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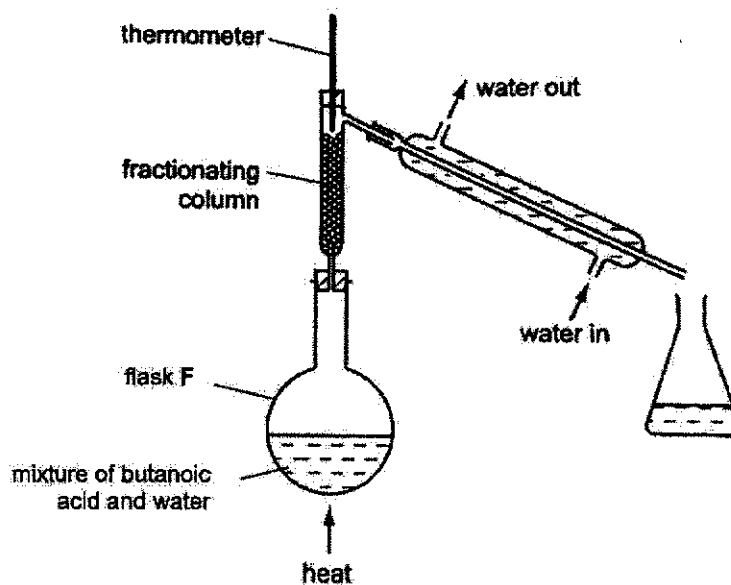


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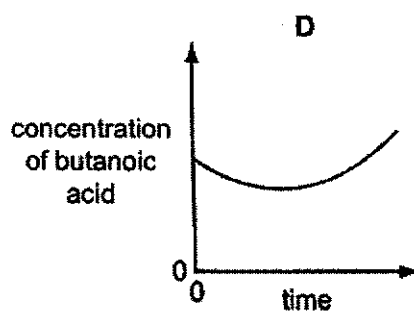
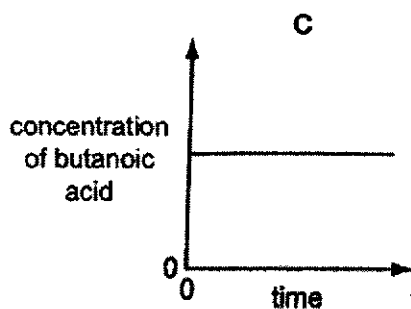
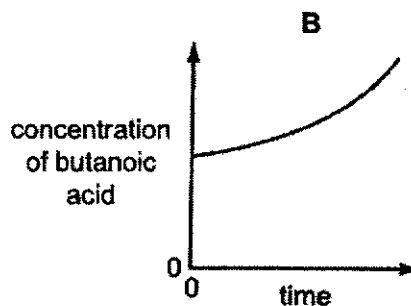
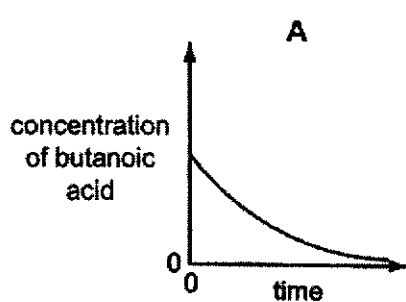
Section A (30 marks)

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

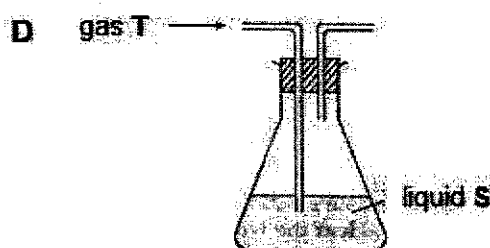
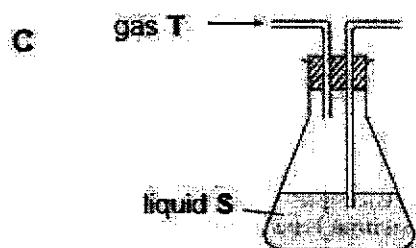
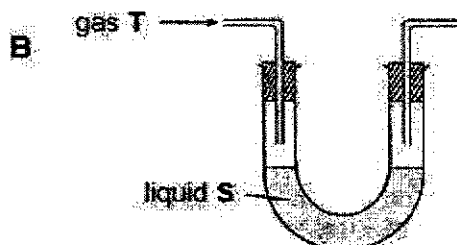
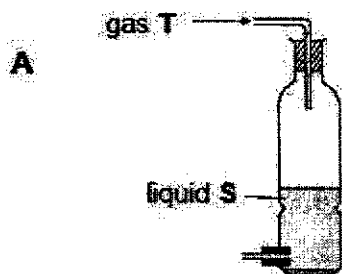
- 1 The set-up shown below is used to purify a sample of butanoic acid (boiling point 164°C) from its mixture with water.



Which graph shows the change in concentration of butanoic acid in flask F over time?



- 2 A sample of a gas, T, can be purified by passing it through a liquid, S. Which set-up is most suitable for this purpose?

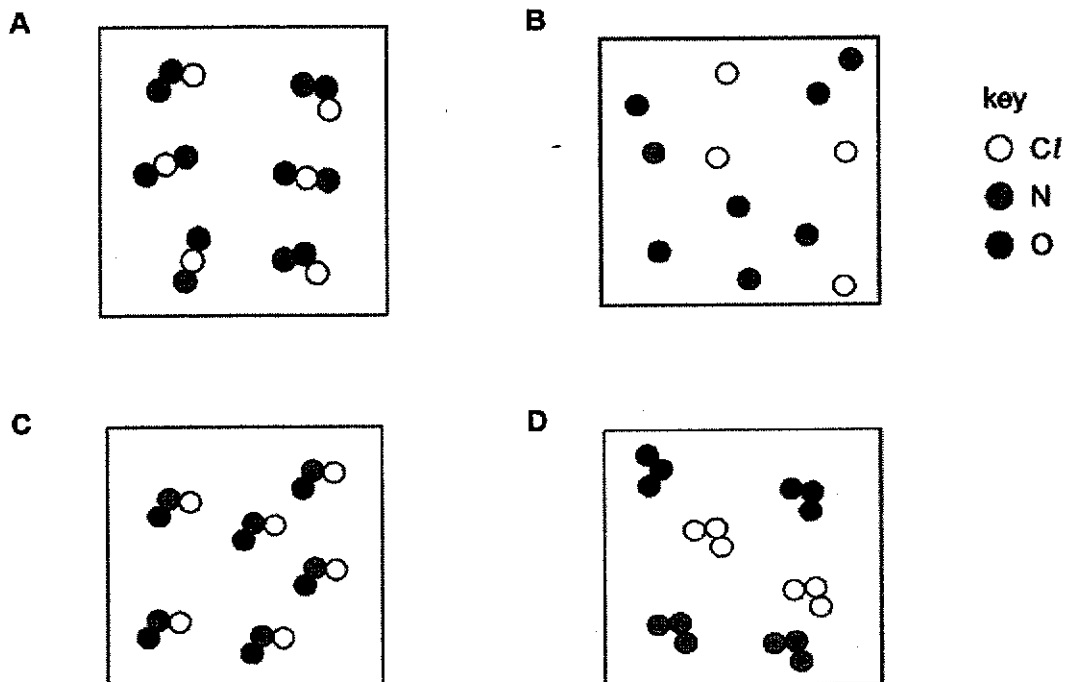


- 3 Which process occurs when sugar crystals are placed in a beaker of water at 50 °C?
- A decomposition
 - B diffusion
 - C evaporation
 - D melting
- 4 An atom of an element has the symbol ${}^4_2\text{Q}$. Which statement about element Q is correct?
- A It is in Group II of the Periodic Table.
 - B It is in Group IV of the Periodic Table.
 - C There are more protons than neutrons in one atom of element Q.
 - D There is an equal number of neutrons and electrons in one atom of element Q.

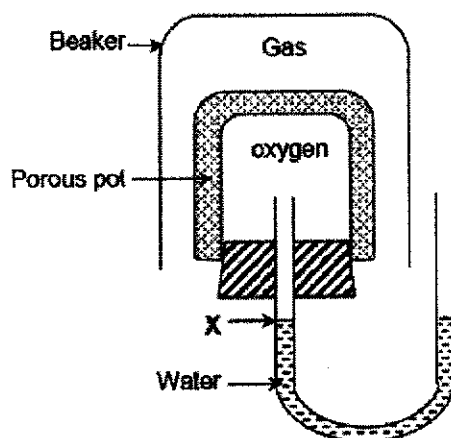
- 5 Three elements X, Y and Z have consecutive, increasing proton numbers. If element X is a noble gas, which of the following ions would element Z form in its compounds?
- A Z^+
 - B Z^{2+}
 - C Z^-
 - D Z^{2-}

[Turn over

6 Which diagram represents a gas with the molecular formula NOC ?



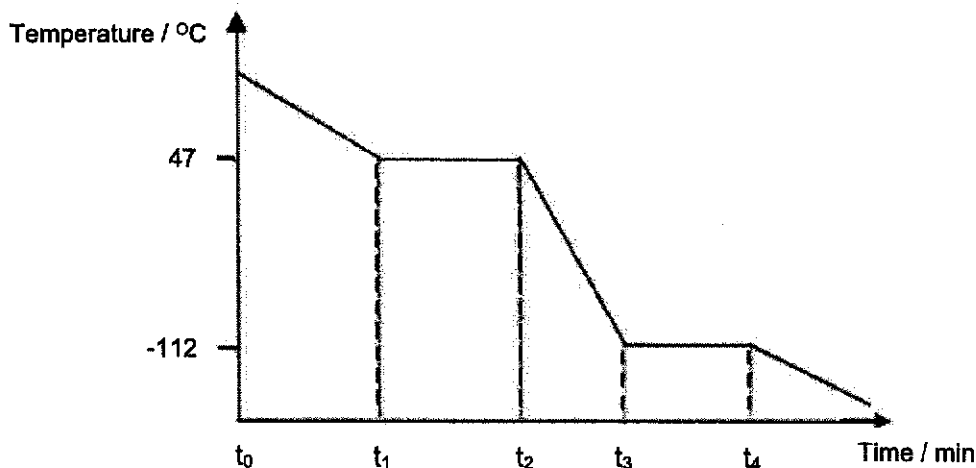
7 An experiment is set up as shown below.



Which gas, when present in the beaker, would cause the water level at X to fall?

- A** carbon dioxide, CO_2
- B** chlorine, Cl_2
- C** methane, CH_4
- D** nitrogen dioxide, NO_2

- 8 The graph below shows the cooling curve of carbon disulfide.



Which statement is **incorrect**?

- A Carbon disulfide is a liquid at -73 °C.
 - B Heat energy is absorbed to overcome forces of attraction between the particles of carbon disulfide between t₁ and t₂.
 - C The melting point of carbon disulfide is -112 °C.
 - D The particles of carbon disulfide are closer to one another at t₁ than at t₀.
- 9 Boron exists naturally as two isotopes. The table below shows the relative abundance of both isotopes.

isotope	relative abundance
¹⁰ ₅ B	19.7 %
¹¹ ₅ B	80.3 %

Based on the data, what would be the average mass of a boron atom?

- A 10.0
 - B 10.6
 - C 10.8
 - D 11.0
- 10 Which set of substances contains an element, a mixture and a compound?
- A air, pure water, calcium chloride
 - B carbon, air, calcium chloride

[Turn over

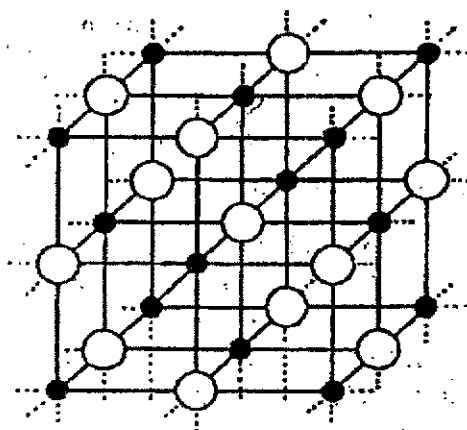
6

- C** pure water, sulfur, calcium
D sulfur, carbon monoxide, calcium chloride

11 Which statement explains why brass is harder than pure copper?

- A** Zinc atoms in brass form strong covalent bonds with the copper atoms.
B Zinc atoms in brass have more electrons than copper atoms.
C Zinc atoms in brass prevent the layers of copper atoms from sliding past one another easily.
D Zinc atoms in brass prevent the 'sea of electrons' from moving freely in the lattice.

12 The diagram below shows part of the arrangement of ions in a compound. Ions of element **M** are represented by $\bullet$ and ions of element **X** are represented by $\circ$.



What is the simplest formula of this compound?

- A** MX
B MX_2
C M_5X_4
D $\text{M}_{14}\text{X}_{13}$

13 Substance **Z** has the following properties:

- melting point lower than 0°C
- insoluble in water
- conducts electricity in solid and molten states

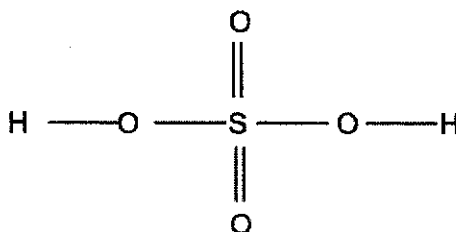
Which of the following could substance **Z** be?

- A** carbon dioxide
B graphite
C mercury
D zinc

14 Elements X, Y and Z belong to Groups I, V and VII of the Periodic Table respectively. Which statement is correct?

- A XZ and YZ₃ are both ionic compounds.
- B XZ and X₃Y are both covalent compounds.
- C XZ is a covalent compound and YZ₃ is an ionic compound.
- D X₃Y is an ionic compound and YZ₃ is a covalent compound.

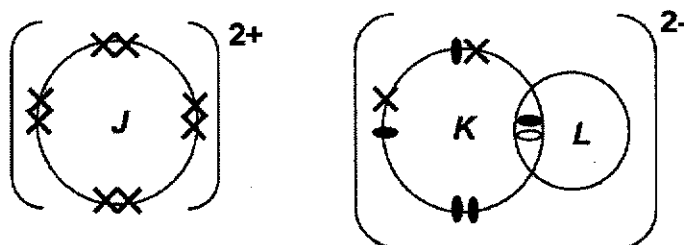
15 The bonding in a molecule of sulfuric acid is shown below.



What is the total number of electrons in the bonds joined to the sulfur atom?

- A 4
- B 6
- C 12
- D 16

16 J, K and L are three different elements in the Periodic Table. The electronic diagram (showing only the valence electrons) of the compound formed between J, K and L is shown below.



Which of the following statements are correct?

- I Element K could be nitrogen.
- II Element J belongs to Group II of the Periodic Table.
- III Element K and element L are bonded together by covalent bond.
- IV Element L is a metal.

- A I, II and III

[Turn over

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

17 Under the same temperature and pressure, a 24 g sample of oxygen gas occupies the same volume as 18 g of gas *P*. What is the relative molecular mass of gas *P*?

- A 12
B 24
C 32
D 56

18 Potassium manganate(VII) decomposes when gently heated according to the equation below.



When 1.65 g of a sample of potassium manganate(VII) crystals is heated until no more gas evolves, the volume of oxygen gas collected at r.t.p is 120 cm³. What is the percentage purity of the sample of potassium manganate(VII) crystals?
(*A_r*: Mn 55, K 39, O 16)

- A 20 %
B 24 %
C 48 %
D 96 %

19 Which statement correctly describes an alkali?

- A A strong alkali has a low pH.
B A weak alkali undergoes a high rate of dissociation.
C Alkalis are bases that are soluble in water.
D Alkalis are not corrosive.

20 Which of the following shows the correct methods a student should use to prepare the named salts in a Science laboratory?

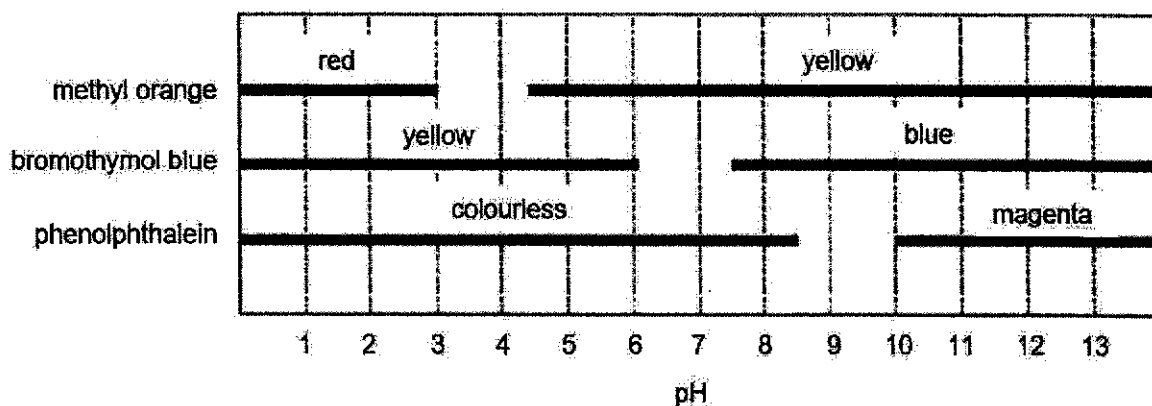
	titration	precipitation	adding excess solid reactants
A	ammonium chloride	lead(II) sulfate	magnesium chloride
B	barium carbonate	calcium sulfate	sodium chloride
C	copper(II) sulfate	ammonium chloride	lead(II) nitrate
D	lead(II) nitrate	barium carbonate	zinc sulfate

21 Both acids and alkalis may be used to remove the layer of aluminium oxide formed on the surface of saucepans. Which statement explains this observation?

- A Aluminium oxide is acidic.

- B Aluminium oxide is amphoteric.
- C Aluminium oxide is basic.
- D Aluminium oxide is neutral.

22 The diagram below shows the colour range of three pH indicators, methyl orange, bromothymol blue and phenolphthalein.



When added separately to solution X, methyl orange is yellow, bromothymol blue is blue and phenolphthalein is colourless. What is the pH range of solution X?

- A 4.5 to 6.0
 - B 6.0 to 7.5
 - C 7.5 to 8.5
 - D 8.5 to 10.0
- 23 Which gas is used to fill light bulbs?
- A argon
 - B krypton
 - C nitrogen
 - D oxygen
- 24 Element M reacts with water producing an acidic solution. This solution gives a white precipitate with aqueous silver nitrate. In which Group or section of the Periodic Table is M found?
- A alkali metals
 - B halogens
 - C noble gases
 - D transition metals
- 25 Rubidium is in Group I of the Periodic Table. Which pair of properties is rubidium likely to have?
- A hard, high melting point

[Turn over

- B hard, low melting point
- C soft, high melting point
- D soft, low melting point

26 An experiment is carried out to determine the order of reactivity of some metals. Three metals are placed in aqueous solutions of metal ions. The results are shown below.

metal	aqueous solutions of metal ions			
	W ²⁺	X ²⁺	Y ²⁺	Z ²⁺
W		reaction observed	reaction observed	reaction observed
Y	no reaction observed	no reaction observed		no reaction observed
Z	no reaction observed	no reaction observed	reaction observed	

Which of the following is the correct order of reactivity, from the most to the least reactive metal?

- A W, X, Y, Z
- B W, X, Z, Y
- C W, Z, Y, X
- D Y, Z, X, W

27 Which of the following correctly describes high-carbon steel?

- A soft and brittle
- B soft and easily shaped
- C strong and brittle
- D strong and easily shaped

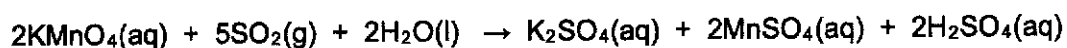
28 Scrap iron is often recycled. Which reason for recycling is **not** correct?

- A It reduces the amount of pollution at the site of the ore extraction.
- B It reduces the amount of waste taken to landfill sites.
- C It reduces the need to collect the scrap iron.
- D It saves natural resources.

29 Which of the following is a redox reaction?

- A $\text{CaCl}_2 + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{PbCl}_2$
- B $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- C $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- D $2\text{O}_3 \rightarrow 3\text{O}_2$

30 In the reaction shown below, which pair of substances correctly identifies the oxidising and reducing agents?



	oxidising agent	reducing agent
A	H ₂ SO ₄	MnSO ₄
B	KMnO ₄	SO ₂
C	KMnO ₄	H ₂ O
D	SO ₂	KMnO ₄

Section B (40 marks)Answer **ALL** questions in the spaces provided.

- 1 A list of substances is given below.

hydrogen	caesium	helium	oxygen
copper	chlorine	graphite	magnesium oxide

Using each substance once, more than once or not at all, identify the substance which

- (a) extinguishes a lighted splint with a 'pop' sound;

.....

- (b) is necessary for rusting;

.....

- (c) exists in variable oxidation states;

.....

- (d) bleaches litmus paper when in gaseous state;

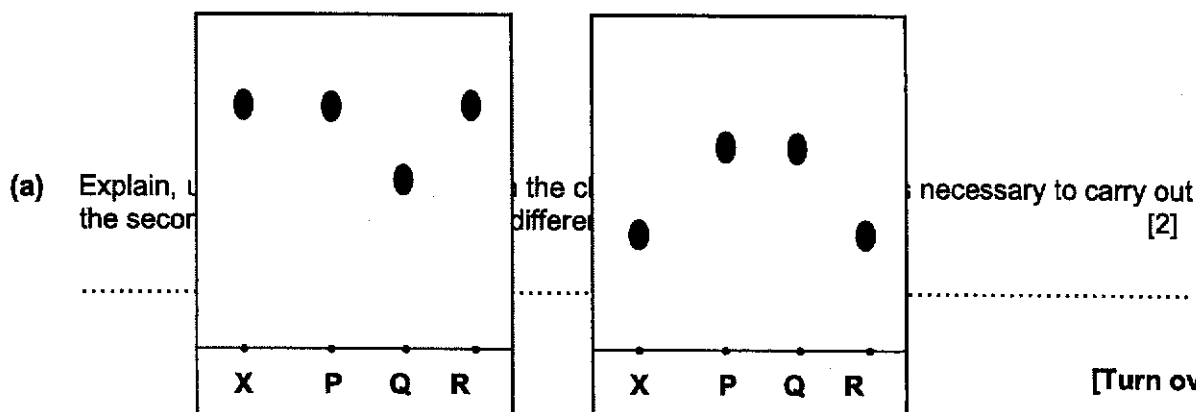
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- (e) is used to line the interior of a blast furnace.

.....

[5]

- 2 The ink, X, from a forged letter was analysed with three other inks, P, Q and R, taken from the pens of three suspects. Two chromatograms, as shown below, were obtained using different solvents - water and ethanol.



[Turn over]

-

 (b) Identify the ink that was used to write the forged letter. [1]

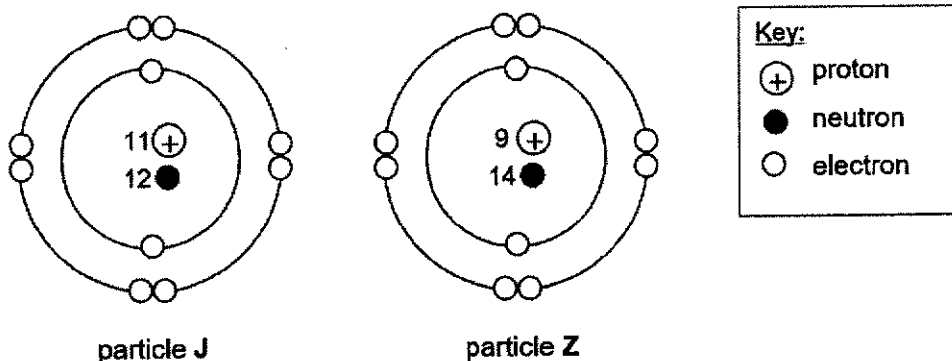
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 (c) In carrying out chromatography, the following precautions are taken. Suggest a reason for each precaution.

- (i) The solvent front must **not** be allowed to reach the top edge of the chromatography paper. [1]

-

 (ii) The start line is drawn in pencil. [1]

-
 3 The structures of two particles, J and Z are shown below.



- (a) State the formula of each particle. [1]

J:

Z:

- (b) State the formula of the compound formed between J and Z. [1]

.....

- (c) Calculate the mass of one mole of the compound formed between J and Z. [1]

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- (d) Explain how the bond between J and Z is formed. [3]

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- (e) Predict whether the compound formed between J and Z has a high or low melting point. Explain your answer. [3]

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- 4 Tartaric acid, H_2T , is a weak acid found in wines. The reaction between sodium hydroxide and tartaric acid can be represented by the equation shown below.



- (a) Explain the meaning of 'weak acid'. [1]

.....

.....

- (b) Write the equation for the reaction between tartaric acid and magnesium ribbon. [1]

.....

- (c) In a titration experiment, it was found that 25.0 cm^3 of wine required 20.0 cm^3 of 0.10 mol/dm^3 sodium hydroxide for complete neutralisation. Calculate the concentration of tartaric acid in the wine. [3]

[Turn over

- 5** Titanium is commonly found in the Earth's crust in the form of its oxide, TiO_2 . To extract titanium, the oxide is first heated with coke and chlorine to produce titanium chloride and a gas **P**. The titanium chloride is then heated in a furnace with magnesium so that titanium will be produced.

(a) (i) Identify gas **P**. [1]

.....

(ii) Describe a test to confirm the identity of gas **P**. [2]

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.....

(b) Compare the reactivity of titanium and magnesium. Explain your answer. [2]

.....

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(c) Name another metal that is also extracted by a similar process. [1]

.....

(d) Titanium is known to be a metal with the strength of steel and also with the low density and corrosion-resistance of aluminium.

- (i) Define the term 'corrosion'. [1]

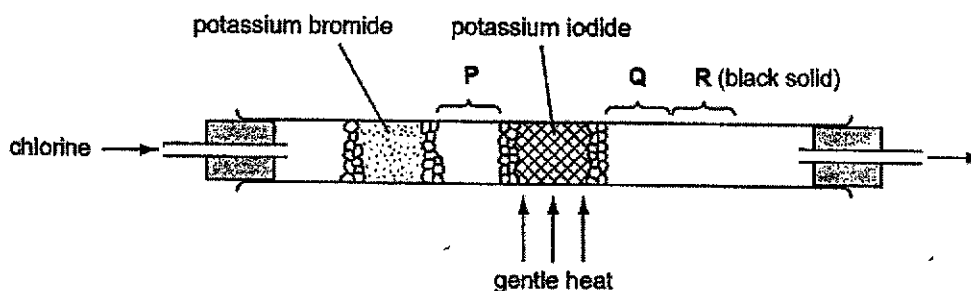
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- (ii) State a possible use of titanium. [1]

.....

6 In an experiment, chlorine gas is passed through a tube as shown below.



After a short while, coloured vapours are observed at P and Q.

- (a) State the colours of the vapours observed at P and Q. [1]

P:

Q:

- (b) With reference to **electron transfer**, explain the redox reaction that occurred in the formation of the vapour at P. [3]

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- (c) Identify the black solid that formed at R. [1]

.....

- (d) State and explain the trend in the reactivity of elements in Group VII. [3]

[Turn over

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Section C (30 marks)

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

- 7 Sodium chloride is commonly known as table salt. A pot of uncooked rice is accidentally contaminated with some salt.

(a) Describe in detail how you would separate the rice from the salt. [4]

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- (b) Sodium chloride crystals are very hard and have regular shapes. In industry, electrolysis of concentrated aqueous sodium chloride produces chlorine.

(i) With reference to the two statements above, state a difference between an element and a compound. [2]

.....

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(ii) Explain why sodium chloride crystals are '*very hard and have regular shapes*'. [2]

.....

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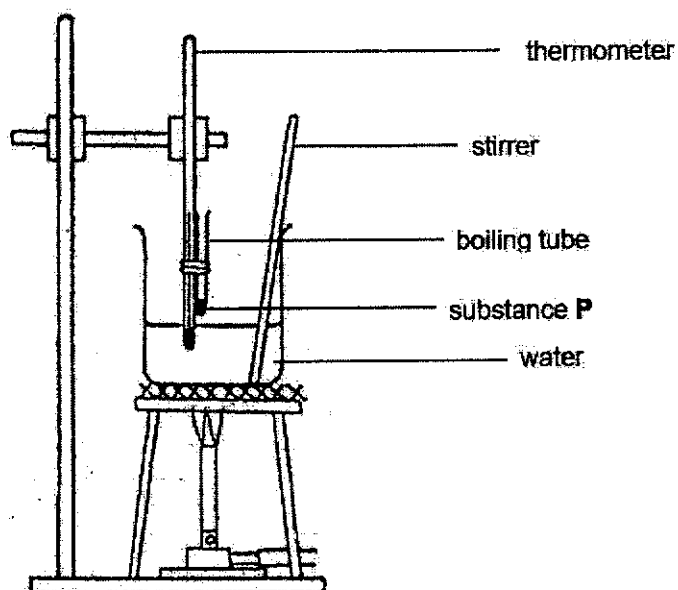
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[Turn over

- (iii) In the space below, draw the dot-and-cross diagram of sodium chloride. [2]

- 8 A student set up an experiment as shown below, to find the melting point of a substance, P.



- (a) (i) Upon checking, the student's teacher identified a mistake in the set-up. Suggest how the student should modify the set-up for greater accuracy. [1]

.....
.....

- (ii) The student made an effort to stir the water in the beaker throughout the experiment. Suggest why the student did so. [1]

.....

- (b) Using the modified set-up, the student observed that the thermometer reading rose from 82 °C to 86 °C as substance P melted. To identify substance P, the student referred to the table below.

substance	melting point / °C
naphthalene	80
octacosanol	83
stearone	88

- (i) Is substance P a pure substance? Explain your answer. [2]

.....

- (ii) Based on the experimental data and table above, suggest the identity of P. Explain your answer. [2]

.....

- (c) In a separate experiment, another student found that solid carbon dioxide sublimates when placed at room temperature and pressure.

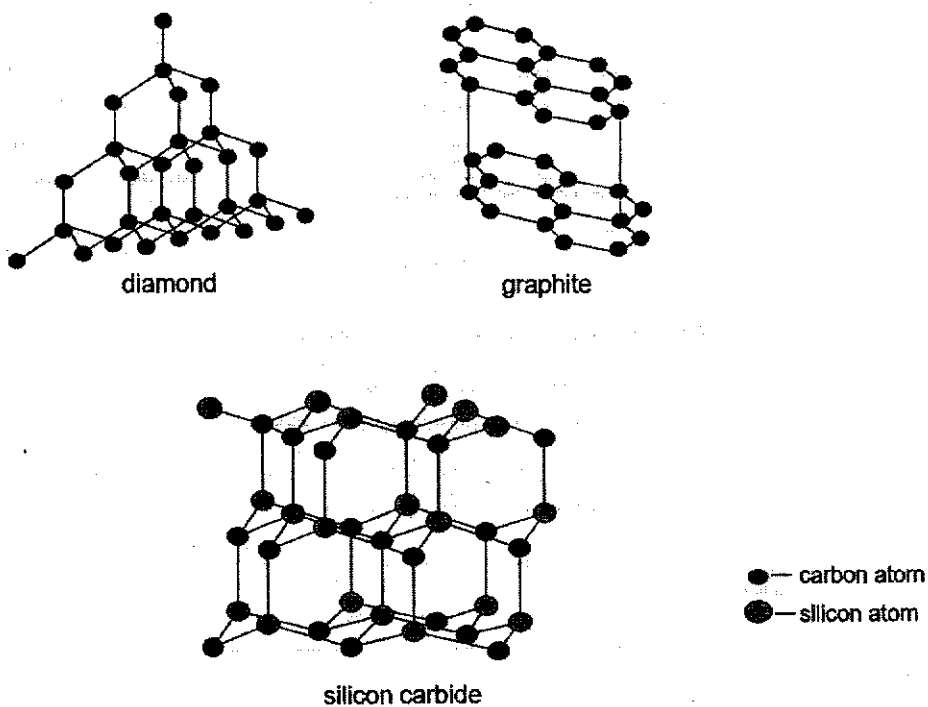
- (i) Draw the dot-and-cross diagram of carbon dioxide, showing only the valence electrons. [2]

- (ii) Using your knowledge of kinetic particle theory and chemical bonding, explain why solid carbon dioxide sublimates when placed at room temperature and pressure. [2]

.....

[Turn over

9 The diagram below shows the structures of three macromolecules.



(a) Identify two allotropes in the diagram above. [1]

.....

(b) Suggest the formula of silicon carbide. [1]

.....

(c) (i) Which macromolecule is able to conduct electricity? [1]

.....

(ii) Explain your answer in (c)(i). [2]

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- (d) With reference to the physical properties of diamond, explain why it is used to make drill tips. [3]

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- (e) Explain why graphite can be used as a solid lubricant. [2]

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End of Paper

[Turn over

The Periodic Table of Elements

Group																				
I	II													III	IV	V	VI	VII	0	
														1 H hydrogen 1						
Key proton (atomic) number atomic symbol name relative atomic mass																				
3 Li lithium 7	4 Be beryllium 9													5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	
11 Na sodium 23	12 Mg magnesium 24													13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84			
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131			
55 Cs caesium 133	56 Ba barium 137	57-71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium -	86 Rn radon -			
87 Fr francium -	88 Ra radium -	89-103 actinoids		104 Rf rutherfordium -	105 Db dubnium -	106 Sg seaborgium -	107 Bh bohrium -	108 Hs hassium -	109 Mt meitnerium -	110 Ds darmstadtium -	111 Rg roentgenium -	112 Cn copernicium -		114 Fl flerovium -		116 Lv livermorium -				
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**Deyi Secondary School
End-of-Year Examination 2019
Chemistry (6092)
Secondary 3 Express**

Marking Scheme

Section A [30m]

Qn No.	Answer	Qn No.	Answer	Qn No.	Answer
1	B	11	C	21	B
2	D	12	A	22	C
3	B	13	C	23	A
4	D	14	D	24	B
5	B	15	C	25	D
6	C	16	A	26	B
7	C	17	B	27	C
8	B	18	D	28	C
9	C	19	C	29	B
10	B	20	A	30	B

Section B [40m]

Question 1

Qn.	Answer	Marks	Remarks
(a)	Hydrogen	1	
(b)	Oxygen	1	
(c)	Copper	1	
(d)	Chlorine	1	
(e)	Magnesium oxide	1	
	Total	5	

Question 2

Qn.	Answer	Marks	Remarks
(a)	Using water as a solvent, R _f values for inks P and R were the same	1	
	Another solvent is used to determine if the ink in the forged letter was P or R	1	
(b)	Ink R	1	
(c)(i)	If the solvent front reaches the top of the chromatography paper, R _f value cannot be calculated	1	
(c)(ii)	Carbon in pencil lead is insoluble in most solvents and would not interfere with the separation process	1	
	Total	5	

Question 3

Qn.	Answer	Marks	Remarks
(a)	J ⁺ Z ⁻	1	
(b)	JZ	1	
(c)	46 g	1	no units - minus ½ m
(d)	Atom of J loses one electron to form a positively charged ion	1	
	Atom of Z gains one electron to form a negatively charged ion	1	
	Ionic bond is formed through the electrostatic force of attraction between both ions	1	
(e)	High melting point		
	Large amount of heat energy is needed to	1	
	Overcome strong electrostatic forces of attraction between	1	
	Oppositely charged J ⁺ and Z ⁻ ions in the giant ionic lattice	1	
	Total	9	

Question 4

Qn.	Answer	Marks	Remarks
(a)	A weak acid partially ionises in water to form hydrogen ions	1	
(b)	$\text{H}_2\text{T} + \text{Mg} \rightarrow \text{MgT} + \text{H}_2$	1	
(c)	Number of moles of sodium hydroxide used = $(20/1000) \times 0.10$ = 0.002 mol	1	
	From the equation, 2 mol of sodium hydroxide reacts with 1 mol of tartaric acid; hence 0.002 mol of sodium hydroxide reacts with 0.001 mol of tartaric acid	1	
	Concentration of tartaric acid = $0.001/(25/1000)$ = 0.04 mol/dm ³	1	
	Total	5	

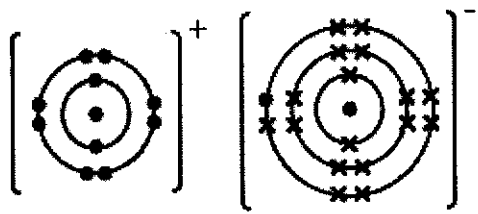
Question 5

Qn.	Answer	Marks	Remarks
(a)(i)	Carbon dioxide	1	
(a)(ii)	Bubble the gas through limewater	1	
	A white precipitate forms	1	
(b)	Titanium is less reactive than magnesium	1	
	Magnesium displaces titanium from its chloride	1	
(c)	Zinc / Iron / Tin / Lead / Copper / Silver	1	accept any metal less reactive than magnesium
(d)(i)	Corrosion is the wearing away of the surface of a metal by a chemical reaction	1	
(d)(ii)	Jewellery / artificial replacements for hip or knee joints / spectacle frames / golf clubs / racing cars or bicycles	1	accept any appropriate use of titanium
	Total	8	

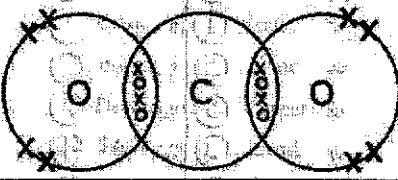
Question 6

Qn.	Answer	Marks	Remarks
(a)	P: reddish-brown Q: violet/purple	1	
(b)	Electrons are transferred from bromide ions to chlorine (atoms)	1	explain both oxidation and reduction (redox)
	Bromide ions lose electrons and are oxidised to bromine (molecules)	1	
	Chlorine (atoms) gains electrons and is reduced to chloride ions	1	
(c)	Iodine	1	
(d)	Reactivity decreases down Group VII	1	
	Atomic radii increases as number of electron shells increases down the Group	1	
	Force of attraction for electrons from the positive nucleus weakens and electrons are attracted less readily	1	
	Total	8	

Section C [30m]**Question 7**

Qn.	Answer	Marks	Remarks
(a)	Add water to the mixture of rice and salt and stir to dissolve the salt	1	
	Filter the mixture to obtain rice as the residue and	1	
	Salt solution as the filtrate	1	
	Heat the filtrate to dryness to obtain the salt crystals	1	
(b)(i)	A compound consists of 2 or more elements chemically combined such as sodium chloride	1	
	An element is a substance that cannot be broken down into simpler substances such as chlorine	1	
(b)(ii)	Sodium and chloride ions are held together by strong electrostatic forces of attraction which require a lot of energy to overcome (hard)	1	
	Ions are held in fixed positions in a giant ionic lattice (regular shape)	1	
(b)(iii)	 sodium ion, $\text{Na}^+ [2,8]^+$ chloride ion, $\text{Cl}^- [2,8,8]^-$	2	1m for each correct ion with all electrons drawn
	Total	10	

Question 8

Qn.	Answer	Marks	Remarks
(a)(i)	The boiling tube should be placed inside the beaker of water OR the position of substance P should be aligned with the bulb of the thermometer	1	
(a)(ii)	To distribute the heat evenly throughout the water bath	1	
(b)(i)	No	1	
	Substance P melted over a range of temperatures	1	
(b)(ii)	P is stearone	1	
	Impurities lower the melting point of a substance and P melted over a range of temperatures lower than 88 °C	1	
(c)(i)		2	1m for correct number of C and O atoms; 1m for correct number of electrons
(c)(ii)	Little heat energy is needed to overcome weak intermolecular forces of attraction between carbon dioxide molecules in solid state	1	
	As forces of attraction are overcome/weakened, molecules move rapidly in all directions in gaseous state	1	
Total		10	

Question 9

Qn.	Answer	Marks	Remarks
(a)	Diamond and graphite	1	1m if both correct
(b)	SiC	1	
(c)(i)	Graphite	1	
(c)(ii)	Each carbon atom is covalently bonded to three other carbon atoms, thus having one valence electron not involved in bonding	1	
	Presence of these delocalised (free-moving) electrons allows graphite to conduct electricity	1	
(d)	Diamond is hard and has high melting and boiling points as	1	
	A lot of heat energy is needed to break the strong covalent bonds between carbon atoms throughout the	1	
	Giant molecular structure	1	
(e)	Weak intermolecular forces of attraction between the layers of carbon atoms allow	1	
	The layers to slide over one another easily when force is applied	1	
Total		10	

