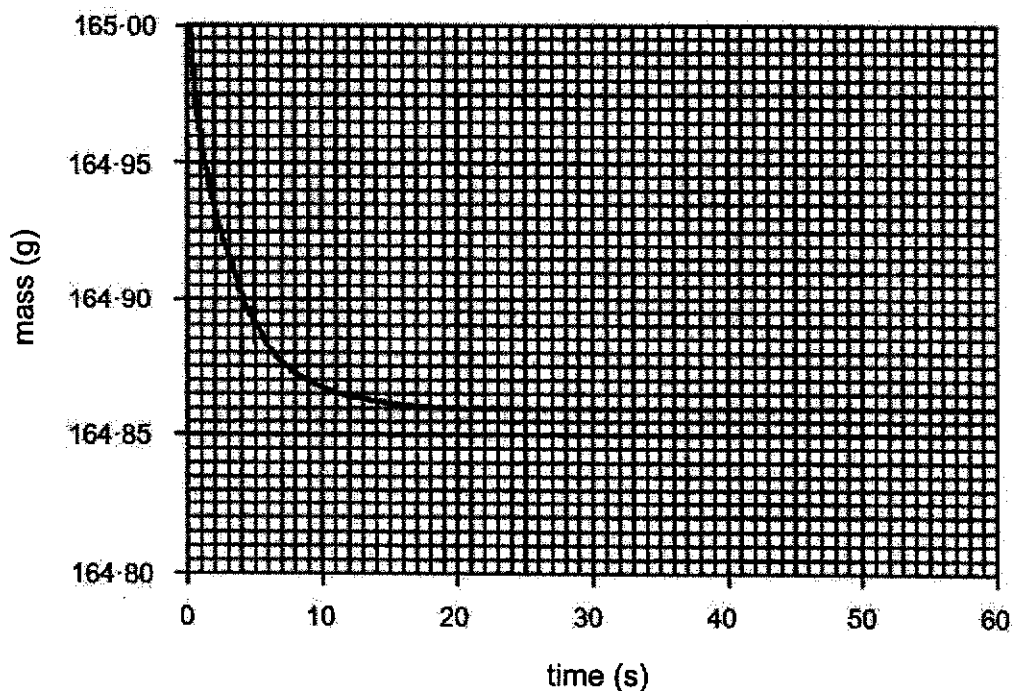
dioxide gas and copper(II) sulfate.



- (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]

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.

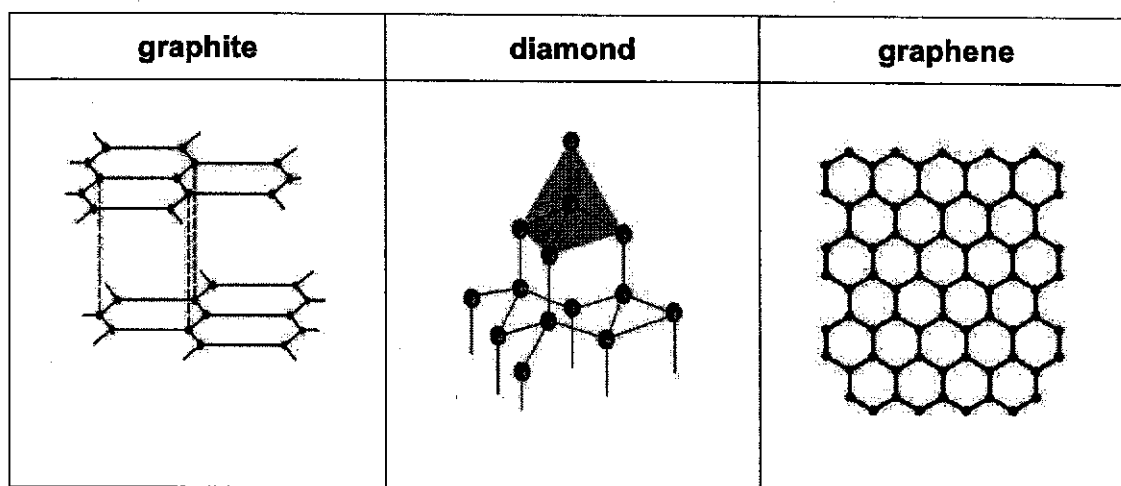


Fig. 1.1

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.

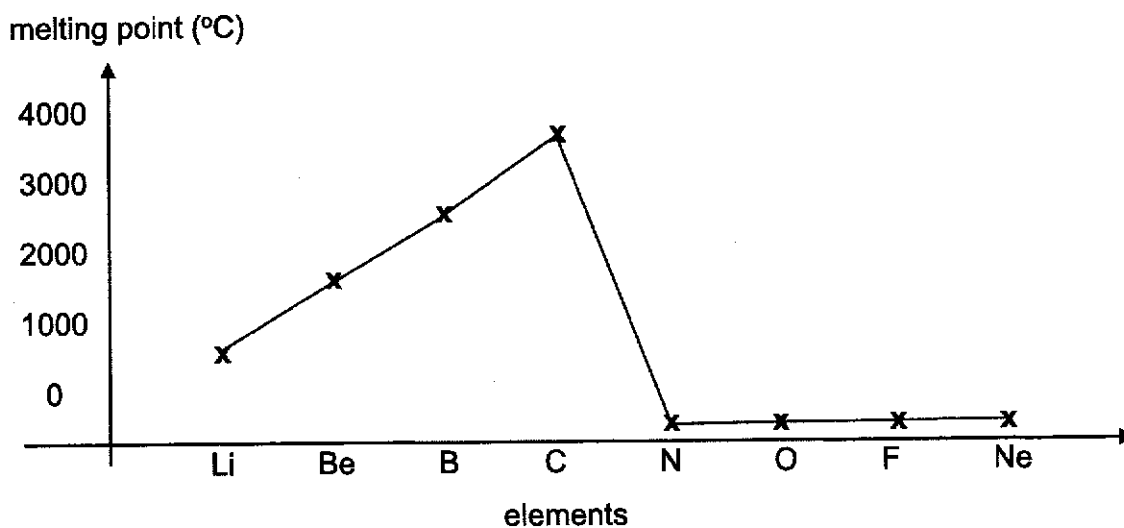


Fig. 1.2

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.

.....

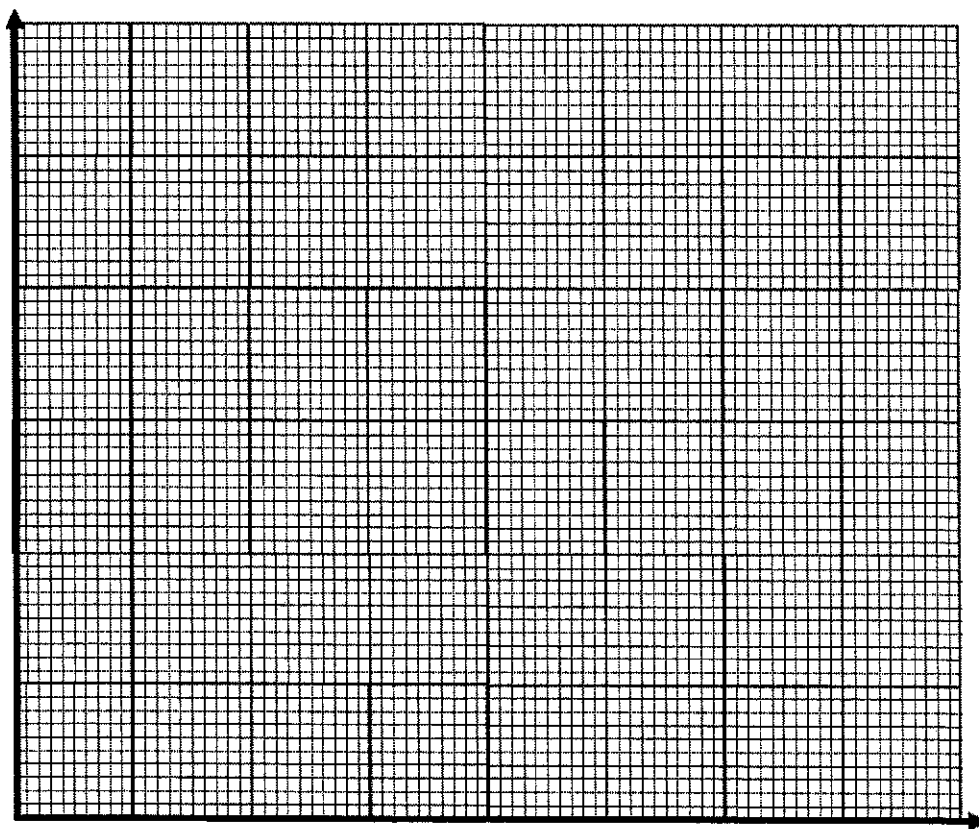
[1]

- 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.

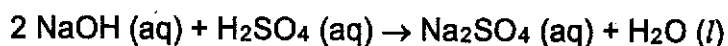
.....

..... [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:



- (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 cm³ of sodium hydroxide.

One of the titration readings for sulfuric acid was 27.40 cm³.

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/dm³ 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

6092/3EXP/MYE/19

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]

The Periodic Table of Elements

(d)

Further experiments showed that oxide I has a molecular mass of 46 and oxide II has a molecular mass of 92. Find the molecular formulae of the two oxides.

		mass of nitrogen (g)		mass of oxygen (g)	
oxide 1		0.35		0.78	
0	1	2	3	4	5
6	7	8	9	10	11
12	13	14	15	16	17
18	19	20	21	22	23
24	25	26	27	28	29
30	31	32	33	34	35
36	37	38	39	40	41
42	43	44	45	46	47
48	49	50	51	52	53
54	55	56	57	58	59
60	61	62	63	64	65
66	67	68	69	70	71
72	73	74	75	76	77
78	79	80	81	82	83
84	85	86	87	88	89
90	91	92	93	94	95
96	97	98	99	100	101
102	103	104	105	106	107
108	109	110	111	112	113
114	115	116	117	118	119
120	121	122	123	124	125
126	127	128	129	130	131
132	133	134	135	136	137
138	139	140	141	142	143
144	145	146	147	148	149
150	151	152	153	154	155
156	157	158	159	160	161
162	163	164	165	166	167
168	169	170	171	172	173
174	175	176	177	178	179
180	181	182	183	184	185
186	187	188	189	190	191
192	193	194	195	196	197
198	199	200	201	202	203
204	205	206	207	208	209
210	211	212	213	214	215
216	217	218	219	220	221
222	223	224	225	226	227
228	229	230	231	232	233
234	235	236	237	238	239
240	241	242	243	244	245
246	247	248	249	250	251
252	253	254	255	256	257
258	259	260	261	262	263
264	265	266	267	268	269
270	271	272	273	274	275
276	277	278	279	280	281
282	283	284	285	286	287
288	289	290	291	292	293
294	295	296	297	298	299
300	301	302	303	304	305
306	307	308	309	310	311
312	313	314	315	316	317
318	319	320	321	322	323
324	325	326	327	328	329
330	331	332	333	334	335
336	337	338	339	340	341
342	343	344	345	346	347
348	349	350	351	352	353
354	355	356	357	358	359
360	361	362	363	364	365
366	367	368	369	370	371
372	373	374	375	376	377
378	379	380	381	382	383
384	385	386	387	388	389
390	391	392	393	394	395
396	397	398	399	400	401
402	403	404	405	406	407
408	409	410	411	412	413
414	415	416	417	418	419
420	421	422	423	424	425
426	427	428	429	430	431
432	433	434	435	436	437
438	439	440	441	442	443
444	445	446	447	448	449
450	451	452	453	454	455
456	457	458	459	460	461
462	463	464	465	466	467
468	469	470	471	472	473
474	475	476	477	478	479
480	481	482	483	484	485
486	487	488	489	490	491
492	493	494	495	496	497
498	499	500	501	502	503
504	505	506	507	508	509
510	511	512	513	514	515
516	517	518	519	520	521
522	523	524	525	526	527
528	529	530	531	532	533
534	535	536	537	538	539
540	541	542	543	544	545
546	547	548	549	550	551
552	553	554	555	556	557
558	559	560	561	562	563
564	565	566	567	568	569
570	571	572	573	574	575
576	577	578	579	580	581
582	583	584	585	586	587
588	589	590	591	592	593
594	595	596	597	598	599
600	601	602	603	604	605
606	607	608	609	610	611
612	613	614	615	616	617
618	619	620	621	622	623
624	625	626	627	628	629
630	631	632	633	634	635
636	637	638	639	640	641
642	643	644	645	646	647
648	649	650	651	652	653
654	655	656	657	658	659
660	661	662	663	664	665
666	667	668	669	670	671
672	673	674	675	676	677
678	679	680	681	682	683
684	685	686	687	688	689
690	691	692	693	694	695
696	697	698	699	700	701
702	703	704	705	706	707
708	709	710	711	712	713
714	715	716	717	718	719
720	721	722	723	724	725
726	727	728	729	730	731
732	733	734	735	736	737
738	739	740	741	742	743
744	745	746	747	748	749
750	751	752	753	754	755
756	757	758	759	760	761
762	763	764	765	766	767
768	769	770	771	772	773
774	775	776	777	778	779
780	781	782	783	784	785
786	787	788	789	790	791
792	793	794	795	796	797
798	799	800	801	802	803
804	805	806	807	808	809
810	811	812	813	814	815
816	817	818	819	820	821
822	823	824	825	826	827
828	829	830	831	832	833
834	835	836	837	838	839
840	841	842	843	844	845
846	847	848	849	850	851
852	853	854	855	856	857
858	859	860	861	862	863
864	865	866	867	868	869
870	871	872	873	874	875
876	877	878	879	880	881
882	883	884	885	886	887
888	889	890	891	892	893
894	895	896	897	898	899
900	901	902	903	904	905
906	907	908	909	910	911
912	913	914	915	916	917
918	919	920	921	922	923
924	925	926	927	928	929
930	931	932	933	934	935
936	937	938	939	940	941
942	943	944	945	946	947
948	949	950	951	952	953
954	955	956	957	958	959
960	961	962	963	964	965
966	967	968	969	970	971
972	973	974	975	976	977
978	979	980	981	982	983
984	985	986	987	988	989
990	991	992	993	994	995
996	997	998	999	1000	1001
1002	1003	1004	1005	1006	1007
1008	1009	1010	1011	1012	1013
1014	1015	1016	1017	1018	1019
1020	1021	1022	1023	1024	1025
1026	1027	1028	1029	1030	1031
1032	1033	1034	1035	1036	1037
1038	1039	1040	1041	1042	1043
1044	1045	1046	1047	1048	1049
1050	1051	1052	1053	1054	1055
1056	1057	1058	1059	1060	1061
1062	1063	1064	1065	1066	1067
1068	1069	1070	1071	1072	1073
1074	1075	1076	1077	1078	1079
1080	1081	1082	1083	1084	1085
1086	1087	1088	1089	1090	1091
1092	1093	1094	1095	1096	1097
1098	1099	1100	1101	1102	1103
1104	1105	1106	1107	1108	1109
1110	1111	1112	1113	1114	1115
1116	1117	1118	1119	1120	1121
1122	1123	1124	1125	1126	1127
1128	1129	1130	1131	1132	1133
1134	1135	1136	1137	1138	1139
1140	1141	1142	1143	1144	1145
1146	1147	1148	1149	1150	1151
1152	1153	1154	1155	1156	1157
1158	1159	1160	1161	1162	1163
1164	1165	1166	1167	1168	1169
1170	1171	1172	1173	1174	1175
1176	1177	1178	1179	1180	1181
1182	1183	1184	1185	1186	1187
1188	1189	1190	1191	1192	1193
1194	1195	1196	1197	1198	1199
1200	1201	1202	1203	1204	1205
1206	1207	1208	1209	1210	1211
1212	1213	1214	1215	1216	1217
1218	1219	1220	1221	1222	1223
1224	1225	1226	1227	1228	1229
1230	1231	1232	1233	1234	1235
1236	1237	1238	1239	1240	1241
1242	1243	1244	1245	1246	1247
1248	1249	1250	1251	1252	1253
1254	1255	1256	1257	1258	1259
1260	1261	1262	1263	1264	1265
1266	1267	1268	1269	1270	1271
1272	1273	1274	1275	1276	1277
1278	1279	1280	1281	1282	1283
1284	1285	1286	1287	1288	1289
1290	1291	1292	1293	1294	1295
1296	1297	1298	1299	1300	1301
1302	1303	1304	1305	1306	1307
1308	1309	1310	1311	1312	1313
1314	1315	1316	1317	1318	1319
1320	1321	1322	1323	1324	1325
1326	1327	1328	1329	1330	1331
1332	1333	1334	1335	1336	1337
1					

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

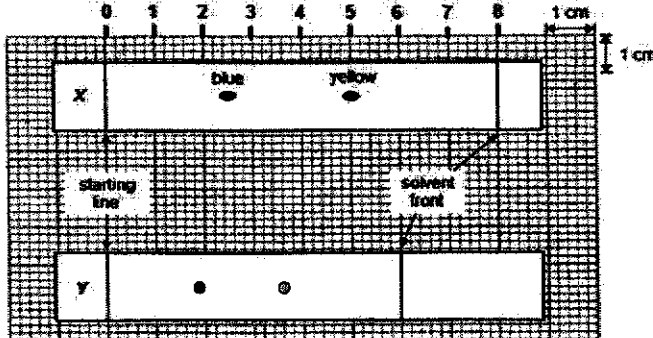
[2]

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]

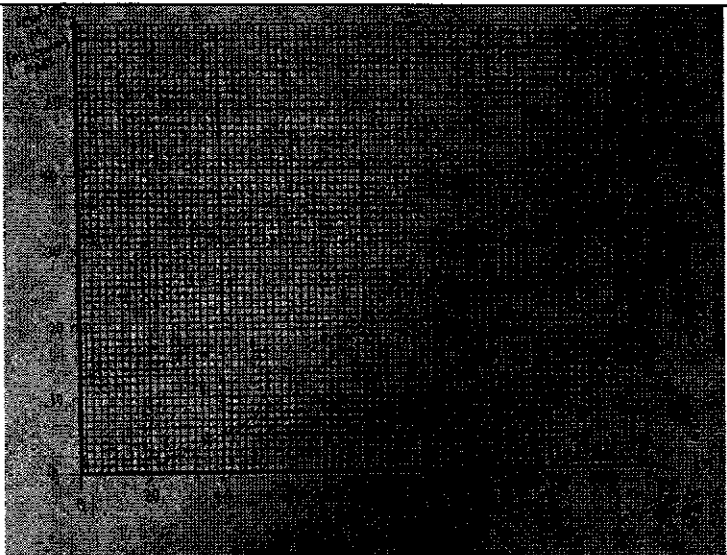
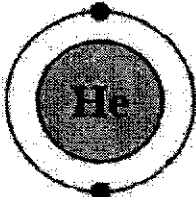
1a	X. Solvent front travels a greater distance due to pull of gravity.	1
bi	Rf of blue dye = $2.5 / 8 = 0.3125$ = 0.3 (1dp) Rf of yellow dye = $5 / 8 = 0.625$ = 0.6 (1dp)	1 1
bil	 Diagram III 0.3 = Blue / 6 Blue = 1.9 cm 0.6 = yellow / 6 Blue = 3.6 cm	Correct distance and labelled 1m Allow ecf from bi
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 $= \frac{78.99}{100} \times 24 + \frac{10.00}{100} \times 25 + \frac{11.01}{100} \times 26$ $= 18.9576 + 2.5 + 2.8626 = 24.3202 = 24.3 \text{ (3sf)}$	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 <u>lattice energy increases</u> as the <u>charges of the ions increase</u>. OR The value of the <u>lattice energy decreases</u> as the <u>charges of the ions decrease</u>.	1
(b)(ii)	As the charges of the ions increase, the <u>electrostatic attraction between the ions also increases/gets stronger</u>. It would take <u>more energy to overcome the electrostatic forces of attraction/break up the ionic lattice structure</u>.	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)	temperature (°C) time (min)	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 sublimates and the <u>gas/vapour touches the cool surface of the filter funnel, it will turn into solid again</u>.	1 mark for showing ideas of sublimation mentioning heating and cooling

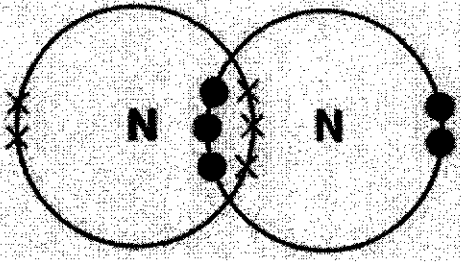
5(a)	Iron is held by strong metallic bonds between iron metal ions and a sea of delocalized electrons in a giant metallic structure.	1
	The delocalized electrons move freely within the structure to act as charge carriers to conduct electricity.	1
(b)	In solid common salt, sodium and chloride ions are held in fixed positions in a giant lattice structure.	1
	Hence there are no mobile ions to act as charge carriers to conduct electricity.	1
(c)	Melt the table salt.	1
	Dissolve the solid in a beaker of water.	1
6(a)	No. of moles of COS used = $6 \div 24 = 0.250$	1
(b)	No. of moles of O ₂ used = $18 \div 24 = 0.750$	1
(c)	2COS: 3O ₂ If O ₂ is LR, no. of moles of COS needed = $\frac{2}{3} \times 0.750$ = 0.500	
	If COS is LR, no. of moles of O ₂ needed = $\frac{3}{2} \times 0.250$ = 0.375	1
	Thus, carbonyl sulfide is limiting.	1
(d)	No. of moles of O ₂ left = $0.750 - 0.375 = 0.375$	
	No. of moles of gases formed = $2 \times 0.250 = 0.50$	1
	No. of moles of gases at the end = $0.50 + 0.375 = 0.875$	1
	Volume of gases at the end = $0.875 \times 24.0 = 21.0 \text{ dm}^3$	1
7(a)	$\text{H}_2\text{SO}_4 + \text{CuCO}_3 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O} + \text{CO}_2$	1
(b)	No. of mole of CO ₂ produced = $(165.00 - 164.86) / 44 = 0.003182 \text{ mol (4sf)}$	1
	Mass of pure CuCO ₃ = $0.003182 \times 124 = 0.3946 \text{ g}$	1
	Percentage purity = $0.3946 / 0.50 \times 100 = 78.9 \%$	1

SECTION C: FREE-RESPONSE QUESTIONS [30 MARKS]

1ai	It has a high melting point.	1																		
aii	It has a macromolecular/ tetrahedral structure/ strong covalent bonds.	1																		
bi	No. It is a non-metal and conducts electricity. Award 1 mark only if reason is correct.	1																		
bii	Graphite and graphene. It has a high melting point and conducts electricity.	1 1																		
biii	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)	1																		
c	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.	1																		
di	<table border="1"><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		ammonia	sulfur dioxide	oil	carbon dioxide	sodium chloride	polarity	polar	polar	non-polar	non-polar	polar	solubility in water	soluble	soluble	insoluble	insoluble	soluble	2
	ammonia	sulfur dioxide	oil	carbon dioxide	sodium chloride															
polarity	polar	polar	non-polar	non-polar	polar															
solubility in water	soluble	soluble	insoluble	insoluble	soluble															
dii	As ammonia is polar, parts of the molecules have a negative side and a positive side and hence soluble in water.	1																		

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	$\text{H}^+ (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l})$	1
b	Pipette Burette	1
ci	$\frac{27.15 + 27.05}{2}$ $= 27.10$	1
cii	Moles $\text{H}_2\text{SO}_4 = 0.100 \times \frac{27.10}{1000} = 0.00271$ Moles $\text{NaOH} = 0.00271 \times 2 = 0.00542$ Concentration $\text{NaOH} = 0.00542/0.025$ $= 0.217 \text{ mol/dm}^3$ (3 s.f.)	1 1 1
d	Moles of $\text{NaOH} = (20/1000) \times 0.18 = 0.0036$ Mass of $\text{NaOH} = 0.0036 \times 40 = 0.144 \text{ g}$	1 1
ei	To show a permanent colour change, indicating complete reaction.	1
eii	Blue to green	1

3OR a		2 1m – correct bonding electrons 1m – correct non-bonding electrons																								
b	The nitrogen molecules are held together in a simple molecular structure by weak van der 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.	1 Both structure and VDW must be mentioned 1 Low m.p.																								
c	Oxide 1: <table border="1"> <thead> <tr> <th></th><th>Nitrogen</th><th>Oxygen</th></tr> </thead> <tbody> <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> </tbody> </table> Empirical formulae = NO_2 Oxide 2: <table border="1"> <thead> <tr> <th></th><th>Nitrogen</th><th>Oxygen</th></tr> </thead> <tbody> <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> </tbody> </table> Empirical formulae = NO_2		Nitrogen	Oxygen	Mass	0.35	0.78	Divide by A_r	$0.35/14 = 0.025$	$0.78/16 = 0.4875$	Divide by smallest ratio	$0.025/0.025 = 1$	$0.4875/0.025 = 1.95 = 2$ (nearest whole no)		Nitrogen	Oxygen	Mass	0.68	1.63	Divide by A_r	$0.68/14 = 0.04857$	$1.63/16 = 0.101875$	Divide by smallest ratio	$0.04857/0.04857 = 1$	$0.101875 / 0.04857 = 2.097 = 2$ (nearest whole no)	1 1 1 1
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