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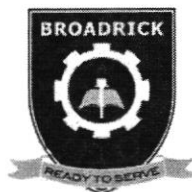


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Name	Class				Index Number		
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BROADRICK SECONDARY SCHOOL

SECONDARY 3 EXPRESS

END-OF-YEAR EXAMINATION 2021

SCIENCE (CHEMISTRY / BIOLOGY)

5078/01

Paper 1 Multiple Choice

Additional Materials: Multiple Choice Answer Sheet

October 2021
1 hour

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 Answer Sheet in the spaces provided.

There are forty questions on 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 Answer Sheet.

Read the instructions on the Answer Sheet 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 question paper.

A copy of the Data Sheet is printed on page 2.

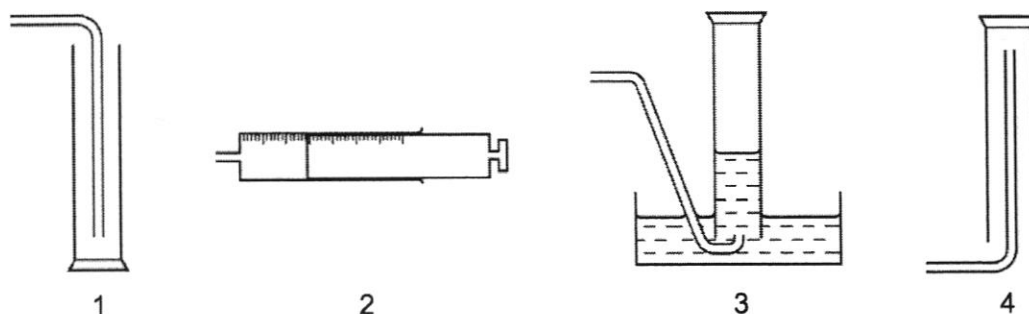
A copy of the Periodic Table is printed on page 3.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **18** printed pages including this cover page.

4

- 1 The diagrams show four different gas collection methods.

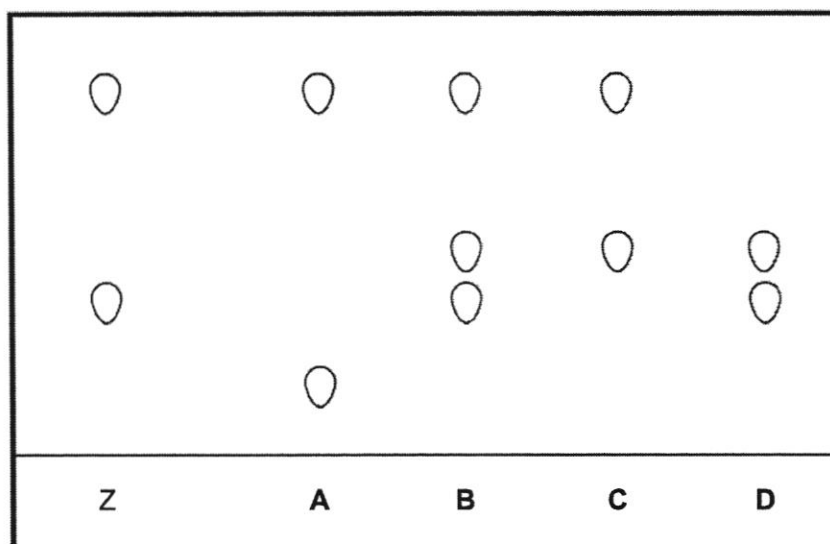


Which method is suitable for collecting a gas which has the properties described?

	gas collection method	properties of gas
A	1	less dense than air and soluble in water
B	2	denser than air and soluble in water
C	3	less dense than air and soluble in water
D	4	denser than air and insoluble in water

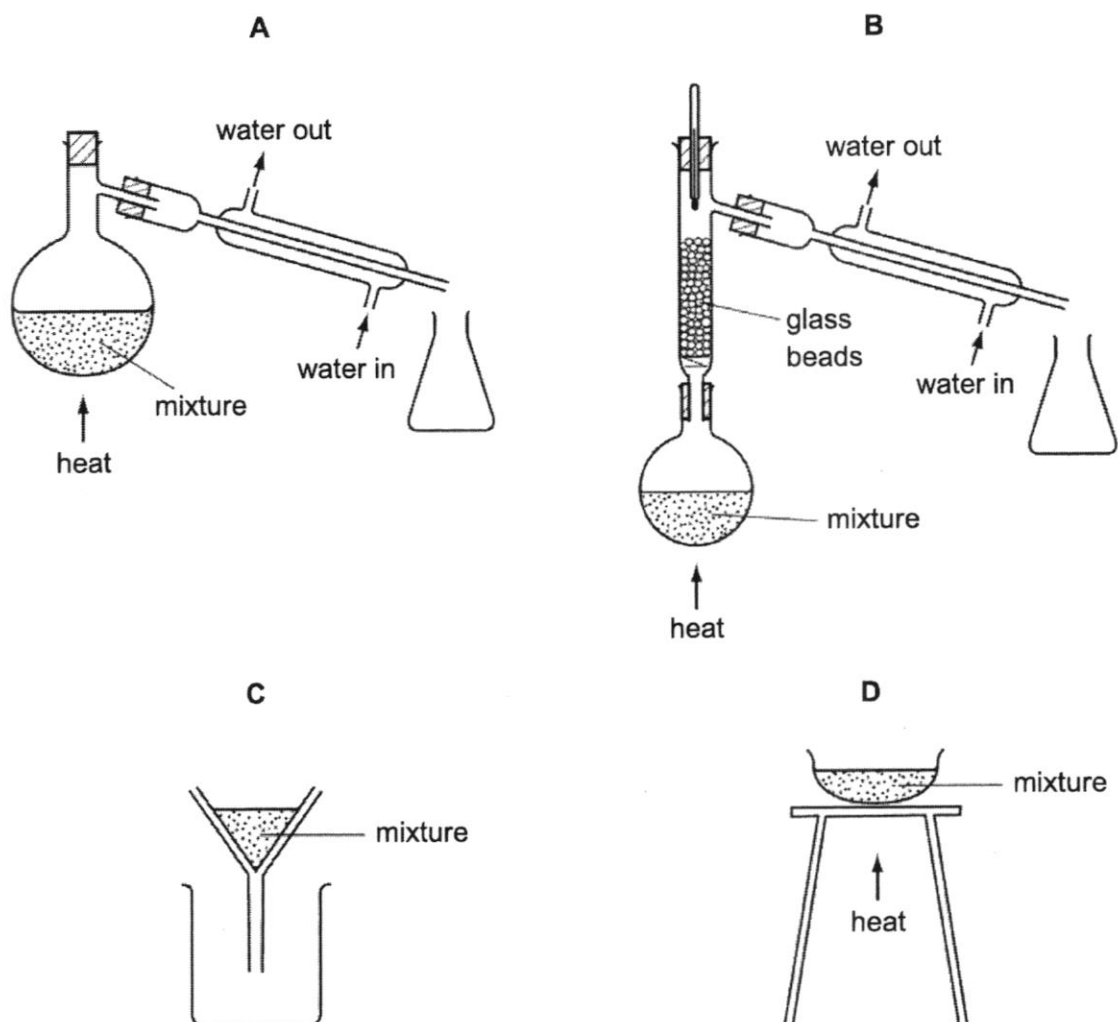
- 2 Chromatography is used to find out if a banned dye, Z, is present in foodstuffs. The results are shown in the diagram.

Which foodstuff contains Z?



- 3 Substance X melts at 58°C and boils at 110°C .
It is insoluble in water.

Which diagram shows the most suitable method used to separate X from a mixture of X and water?



- 4 Air is a mixture of gases.
The melting and boiling points of some gases present in clean, dry air are shown.

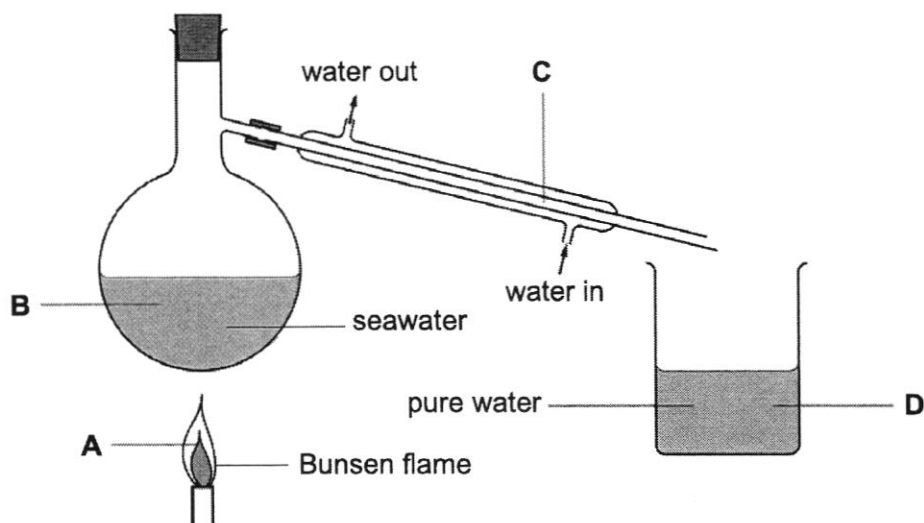
In the fractional distillation of liquid air, which gas boils first?

	gas	melting point / $^{\circ}\text{C}$	boiling point / $^{\circ}\text{C}$
A	argon	- 189	- 186
B	krypton	- 157	- 153
C	nitrogen	- 210	- 196
D	oxygen	- 219	- 183

6

- 5 The diagram shows how to obtain pure water from seawater.

Where do water molecules lose energy?



- 6 Which three elements exist as diatomic molecules at room temperature?

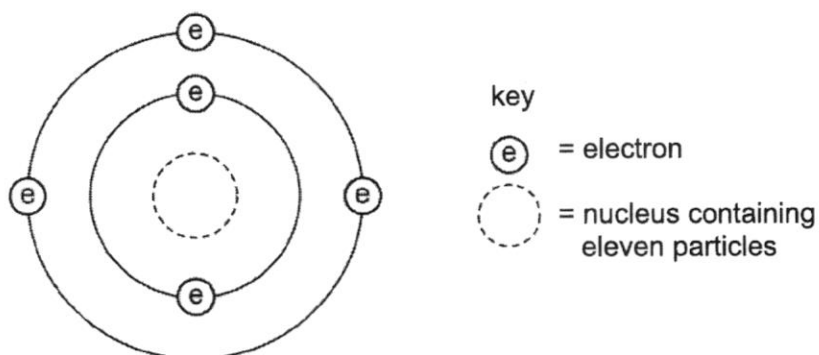
- A hydrogen, oxygen, helium
- B oxygen, chlorine, helium
- C nitrogen, chlorine, neon
- D nitrogen, oxygen, fluorine

- 7 Which particle is an ion?

	number of protons	number of neutrons	number of electrons
A	1	0	1
B	3	4	3
C	6	6	6
D	11	12	10

7

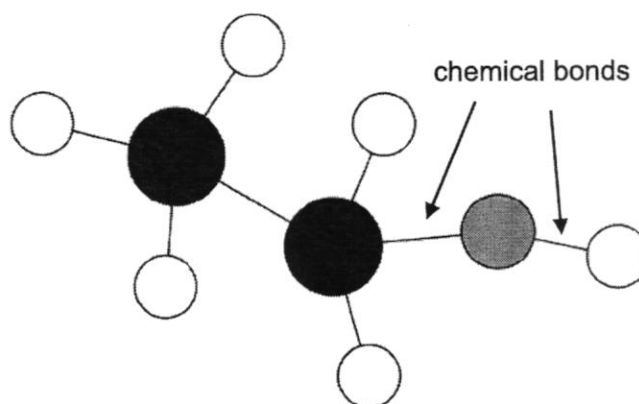
- 8 The diagram shows an atom of an element.



Which row represents the correct information about this atom?

	number of protons	number of neutrons	group number	period number
A	5	6	3	2
B	5	11	2	3
C	6	5	3	2
D	6	11	2	3

- 9 The diagram shows a model of a molecule containing carbon, hydrogen and oxygen.



How many atoms of each element are in the molecule?

	carbon	hydrogen	oxygen
A	1	6	2
B	2	1	6
C	2	6	1
D	6	2	1

- 10** The table shows some properties of four substances.

Which substance is an ionic compound?

	melting point / °C	dissolves in water	conducts electricity when solid	conducts electricity in aqueous state
A	- 102	✓	✗	✓
B	801	✓	✗	✓
C	842	✓	✓	✓
D	3000	✗	✓	✗

- 11** Which compound contains the largest number of Group VII atoms?

- A** $\text{C}_{13}\text{H}_{13}\text{IO}_8$ **B** Cl_2O_6
C $\text{Al}(\text{BrO}_3)_3$ **D** $\text{NaFC}_2\text{H}_2\text{O}_2$

- 12** Part of the Periodic Table is shown with four elements, W, X, Y and Z. These are not the elements' actual symbols.

[illegible]

Some pairs of these elements may react to form compounds.

Which formulae are correct?

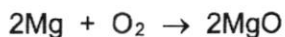
- A** WX and YZ
B WY_2 and WZ
C WZ and XZ
D X_2Z_3 and YZ

- 13** A metal chloride has the chemical formula of $\text{XC}\ell_2$. Its relative molecular mass is 111.

What is the identity of metal X?

- A** argon **B** calcium **C** iridium **D** zirconium

- 14 Magnesium burns in oxygen to form magnesium oxide.
The equation for the reaction is shown.



What mass of magnesium oxide is formed when 48 g of magnesium is burned?

- A 20 g B 40 g C 80 g D 160 g
- 15 1.00 dm³ of ammonia gas is passed over heated copper(II) oxide.



What is the volume of nitrogen formed when measured at the same temperature and pressure as the ammonia?

- A 0.25 dm³ B 0.50 dm³ C 1.00 dm³ D 2.00 dm³
- 16 Which statement explains why the chemical properties of sodium and potassium are similar?

- A They have the same number of valence electron.
B They are in the same period of the Periodic Table.
C They are soft and can be cut with a knife.
D They have similar melting points.
- 17 The table shows the proton numbers of four elements.

element	Q	R	T	Z
proton number	9	11	17	19

Which statement is correct?

- A Q is a metal.
B Q is more reactive than T.
C R is more reactive than Z.
D T and Z are in the same period.

- 18 Helium and neon are both noble gases.

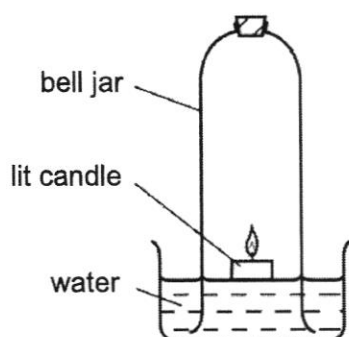
What is true of both elements?

	they are chemically inert	the atoms have eight electrons in their outer shell
A	✓	✗
B	✓	✓
C	✗	✗
D	✗	✓

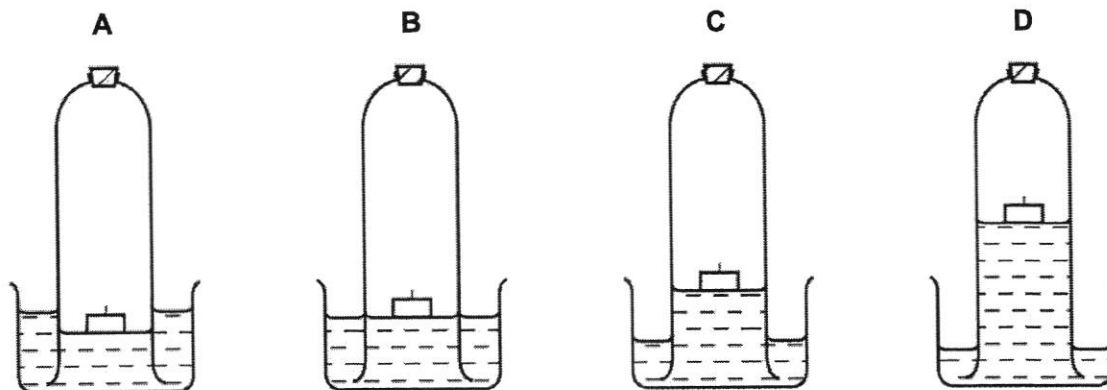
- 19 Which row does **not** match an atmospheric pollutant to its source?

	pollutant	source
A	carbon monoxide	complete combustion of fossil fuels
B	nitrogen oxides	internal combustion engines
C	nitrogen oxides	lightning activities
D	sulfur dioxide	volcanic eruptions

- 20 The diagram shows an experiment to determine the percentage of oxygen in air.



Which diagram shows the correct level of water after the candles stops burning?



Name

Class	3	A
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Index Number		
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BROADRICK SECONDARY SCHOOL

SECONDARY 3 EXPRESS

END-OF-YEAR EXAMINATION 2021

SCIENCE (PHYSICS / CHEMISTRY)

5076/03

SCIENCE (CHEMISTRY / BIOLOGY)

5078/03

Paper 3 Chemistry

Candidates answer on Question Paper.

October 2021

No Additional Materials are required.

1 hour 15 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use a pencil for any diagrams or graphs, tables or rough working.

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

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Section A [45 marks]

Answer **all** questions in the spaces provided on the question paper.

Section B [20 marks]

Answer **all** questions in the spaces provided on the question paper.

A copy of the Data Sheet is printed on page 2.

A copy of the Periodic Table is printed on page 3.

At the end of the examination, fasten all your work securely.

The number of marks is given in brackets [] at the end of each question or part question.

The total marks for this paper is 65.

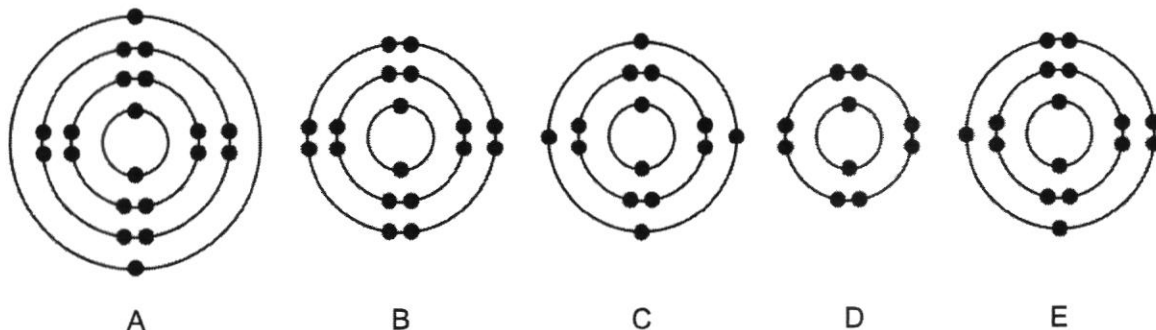
For Examiner's Use	
Section A	
Section B	
Total	65

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Setter : Mdm Karen Kim

Section A [45 marks]Answer **all** the questions in the spaces provided.

- 1 (a) The electronic configurations of five atoms are shown.

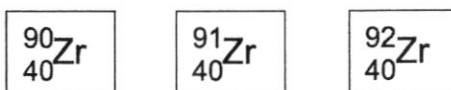
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Use

Which electronic configuration matches each of the following descriptions?
Each electronic configuration may be used once, more than once or not at all.

- | | | |
|---|-------|-----|
| (i) a sulfur atom | | [1] |
| (ii) a metallic atom | | [1] |
| (iii) an atom with a proton number of 14 | | [1] |
| (iv) an atom which achieves a noble gas electronic configuration when it loses two electrons. | | [1] |

- (b) Zirconium (Zr) is an element found in Period 5 of the Periodic Table.

The following three atoms are all zirconium atoms:



In terms of numbers of electrons, neutrons and protons, specify how these three atoms are the same and different.

They are the same because

.....

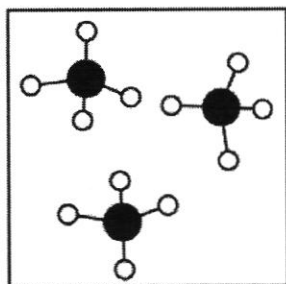
They are different because

.....

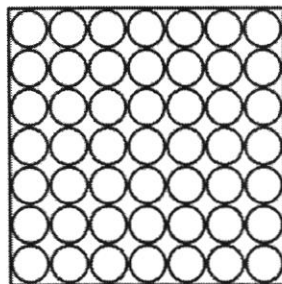
[2]

- 2 The diagrams, P, Q, R, S, T and U represent the particles in different substances.

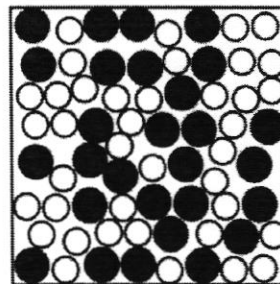
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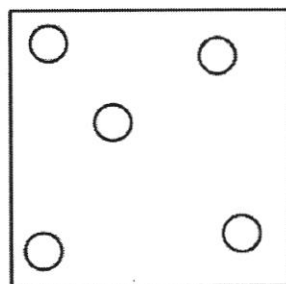
P



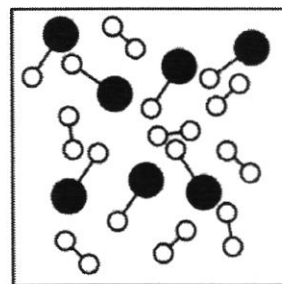
Q



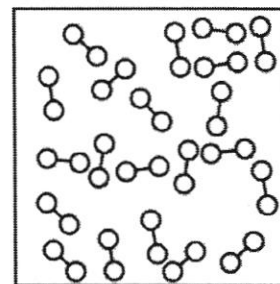
R



S



T



U

Each diagram can only be used once or not at all.

Which of the diagrams, P, Q, R, S, T and U best represents a

- (a) gaseous compound,
- (b) liquid element,
- (c) liquid mixture,
- (d) solid mixture?

[1]

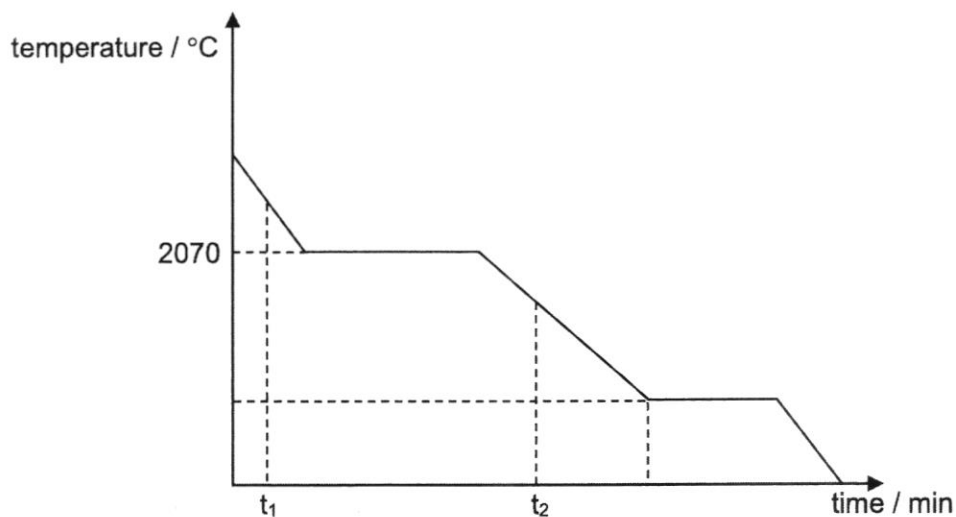
[1]

[1]

[1]

- 3 Indium is a metal that has a high boiling point and melting point.
The graph below shows the changes in the temperature of a sample of indium.

For
Examiners'
Use



Using Kinetic Particle Theory, complete the following table to describe how do the indium particles differ in terms of arrangement, movement and attraction at t_1 and t_2 .

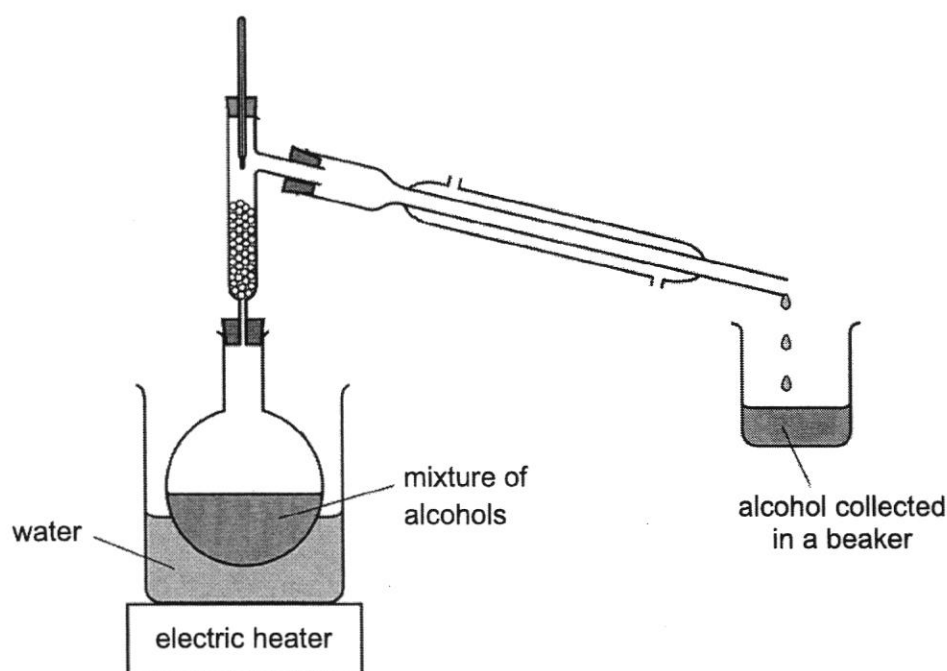
how particles differ	at t_1	at t_2
arrangement		
movement		
attractive forces between particles		

[5]

- 4 The table gives the boiling points of four alcoholic substances.

alcoholic substances	boiling point/ °C
butanol	117
ethanol	79
methanol	65
propanol	97

The apparatus shown can be used to obtain methanol from a mixture containing butanol, ethanol, methanol and propanol.



- (a) Name this method of separation.

.....

[1]

- (b) Explain why it is safer to heat the mixture of alcohols in the way shown rather than heating directly with a Bunsen burner.

.....

.....

[1]

8

- (c) (i) Explain why the apparatus in the diagram **cannot** be used to separate the mixture to collect butanol in the beaker.

For
Examiners'
Use

.....
.....

[1]

- (ii) For the **remaining three** alcoholic substances, arrange them according to the sequence of collection during this separation method.

first to be collected

.....

last to be collected

[1]

- 5 The table shows the names and formulae for some ions.

For
Examiners'
Use

name of ion	formula of ion
aluminium	Al^{3+}
	NH_4^+
calcium	Ca^{2+}
	Cu^{2+}
iron(III)	Fe^{3+}
magnesium	Mg^{2+}
nitrate	NO_3^-
phosphate	PO_4^{3-}
potassium	K^+
	SO_4^{2-}

- (a) State the name of the Cu^{2+} ion. [1]
- (b) State the name of the SO_4^{2-} ion. [1]

- (c) Name and provide the formula of the compound that contains NH_4^+ ions and NO_3^- ions.

name of compound [1]

formula of compound [1]

- (d) The names and formulae for some compounds are shown.

name of compound	formula of compound
aluminium phosphate	AlPO_4
calcium phosphate	$\text{Ca}_3(\text{PO}_4)_2$
potassium phosphate	K_3PO_4

Deduce the formula for magnesium phosphate.

..... [1]

- 6 The table below shows some properties of the Group I elements.

For
Examiners'
Use

metal	density in g/cm ³	melting point / °C	boiling point / °C
lithium	0.53	181	1342
sodium	0.97	98	883
potassium	0.86	63	
rubidium	1.53	39	686
caesium	1.88	29	669

- (a) Use the information in the table to explain why caesium is a liquid at 50 °C.

..... [1]

- (b) Suggest a value for the boiling point of potassium.°C [1]

- (c) (i) Describe the **general** trend in density down the group.

..... [1]

- (ii) Which element does **not** follow this trend? [1]

- (d) State **two** physical properties of potassium, other than density, melting point and boiling point.

1:

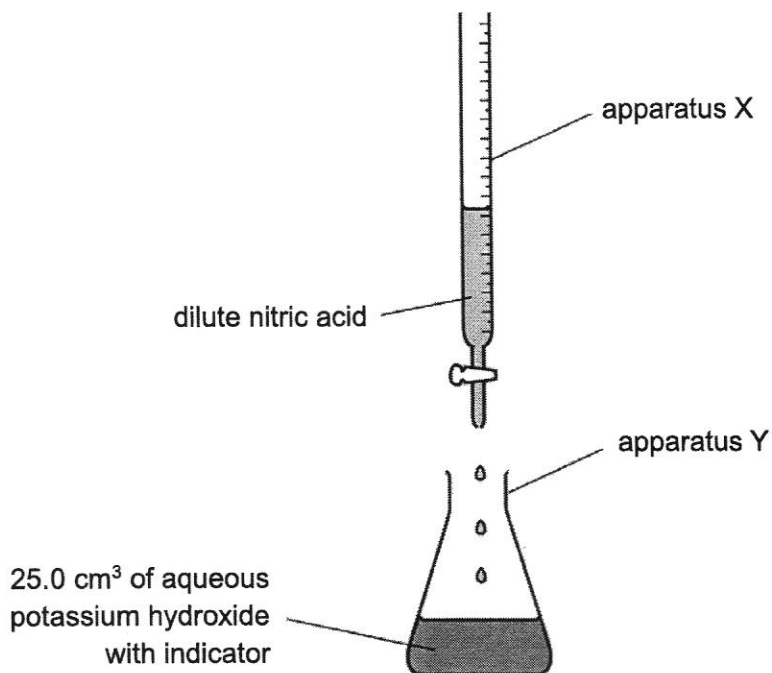
2: [2]

- (e) Write the balanced chemical equation, with state symbols, for the reaction between lithium and water.

..... [2]

- 7 A titration process can be used to determine the concentration of a solution. The experimental set-up is shown.

For
Examiners'
Use



In this titration, 25.0 cm³ of aqueous potassium hydroxide was used to react with dilute nitric acid. The concentration of the dilute nitric acid used in this titration is 1.25 mol/dm³.

- (a) Name the apparatus in the set-up above.

apparatus X:

apparatus Y:

[2]

- (b) Suggest an apparatus that can be used to measure 25.0 cm³ of aqueous potassium hydroxide exactly before transferring the solution into apparatus Y.

.....

[1]

The chemical reaction between aqueous potassium hydroxide and dilute nitric acid can be represented by the following chemical equation:



A student conducted the titration four times and recorded the results in the table below.

titration number	volume of dilute nitric acid used / cm ³
1	18.10
2	18.90
3	18.30
4	18.20

(c) (i) Which **one** of the results is anomalous? titration number [1]

(ii) Use the **remaining three** results to calculate the average volume of dilute nitric acid that reacted with the aqueous potassium hydroxide.

..... cm³ [1]

(iii) The student concluded that the aqueous potassium hydroxide was more concentrated than the dilute nitric acid.

Explain whether you agree with the student's conclusion.

.....

[3]

13

- 8 Iron(II) carbonate reacts with dilute hydrochloric acid to form iron(II) chloride.

For
Examiners'
Use



2.32 g of iron(II) carbonate was reacted with 50 cm³ of 0.10 mol/dm³ of dilute hydrochloric acid.

- (a) Calculate the number of moles of iron(II) carbonate present.

..... mol [1]

- (b) Calculate the number of moles of dilute hydrochloric acid present.

..... mol [1]

- (c) (i) Identify the limiting reactant in this reaction.
You are to show relevant explanation to support your answer.

limiting reactant: [1]

- (ii) Calculate the volume (in dm³) of carbon dioxide produced in this reaction, measured at room temperature and pressure.

..... dm³ [2]

Section B [20 marks]Answer **all** questions in this section.

Write your answers in the space provided.

- 9 The table shows the mass of air pollutants, in nanograms, in 1000 cm³ samples of air taken over a period of four months.

For
Examiners'
Use

month	mass of pollutant in 1000 cm ³ of air / nanograms				
	nitrogen oxides	sulfur dioxide	carbon monoxide	ozone	particulates
April	124.3	5.9	2.5	33.9	21.9
May	144.2	2.0	2.1	39.6	21.5
June	110.3	6.1	1.9	31.4	21.3
July	115.4	2.4	2.6	24.2	19.0

- (a) Answer these questions using only the information in the table.

- (i) Name the pollutant that shows a continual decrease in concentration between April and July.

.....

[1]

- (ii) Name the pollutant present in the lowest concentration in May.

.....

[1]

- (iii) Name the month in which there will be highest occurrence of acid rain.

.....

[1]

- (iv) Calculate the mass of carbon monoxide in 200 cm³ samples of air taken in April.

..... nanograms

[1]

- (b) Different air pollutants will have different harmful effects on human health and the environment.

- (i) Describe the harmful effect that carbon monoxide has on human health.

.....

[1]

- (ii) Some of these air pollutants will dissolve in rain to form acid rain.
 Describe **two** harmful effects that acid rain has on the environment.

1:

2:

[2]

- (c) Nitrogen oxides and carbon monoxide are harmful gases released from car exhausts.

In Singapore, it is a legal requirement for all vehicles to be installed with catalytic converters. In a converter, nitrogen monoxide will react with carbon monoxide to produce two gases that are present in clean dry air.

- (i) State the percentage composition of clean dry air.

.....

[1]

- (ii) Write a balanced chemical equation for the conversion of nitrogen monoxide and carbon monoxide into two gases that are present in clean dry air.
 State symbols are **not** required.

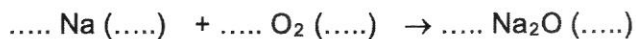
.....

[2]

10 Oxide compounds can be formed when an element burns in air.

For
Examiners'
Use

- (a) Sodium burns in air to form a white solid of sodium oxide, Na_2O , as shown in the following equation:



- (i) Fill in the blanks above to balance the chemical equation and to provide the state symbols for each substance.
- (ii) Draw a 'dot and cross' diagram to show the arrangement of the outer shell electrons in sodium oxide.

[2]

- (iii) Explain why sodium oxide is able to conduct electricity in molten state but not in solid state.

.....

.....

.....

[2]

[2]

- (b) Hydrogen burns in air to form hydrogen oxide, H_2O .

- (i) Draw a 'dot and cross' diagram to show the arrangement of the outer shell electrons in one molecule of hydrogen oxide.

[2]

17

- (ii) In terms of structure and bonding, explain why hydrogen oxide exists as a liquid at room temperature and pressure.

For
Examiners'
Use

.....

.....

.....

[2]

---- End of Paper 3 ----

Broadrick Secondary School
Sec 3 Express Science (Chemistry) 5076 / 5078
End of Year Examination 2021 Answers

Paper 1

Answer to MCQ [20 marks]

1	2	3	4	5	6	7	8	9	10
B	B	C	C	C	D	D	A	C	B

11	12	13	14	15	16	17	18	19	20
C	B	B	C	B	A	B	A	A	C

Paper 3

Answer to Section A [45 marks]

No.			Answers	Mk	Tot mk
1	a	i	E	1	6
		ii	A	1	
		iii	C	1	
		iv	A	1	
	b		Same because they all have 40 protons and 40 electrons	1	
			Different because ^{90}Zr , ^{91}Zr and ^{92}Zr have 50, 51 and 52 neutrons respectively	1	
			Only award 1 mark if answer did not specify the exact numbers of sub-atomic particles, i.e. 'same number of protons and electrons, different number of neutrons'		
2	a		P	1	4
	b		U	1	
	c		T	1	
	d		R	1	

Broadrick Secondary School
Sec 3 Express Science (Chemistry) 5076 / 5078
End of Year Examination 2021 Answers

3			how particles differ	at t_1	at t_2	5	5
			[2] arrangement	[1] far apart / irregular arrangement	[1] closely packed in an irregular arrangement		
			[2] movement	[1] rapid and random	[1] slide past one another		
			[1] attractive forces between particles	weak	strong / stronger than t_1		
4	a		fractional distillation			1	4
	b		alcohols are flammable			1	
	c	i	butanol boils at above 100 °C / water boils at 100 °C / water bath will not go above 100 °C			1	
		ii	(first) methanol , ethanol , propanol (last)			1	
5	a		copper(II)			1	5
	b		sulfate			1	
	c		ammonium nitrate ; NH_4NO_3 ;			2	
	d		$\text{Mg}_3(\text{PO}_4)_2$			1	
6	a		Caesium has melted (at 29 °C) but have not boiled (at 669 °C) / 50 °C is above the melting point but below the boiling point.			1	8
	b		accept range 700 - 820 °C (actual: 760 °C)			1	
	c	i	density increases down the group			1	
		ii	potassium			1	
	d		any two points: • soft • shiny (when freshly cut) / silver colour • conducts heat / electricity • ductile / can be drawn into wires • malleable / can be shaped • solid at room temperature do not accept 'it is a metal / metallic'			2	
	e		$2\text{Li(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{LiOH(aq)} + \text{H}_2\text{(g)}$ [1] correct balanced chemical equation [1] correct state symbols, awarded only when chemical equation is correct			2	

Broadrick Secondary School
Sec 3 Express Science (Chemistry) 5076 / 5078
End of Year Examination 2021 Answers

7	a	X: burette ; Y: conical flask ;	2	8
	b	pipette	1	
	c	i titration number 2	1	
		ii Average volume of $\text{HNO}_3(\text{aq})$ used = $\frac{18.10 + 18.30 + 18.20}{3} = 18.20 \text{ cm}^3$; working not required, allow 18.2 cm^3 , allow for ECF from (c)(i)	1	
		iii	3	
		- Do not agree / nitric acid is more concentrated ; - Mole ratio between the two reactants is 1:1 / equal amount (moles) of reactants is required for complete reaction ; - Since a smaller volume of acid was used to react completely with potassium hydroxide, implying that acid used is of higher concentration. Note: reason can be in the form of calculations also No of moles of $\text{HNO}_3(\text{aq})$ = No of moles of $\text{KOH}(\text{aq})$ $= \frac{18.20}{1000} \times 1.25 = 0.02275 \text{ mol}$; Concentration of KOH used = $0.02275 \text{ mol} \div 0.025 \text{ dm}^3$; $= 0.91 \text{ mol/dm}^3$		
8	a	M_r of $\text{FeCO}_3 = 56 + 12 + 3(16) = 116$ No of moles of $\text{FeCO}_3 = 2.32 \div 116 = \mathbf{0.02 \text{ mol}}$;	1	5
	b	No of moles of $\text{HCl} = \frac{50}{1000} \times 0.10 = \mathbf{0.005 \text{ mol}}$;	1	
	c	i Based on the balanced chemical equation, 1 mol of FeCO_3 will react completely with 2 mol of HCl . 0.02 mol of FeCO_3 will react completely with 0.04 mol of HCl , but there is insufficient HCl . <u>or</u> 0.005 mol of HCl only require 0.0025 mol of FeCO_3 for complete reaction, so FeCO_3 is in excess. (some form of explanation required) Limiting reactant: dilute hydrochloric acid / HCl	1	
		ii Mole ratio of $\text{HCl} : \text{CO}_2 = 2 : 1$ No of moles of CO_2 produced = 0.0025 mol ; Volume of CO_2 produced = $0.0025 \text{ mol} \times 24 \text{ dm}^3 = \mathbf{0.06 \text{ dm}^3}$;	2	

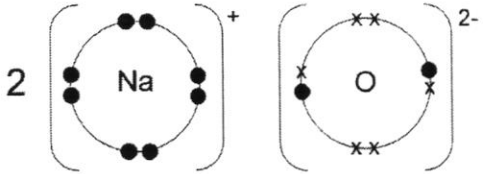
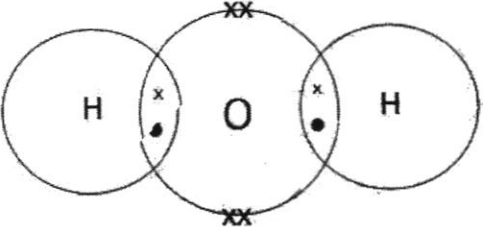
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Section B [20 marks]

Answer both questions from this section.

No.		Answers	Mk	Tot mk	
9	a	i	particulates	1	10
		ii	sulfur dioxide	1	
		iii	May	1	
		iv	There are 2.5 nanograms of CO in every 1000 cm ³ of air Hence in 200 cm ³ of air, there will be 0.5 nanograms of CO	1	
	b	i	Reduces the ability of red blood cells to transport oxygen in human body, leading to breathing difficulty / suffocation / brain damage and eventual death.	1	
		ii	any two points: • corrodes buildings or statues made of limestone or marble • acidify water bodies and kills marine lives / aquatic plants • makes soil too acidic for plants to grow well	2	
	c	i	78% nitrogen , 21% oxygen and 1% other gases	1	
		ii	2NO + 2CO → N ₂ + 2CO ₂ [1] identifying products to be nitrogen and carbon dioxide [1] balanced chemical equation	2	

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10	a	i	<u>4</u>Na (<u>s</u>) + <u>1</u>O₂ (<u>g</u>) → <u>2</u>Na₂O (<u>s</u>) Note: allow for blank if balancing coefficient is '1' [1] correct balancing coefficients [1] all correct state symbols	2	10
		ii	 <u>Legend /key:</u> • electron of sodium x electron of oxygen [1] correct Na⁺ ion [1] correct O²⁻ ion	2	
		iii	In molten state, sodium ions and oxide ions are mobile and can act as charge carriers ; In solid state, the ions are held at fixed position / are not free-moving to conduct electricity ;	2	
	b	i	 <u>Legend /key:</u> • electron of oxygen x electron of hydrogen [1] correct bond pairs [1] correct unshared electrons	2	
		ii	Hydrogen oxide has a simple <u>covalent</u> / molecular structure ; The surrounding energy / the low amount of energy is sufficient to overcome the <u>weak intermolecular forces of attraction</u> ;	2	