Geylang Methodist School (Secondary)
End-of-Year Examination 2019

CHEMISTRY **6092/01**

Paper 1 Multiple Choice **Sec 3 Express**

Additional materials: OAS **45 minutes**

10 October 2019

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and register number on the Answer Sheet in the spaces provided.

There are **thirty** questions in this paper. Answer **all** questions.
For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate 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 paper.
A copy of the Periodic Table is printed on page 11.

This document consists of **11** printed pages and **1** blank page.

[Turn over

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1 A student takes 2 g samples of calcium carbonate and adds them to 20 cm^3 samples of dilute hydrochloric acid at different temperatures. She measures how long it takes for the effervescence to stop.
Which apparatus does she use?

	balance	stopwatch	filter funnel	measuring cylinder	thermometer
A	✓	✓	✓	✓	✗
B	✓	✓	✗	✓	✓
C	✓	✗	✓	✓	✓
D	✗	✓	✓	✗	✓

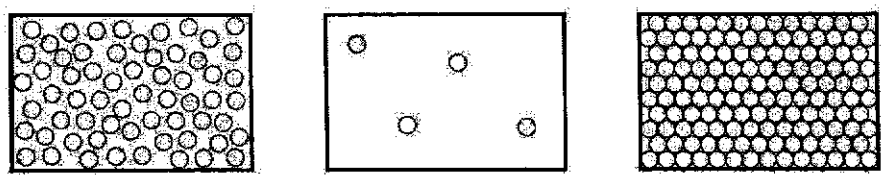
2 What could be the boiling point of water containing dissolved sodium chloride?

A 95 °C
B 100 °C
C 103 °C
D 350 °C

3 A student was trying to obtain copper(II) sulfate crystals by reacting copper(II) oxide with dilute sulfuric acid. However, instead of blue crystals, his final product was a white compound.
What mistake did the student make?

A heating the filtrate to dryness
B adding excess copper (II) oxide
C using excess dilute sulfuric acid
D using dilute sulfuric acid instead of concentrated sulfuric acid

4 The diagrams below show the arrangement of particles of substance X in three different physical states.



state 1 state 2 state 3

Which statement about the physical states of substance X is correct?

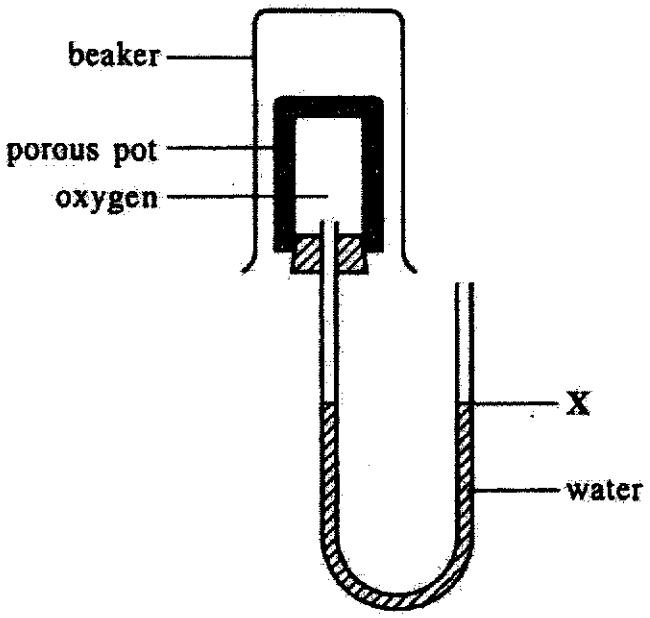
A Particles in state 1 vibrate about fixed positions.
B State 1 changes to state 2 by diffusion.
C State 2 changes directly to state 3 by condensation.
D The substance in state 3 has a fixed volume.

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5 Two gases, P and Q were separately released in a laboratory on a cold day. The experiment was repeated on a hot day. The time taken for the gases to reach the opposite end of the laboratory was recorded for each experiment. The M_r of gas P was 34 and the M_r of Q was 64.
Which gas on which day would reach the end of the laboratory in the shortest time?

	gas	day
A	P	cold
B	P	hot
C	Q	cold
D	Q	hot

6 The apparatus shown below is set up.



Which gas, when present in the beaker, will cause the water level at X to rise?

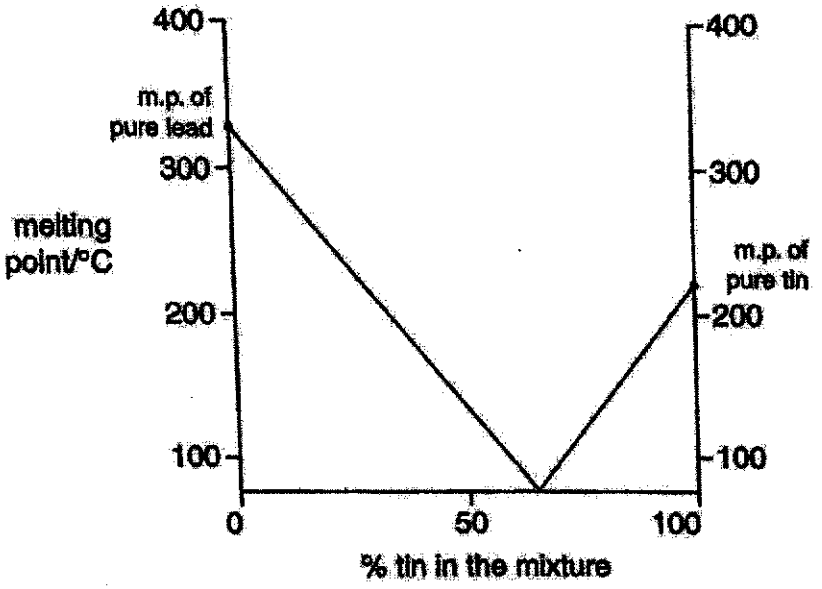
A carbon dioxide
B chlorine
C nitrogen dioxide
D methane

7 At the same temperature and pressure, different gas molecules move with different average speeds.
Which of the following lists the molecules in order of decreasing average speeds?

	fastest → slowest			
A	ammonia	methane	chlorine	sulfur dioxide
B	ammonia	methane	sulfur dioxide	chlorine
C	methane	ammonia	sulfur dioxide	chlorine
D	methane	ammonia	chlorine	sulfur dixoide

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8 The graph below gives the melting points of mixtures of lead and tin.



Which of the following statements is true?

A Any mixture of lead and tin must have a melting point above that of tin.
B Any mixture of lead and tin must have a melting point below that of lead.
C Any mixture of lead and tin must have a melting point below that of both tin and lead.
D Any mixture of lead and tin must have a melting point between that of tin and lead.

9 Oxygen crystals are obtained by freezing oxygen at -223 °C.
What will the oxygen crystals contain?

A oxygen atoms and molecules
B oxygen ions and oxygen atoms
C oxygen molecules only
D oxygen atoms only

10 In which compound does one of the atoms **not** achieve the electronic configuration of 2.8?

A Na_2O
B CO_2
C MgO
D CCl_4

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11 The symbol of an element is $^{75}_{33}As$.

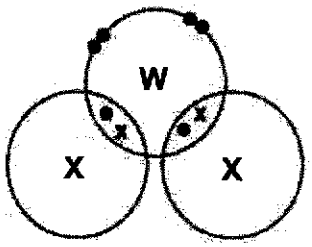
How many electrons does an ion of this element contain?

A 30
B 33
C 36
D 42

12 Which element has the greatest tendency to accept electrons?

A fluorine
B iodine
C lithium
D potassium

13 The diagram below shows the valence electrons of element W when combined with element X.

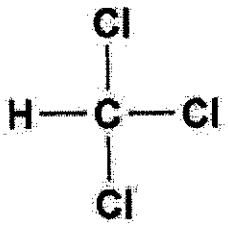


Which of the following statements is **incorrect**, given that W is found in Period 3 of the Periodic Table?

A W can react with lithium to form an ionic compound.
B W can react with oxygen to form an ionic compound.
C W cannot conduct electricity in any state.
D W is a solid at room temperature.

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14 Chloroform, $CHCl_3$, is an important solvent used in many organic reactions. The following diagram shows the bonding present in a molecule of $CHCl_3$.



How many electrons in a molecule of $CHCl_3$ are **not** involved in bonding?

A 8
B 18
C 24
D 50

15 Which substance does **not** contain four covalent bonds?

A diamond
B graphite
C carbon dioxide
D methane

16 Which feature of a metal's structure is responsible for conducting electricity?

A It contains positive ions.
B It has a 'sea of electrons'.
C Its ions are tightly packed together.
D Its positive ions attract electrons.

17 Which substance contains the greatest number of atoms in 1 g?

A carbon
B oxygen gas
C ammonia gas
D carbon monoxide

18 Which solution contains the greatest number of moles of Na^+ ions?

A 5 cm^3 of 0.2 mol/dm^3 NaCl
B 5 cm^3 of 0.2 mol/dm^3 Na_3PO_4
C 10 cm^3 of 0.1 mol/dm^3 NaOH
D 10 cm^3 of 0.1 mol/dm^3 Na_2SO_4

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19 When heated, two moles of X gives one mole of oxygen and two moles of chlorine.
What is the molecular formula of X?

A ClO_2
B Cl_2O
C Cl_2O_2
D Cl_4O_2

20 Below are the overall equations for the manufacture of three fertilisers (underlined).

Reaction I : $H_2SO_4 + 2NH_3 \rightarrow \underline{(NH_4)_2SO_4}$
Reaction II : $2H_2SO_4 + Ca_3(PO_4)_2 \rightarrow \underline{Ca(H_2PO_4)_2} + 2CaSO_4$
Reaction III: $3H_2SO_4 + Ca_3(PO_4)_2 + 6NH_3 \rightarrow \underline{2(NH_4)_3PO_4} + 3CaSO_4$

The relative molecular masses, M_r, of sulfuric acid and each fertiliser are shown in the table below.

	H_2SO_4	$(NH_4)_2SO_4$	$Ca(H_2PO_4)_2$	$(NH_4)_3PO_4$
M_r	98	132	234	149

In each reaction, 98 kilograms of sulfuric acid were used.
Which reactions gave the greatest mass and smallest mass of fertiliser?

	greatest mass	smallest mass
A	I	III
B	I	II
C	II	I
D	III	II

21 Astatine is the element below iodine in the Periodic Table. It is black in colour and radioactive.
Which of the following would **not** be a correct prediction of astatine or its compounds?

A Astatine is a solid at room temperature.
B Astatine gains an electron more readily than chlorine.
C Aqueous hydrogen astatide turns blue litmus paper red.
D Astatide ions are displaced when aqueous bromine is added to potassium astatide.

22 The metal rubidium is below potassium in Group I of the Periodic Table.
Which statement is most likely to be correct?

A Rubidium is less dense than potassium.
B Rubidium has a higher melting point than potassium.
C Rubidium reacts less vigorously in water than potassium.
D Rubidium has a higher tendency to lose electrons than potassium.

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23 Which statement describes the changes in the elements from left to right across a period of the Periodic Table?

A The ability to conduct electricity increases.
B The metallic properties decreases.
C The number of valence electrons decreases.
D The number of neutrons in an atom decreases.

24 There are 3 solutions containing metal ions X, Y and Z respectively. Manganese (Mn) and nickel (Ni) metals are put into the solutions separately.
The following table shows whether a reaction occurs between them.

	solution of X	solution of Y	solution of Z
Mn	X displaced	no reaction	no reaction
Ni	X displaced	no reaction	Z displaced

Which is the correct order of reactivity of the metals in **descending** order?

A X, Mn, Y, Ni, Z
B Z, Ni, Y, Mn, X
C Y, Mn, X, Ni, Z
D Y, Ni, Z, Mn, X

25 The following statements describe some properties of metals.

I form coloured compounds
II good conductors of electricity
III react with dilute acids to liberate hydrogen gas

Which of the above statements apply to **all** transition metals?

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

26 Q is a solid which conducts electricity and has a high melting point. On warming, Q partly dissolves in excess dilute hydrochloric acid, leaving behind a residue.
What is Q?

A steel
B copper(II) oxide
C sodium chloride
D zinc

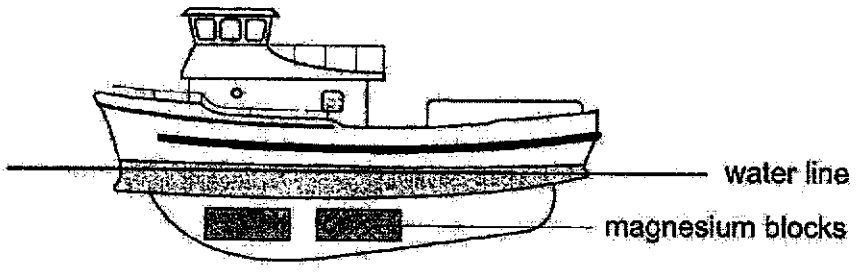
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27 X, Y and Z are metals. Red hot carbon will reduce both the oxides of X and Y but not the oxide of Z. The metal Y can remove the oxygen from the oxide of metal X.

Which option shows the order of increasing reactivity for the three metals?

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

28 Most boats are built with a body that consists of a high percentage of iron. Some magnesium blocks are attached to the hull below the water line to prevent the iron from rusting as shown in the diagram below.



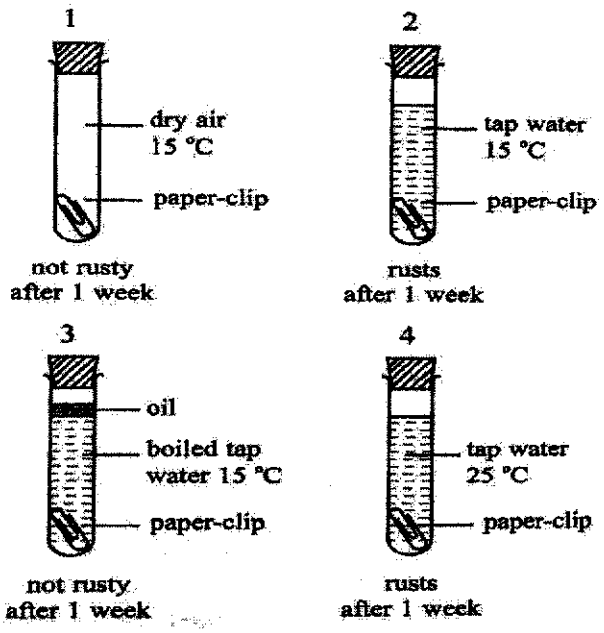
Which statement explains why magnesium stops the iron from rusting?

A Magnesium forms an alloy with iron.
B Magnesium forms its ions more readily than iron.
C Magnesium prevents oxygen in the water from reacting with iron.
D Magnesium protects iron by forming a protective layer of magnesium oxide.

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29 Four experiments on rusting are shown below.



Which pair of experiments can be used to show that air is needed for iron to rust?

A 1 and 3
B 1 and 4
C 2 and 3
D 2 and 4

30 During the manufacture of iron from haematite, which gas(es) is/are present in the blast furnace?

A carbon dioxide
B carbon monoxide
C carbon dioxide and carbon monoxide
D carbon dioxide, carbon monoxide and nitrogen

END OF PAPER 1

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
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 –	85 At astatine –	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 –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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

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End-of-Year Examination 2019

Candidate Name			
Class		Index Number	

CHEMISTRY

6092/02

Paper 2

Sec 3 Express

Additional material: None

1 hour 30 minutes

2 October 2019

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

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

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 15.

For Examiner's Use		
Section A		/40
Section B	B7	/10
	B8	/10
	B9	/10
	Total	70

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Section A

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

A1 **(a)** Group I metals show trends in both their physical and chemical properties.

(i) How do their melting points vary down the group?

..... [1]

(ii) Which element in the group has the highest density?

..... [1]

(b) State whether the reactivity of the elements will increase, remain the same or decrease **down** Group I and Group VII.

group	reactivity
I	
VII	

[2]

(c) Colourless potassium bromide will turn brown if reacted with chlorine gas. Explain this observation.

.....

..... [2]

[Total: 6]

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A2 Copper is a transition element that is mainly used for electrical wiring and motors.

(a) Copper can be extracted from copper(II) carbonate in a two-stage process.

Stage 1: $CuCO_3 \rightarrow CuO + CO_2$
Stage 2: $CuO + C \rightarrow Cu + CO$

(i) State the condition for Stage 1 to take place.

..... [1]

(ii) Explain why potassium cannot be extracted from potassium carbonate by using the same process.

.....

.....

..... [2]

(b) State the chemical formula of the following compounds.

(i) copper(I) sulfide

..... [1]

(ii) copper(II) nitrate

..... [1]

(iii) lithium oxide

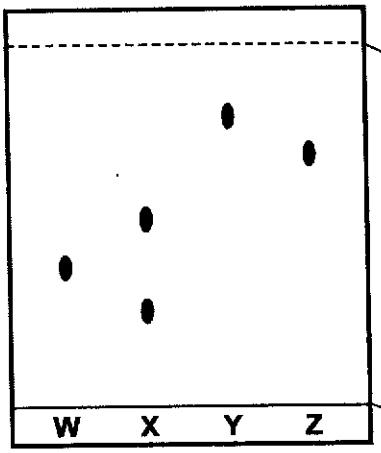
..... [1]

(c) In the space below, draw the dot-and-cross diagram of lithium oxide, showing only the valence electrons. [2]

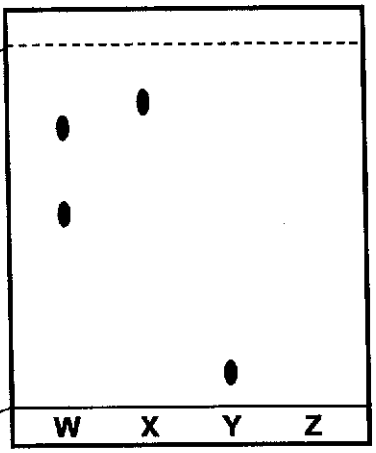
[Total: 8]

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A3 Four food colourings, **W**, **X**, **Y** and **Z** were analysed using paper chromatography. Fig. 3.1 and Fig. 3.2 show the chromatograms obtained with water and ethanol as the solvent respectively.



water as solvent
Fig. 3.1



ethanol as solvent
Fig. 3.2

(a) A student studies the chromatograms and claims that food colouring **W** is a pure substance. Do you agree with the student's claim? Explain your answer.

.....

..... [2]

(b) Food colourings can either be covalent or ionic substances.

Based on the chromatograms, predict which of the three food colourings **W**, **X** or **Y** is likely to be an ionic substance. Explain your answer.

.....

..... [2]

(c) The R_f of food colouring **Z** in ethanol is 0.4 times of its R_f in water.

(i) Calculate the R_f of food colouring **Z** in ethanol, showing your working clearly. [2]

(ii) On Fig. 3.2, indicate the expected position of the spot due to food colouring **Z** when ethanol is used as the solvent. [1]

[Total: 7]

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A4 Lavandulol is found in lavender plants. Fig. 4.1 shows the formula of lavandulol.

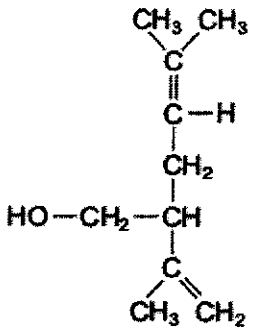


Fig. 4.1

(a) What is the empirical formula of lavandulol?

..... [1]

(b) Lavandulol can be extracted from lavender flowers by distillation using the apparatus shown in Fig. 4.2. The lavandulol is distilled off in small droplets with the steam.

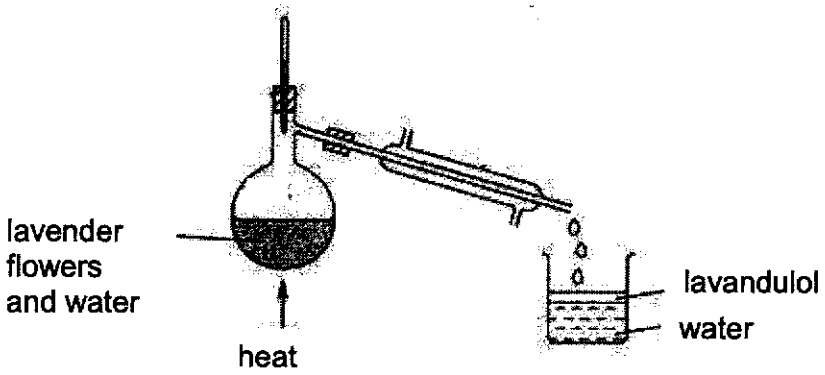


Fig. 4.2

Based on the diagram and information given, suggest and explain how the lavandulol can be separated from the water after distillation.

.....

.....

..... [2]

[Total: 3]

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A5 The structures of two substances are shown in Fig. 5.1 and Fig. 5.2 below. Both substances consist solely of carbon.

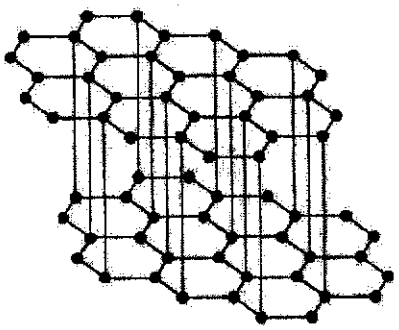


Fig. 5.1

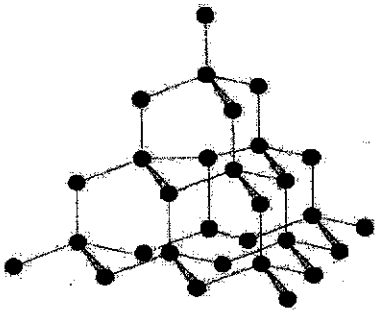


Fig. 5.2

(a) Complete the following table which gives some information about the two substances.

	structure in Fig. 5.1	structure in Fig. 5.2
name of substance		
one application		

[2]

(b) Give the name of the **type** of structure of these two substances.

..... [1]

(c) State two differences in physical properties between the two substances.

1. .....

.....

2. .....

..... [2]

(d) Give the name of a compound that has a similar structure as the substance shown in Fig. 5.2.

..... [1]

[Total: 6]

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A6 A solution **R** is made by adding 106 g of solid sodium carbonate to 500 cm^3 of water in a volumetric flask and shaking the flask till all the sodium carbonate has dissolved.

(a) What is the concentration in mol/dm^3 of solution **R**? [2]

(b) 25.0 cm^3 of solution **R** is reacted with 0.5 mol/dm^3 sulfuric acid to give a colourless solution and a colourless gas.

(i) Write down the balanced chemical equation, with state symbols, for the reaction between sodium carbonate and sulfuric acid.

..... [2]

(ii) How many moles of sulfuric acid are needed to completely react with 25.0 cm^3 of solution **R**? [2]

(iii) What is the volume of sulfuric acid required to react completely with 25.0 cm^3 of solution **R**? [1]

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(iv) What is the volume of carbon dioxide gas evolved when measured at room temperature and pressure? [2]

(v) Give the chemical formula of another acid that will react similarly with sodium carbonate.

..... [1]

[Total: 10]

END OF SECTION A

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Section B

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

B7 Ionic compounds exist as an ionic crystal lattice in the solid state. Lattice energy can be described as the amount of energy needed to convert an ionic crystal into separate ions. The higher the value of lattice energy, the higher the melting and boiling points of the ionic compound. The following chemical equation shows this process using sodium chloride as an example.

$$NaCl(s) \rightarrow Na^+(g) + Cl^-(g)$$

Table 7.1 below shows the radii of some elements and their respective ions.

Table 7.1

element	atomic radius ($\times 10^{-10}$ m)	ion	ionic radius ($\times 10^{-10}$ m)
Na	1.86	Na^+	0.95
K	2.31	K^+	1.33
Mg	1.60	Mg^{2+}	0.65
Ca	1.97	Ca^{2+}	0.99

Table 7.2 below shows the lattice energies of some ionic compounds.

Table 7.2

compound	lattice energy (kJ/mol)
sodium chloride	787
potassium chloride	715
magnesium chloride	2524
calcium chloride	2258

(a) Explain why ionic compounds have high lattice energy.

.....

.....

..... [2]

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(b) With reference to Table 7.1, suggest a reason for the difference in the:

(i) atomic radii of Na and K

.....

..... [1]

(ii) radii of Na and Na^+

.....

..... [1]

(c) **(i)** Using the ionic radii in Table 7.1 and lattice energy values in Table 7.2, account for the difference in the lattice energy values of magnesium chloride and calcium chloride.

.....

.....

.....

.....

.....

..... [3]

(ii) Hence, predict whether magnesium chloride or calcium chloride is expected to have the higher melting point.

..... [1]

(d) Potassium reacts more violently with water as compared to sodium.

Use relevant data from Table 7.1 to suggest a reason for this difference in reactivity.

.....

.....

..... [2]

[Total: 10]

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B8 **(a)** Iron is industrially extracted in the blast furnace as shown in Fig. 8.1. Some raw materials are added in at position **A** and hot air is blasted in from the bottom of the furnace.

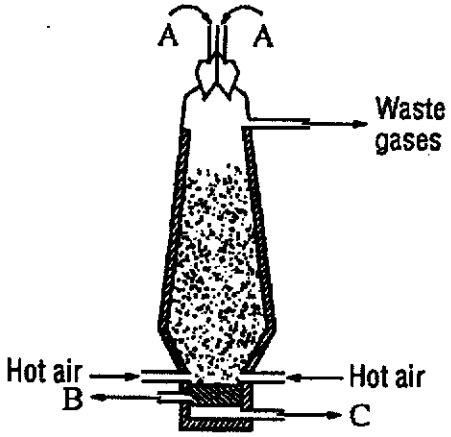


Fig. 8.1

(i) Using suitable chemical equations including state symbols, explain the purpose of adding coke at position **A** into the furnace.

.....

.....

.....

.....

.....

..... [4]

(ii) The two products from this furnace are substances **B** and **C**, found at the bottom of the furnace.

State the raw material required for the formation of substance **B**.

..... [1]

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(b) Small pieces of different metals were added to solutions of metal ions in water. The results are summarised in Table 8.1.

Table 8.1

solution	metal added				
	copper	nickel	iron	scandium	zinc
copper(II) chloride	-	copper displaced	copper displaced	copper displaced	copper displaced
nickel(II) nitrate	no reaction	-	nickel displaced	nickel displaced	nickel displaced
iron(II) chloride	no reaction	no reaction	-	iron displaced	iron displaced
scandium(III) chloride	no reaction	no reaction	no reaction	-	no reaction
zinc chloride	no reaction	no reaction	no reaction	zinc displaced	-

(i) List the five metals in ascending order of reactivity.

..... [1]

(ii) The student decides to investigate the thermal stability of zinc carbonate and copper(II) carbonate. He heats each metal carbonate in a test tube and bubbles the gas given off through the same volume of limewater.

Describe how he can determine if zinc carbonate or copper(II) carbonate is more thermally stable. Predict which carbonate is more thermally stable.

.....

.....

.....

.....

..... [4]

[Total: 10]

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B9 The element chlorine is found in Group VII and is one of the halogens that is more commonly used in industrial applications. Two such applications are shown below.

(a) Phosphorus trichloride, PCl_3, is a liquid that is widely used as one of the starting materials in the manufacture of insecticides and flame retardants. It can be prepared by passing pure dry chlorine gas over heated phosphorus powder, P_4.

(i) Write a chemical equation, including state symbols, for the reaction between phosphorus and chlorine.

..... [2]

(ii) State the type of bonding present in a molecule of chlorine.

..... [1]

(iii) Draw a dot-and-cross diagram to show the arrangement of the valence electrons present in a molecule of phosphorus trichloride. [2]

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(b) Chlorine is found in most common bleaches in the form of sodium hypochlorite, NaClO. Bleach containing sodium hypochlorite can be neutralized by aqueous sodium thiosulfate, $Na_2S_2O_3$, shown in the equation below.

$$4\ NaClO + Na_2S_2O_3 + 2\ NaOH \rightarrow 4\ NaCl + 2\ Na_2SO_4 + H_2O$$

1.00 dm^3 of aqueous sodium thiosulfate contains 12.4 g of $Na_2S_2O_3.5H_2O$.

(i) Calculate the molar concentration of the sodium thiosulfate solution. [2]

(ii) 236 cm^3 of this sodium thiosulfate solution and 125 cm^3 of 0.1 mol/dm^3 sodium hydroxide solution reacted with excess bleach to produce 0.52 g of sodium sulfate.

Calculate the percentage yield of this reaction. [3]

[Total: 10]

END OF PAPER

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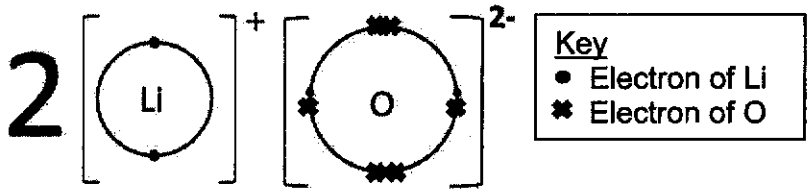
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EOY 2019
Sec 3 Pure Chemistry Marking Scheme

Paper 1

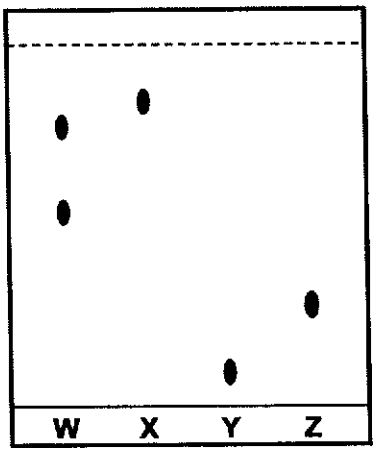
Qn	1	2	3	4	5	6	7	8	9	10
	B	C	A	D	B	D	C	B	C	D
Qn	11	12	13	14	15	16	17	18	19	20
	C	A	B	D	B	B	C	B	B	A
Qn	21	22	23	24	25	26	27	28	29	30
	B	D	B	D	B	A	A	B	C	D

Paper 2

Section A

A1	**(a)**	**(i)**	It decreases down the group.	1m
		(ii)	Francium	1m
	(b)		group: I — reactivity: **increases** group: VII — reactivity: **decreases**	1m each
	(c)		Chlorine will displace bromine and the bromine results in the brown colouration. This is because chlorine is more reactive than bromine.	1m 1m
A2	**(a)**	**(i)**	Presence of heat / heating of $CuCO_3$ / high temperature	1m
		(ii)	Potassium is more reactive than carbon. Hence, K_2O cannot undergo reduction by carbon to form potassium as potassium forms a very stable metal carbonate compound.	1m 1m
	(b)	**(i)**	Cu_2S	1m
		(ii)	$Cu(NO_3)_2$	1m
		(iii)	Li_2O	1m
	(c)		 -1m for any error (no penalty for no key, but they should be reminded to have it)	1m each for BOTH no. and structure of cation and anion
A3	**(a)**		W is not a pure substance. / I do not agree with student's claim.	1m

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		W shows two spots when ethanol is used. / W is a mixture of at least two substances.		1m
	(b)	Y Y is more soluble in water than in ethanol / organic solvent.		1m 1m
	(c)	(i)	R_f of Z in water = 3.4 / 4.8 = 0.71 R_f of Z in ethanol = 0.71 x 0.4 = 0.28	1m 1m
		(ii)	spot drawn 1.4 cm from the start line, directly above the label "Z" in Fig. 3.2  	1m
A4	(a)	$C_{10}H_{18}O$		1m
	(b)	They can be separated using a separating funnel. Lavandulol and water are immiscible and have different density.		1m 1m
A5	(a)		structure in Fig. X / structure in Fig. Y	1m each for BOTH name and application
		name of substance	**graphite** / **diamond**	
		one application	**lubricant / inert electrodes / pencil lead** / **drill tips / cutting edges of tools**	
	(b)	Giant covalent structure / Giant molecular structure		1m
	(c)	Graphite is soft and slippery while diamond is hard. Graphite is able to conduct electricity while diamond is unable to conduct electricity.		1m 1m
	(d)	Silicon dioxide		1m

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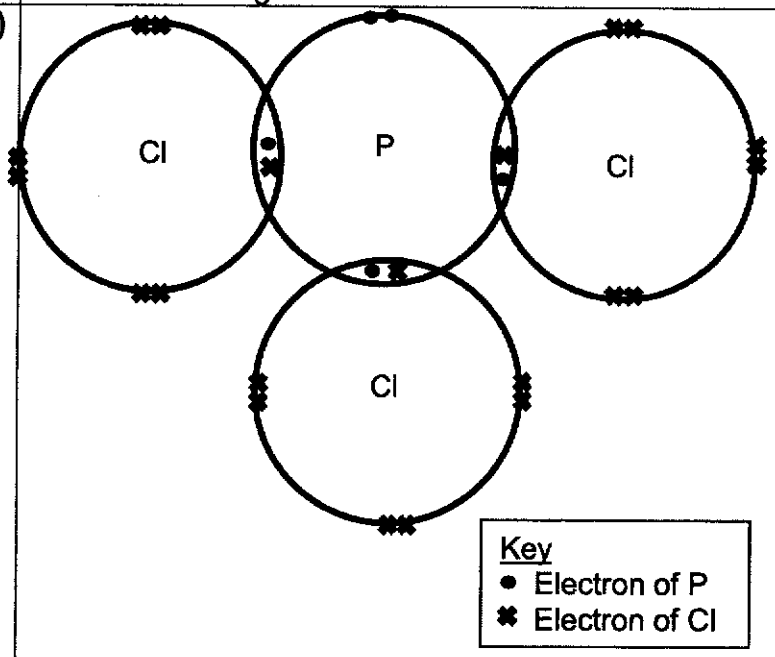
A6	**(a)**		Number of moles of sodium carbonate in solution R = mass / molar mass = 106 g / 106 g = 1 mol Concentration of solution R = number of moles / volume of solution = 1 mol / 500 cm^3 = 1 mol / 0.5 dm^3 = 2 mol/dm^3	1m 1m, ecf applies
	(b)	**(i)**	$Na_2CO_3(aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + CO_2(g) + H_2O(l)$ 1m for BOTH formula and balancing 1m for state symbol	2m, ecf applies for whole of (b)
		(ii)	Number of moles of sodium carbonate = volume of solution x concentration of solution = 0.025 dm^3 x 2 mol/dm^3 = 0.05 mol Number of moles of sulfuric acid needed = 0.05 mol	1m 1m
		(iii)	Volume of sulfuric acid required = number of moles / concentration of solution = 0.05 mol / 0.5 mol dm^{-3} = 0.1 dm^3 = 100 cm^3	1m
		(iv)	Number of moles of carbon dioxide formed = 0.05 mol Volume of carbon dioxide evolved = number of moles x molar volume = 0.05 mol x 24 dm^3 = 1.2 dm^3	1m 1m
		(v)	HCl / HNO_3	1m

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Section B

B7	**(a)**		There are strong electrostatic forces of attraction between ions in ionic compounds. Large amount of energy is needed to overcome these forces, resulting in high lattice energy.	1m 1m
	(b)	**(i)**	Potassium has one more electron shell than sodium and hence has a larger atomic radius.	1m
		(ii)	Sodium atom loses one valence electron to form sodium ion, which results in sodium ion having one less electron shell than sodium atom and hence a smaller atomic radius.	1m
	(c)	**(i)**	• Magnesium ion has smaller radii than calcium ion • Stronger forces of attraction between magnesium and chloride ions • More energy needed to overcome the forces of attraction, resulting in higher lattice energy	1m 1m 1m
		(ii)	Magnesium chloride	1m
	(d)		Potassium has an atomic radius of 2.31×10^{-10} m, which is larger than the atomic radius of 1.86×10^{-10} m for sodium. Hence, the valence electron of potassium is further from the nucleus compared to sodium / there is a weaker attraction between the nucleus and the valence electron in potassium. Potassium loses the valence electron more easily and is hence more reactive.	1m (data should be quoted) 1m
B8	**(a)**	**(i)**	Coke combusts to produce carbon dioxide. $C(s) + O_2(g) \rightarrow CO_2(g)$ The carbon dioxide then reacts with more coke to produce carbon monoxide, the main reducing agent. $CO_2(g) + C(s) \rightarrow 2\,CO(g)$	1m 1m 1m 1m
		(ii)	Calcium carbonate / limestone	1m
	(b)	**(i)**	Cu, Ni, Fe, Zn, Sc	1m
		(ii)	He should record the time taken for a white precipitate to be formed in the same volume of limewater. If the time taken for the white precipitate to be formed is longer, then the carbonate is more thermally stable. Zinc carbonate is more thermally stable.	1m 1m 1m 1m

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B9	**(a)**	**(i)**	P_4 (s) + 6 Cl_2 (g) → 4 PCl_3 (l) 1m for BOTH formula and balancing 1m for state symbol	2m
		(ii)	Covalent bonding	1m
		(iii)		1m each for BOTH no. and structure of P and Cl
	(b)	**(i)**	Number of moles of sodium thiosulfate = 12.4 / 248 = 0.05 mol Molar concentration of sodium thiosulfate = 0.05 mol / 1 dm^3 = 0.05 mol/dm^3	1m, ecf applies for whole of (b) 1m

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		(ii)	Number of moles of $Na_2S_2O_3$ = (236/1000) x 0.05 = 1.18 x 10^{-2} mol Number of moles of NaOH = (125/1000) x 0.1 = 1.25 x 10^{-2} mol Mole ratio of $Na_2S_2O_3$: NaOH = 1 : 2 Number of moles of NaOH required to react with 1.18 x 10^{-2} mol of $Na_2S_2O_3$ = 1.18 x 10^{-2} x 2 = 2.36 x 10^{-2} mol Therefore, NaOH is the limiting reagent here. Mole ratio of NaOH : Na_2SO_4 = 2 : 2 No. of moles of Na_2SO_4 produced = 1.25 x 10^{-2} mol Theoretical yield of Na_2SO_4 produced = (1.25 x 10^{-2}) x (23 x 2 + 32 + 16 x 4) = 1.775 g Percentage yield of Na_2SO_4 = (0.52 / 1.775) x 100% = 29.3% (3 s.f.)	1m for BOTH no. of moles 1m for BOTH limiting reagent and no. of moles of Na_2SO_4 1m for BOTH theoretical and % yield

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