Name: ..... Register/Index Number: ..... Class: .....

PRESBYTERIAN HIGH SCHOOL

SCIENCE (CHEMISTRY) **5076/3, 5078/3**

Paper 3

12 August 2022 **Friday** **1 hour 15 minutes**

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2022 SECONDARY FOUR EXPRESS / FIVE NORMAL (ACADEMIC)
PRELIMINARY EXAMINATION

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

Write your class, register number and name on all the work you hand in.
Write in dark blue or black pen.
Do not use correction fluid.

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

Section B
Answer **any two** questions.
Write your answers in the spaces provided on the question paper.

A copy of the Periodic Table is printed on page 13.

For Examiner's Use	
Section A	/45
Section B	/20
Total	/65

Setter: Mr Muhammad Faeez
Vetted by: Ms Chan Poh Hoon

This question paper consists of **13** printed pages.

[Turn over

Section A (45 marks)

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

1 Use the list of elements below to answer the questions that follow.

copper	**sodium**	**chlorine**	**aluminium**	**nitrogen**
oxygen	**iron**	**carbon**	**helium**	**bromine**

In your answers, you may use an element once, more than once, or not at all.

Name **one** element which

(a) is used in the manufacture of steel, iron/carbon [1]

(b) can displace tin from its compound, sodium/aluminium/iron [1]

(c) has six valence electrons, oxygen [1]

(d) has a triple bond within its molecule, nitrogen [1]

(e) is an inert gas. helium [1]

2 Zinc smelting is a process that converts zinc concentrates (ores that contain zinc) into pure zinc. One of the last stages involves purifying zinc by fractional distillation in a column made up of silicon carbide. The main impurities in zinc are shown in Table 2.1. Pure zinc has a boiling point of 908 ^{o}C.

Table 2.1

impurities	boiling point /^{o}C
cadmium	765
copper	2582
iron	2887
lead	1751

(a) State why it is possible to purify zinc by fractional distillation.

It has different boiling points

(b) When fractional distillation is carried out, which metal will be distilled first?

Cadmium

(c) How would you test if the zinc purified from the fractional distillation is free from any impurities?

Test the melting point to see if its fixed

3 In an experiment, 0.100 g of zinc granules was reacted with excess of 1.00 mol/dm^3 hydrochloric acid and the total volume of gas produced was measured every ten seconds until the reaction stopped. The results are shown in Table 3.1.

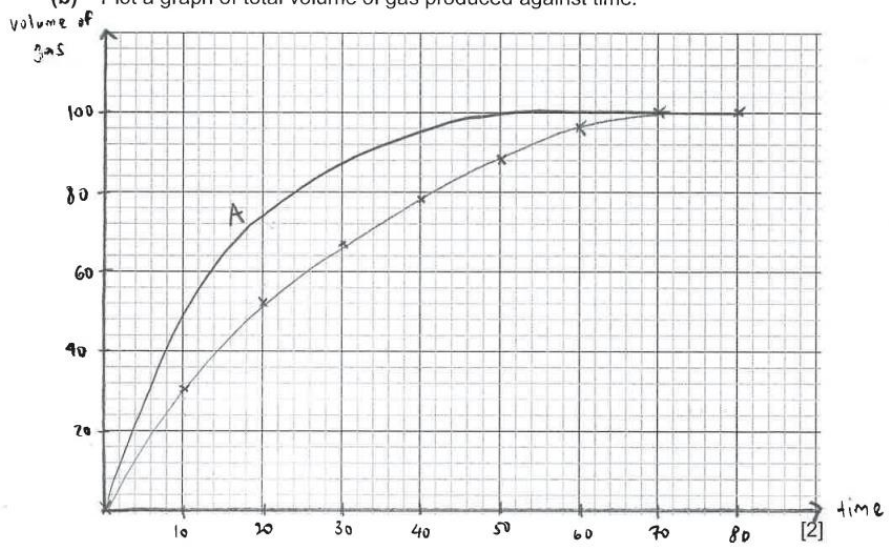
Table 3.1

time from the start of experiment/ s	total volume of gas produced/ cm^3
0	0
10	31
20	52
30	67
40	78
50	88
60	96
70	100
80	100

(a) Construct a balanced equation for the reaction.

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

(b) Plot a graph of total volume of gas produced against time.



[2]

[2]

(c) **(i)** How long did it take for the reaction to stop?

70 seconds

(ii) Explain why the reaction stops.

All the zinc had reacted

(d) The experiment was repeated using the same mass of powdered zinc, with the other conditions being kept constant.

(i) Explain, using the collision theory, how changing from zinc granules to zinc powder affects the speed of reaction.
There is an increase in the total surface area
Frequency of effective collision increases

Speed of reaction increases

(ii) Sketch, on the same grid given, a graph of how the volume of gas produced will change for the new experiment. Label this new graph **A**. [1]

4 Fig 4.1 shows a solution mixture **V**, which contains two cations and one anion.

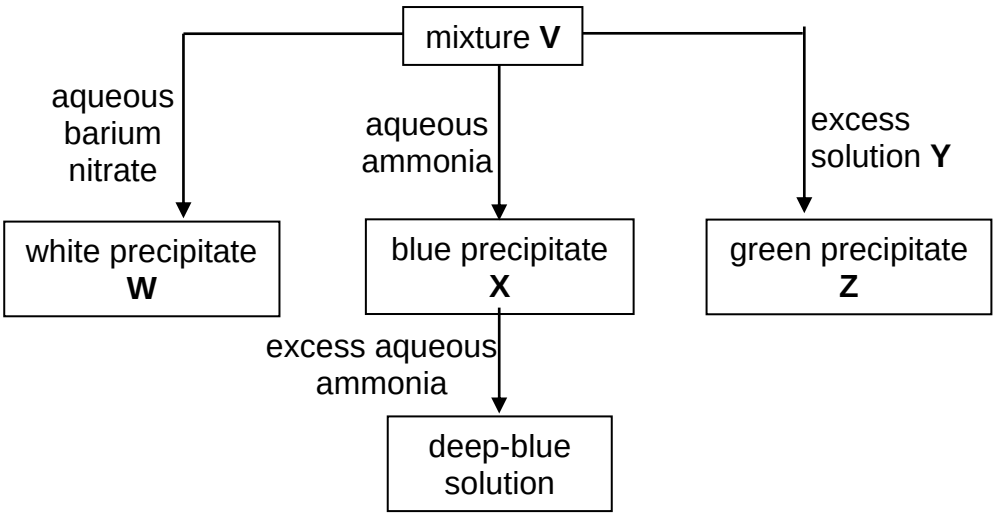


Fig 4.1

(a) State the identity of the following:

(i) white precipitate **W** barium sulfate/$BaSO_4$1]

(ii) blue precipitate **X** copper(II) hydroxide/ $Cu(OH)_2$

(iii) green precipitate **Z** iron(II) hydroxide/ $Fe(OH)_2$

(iv) solution **Y** aqueous ammonia/sodium hydroxide/ aq NH_3/ NaOH

(b) Suggest the ions present in mixture **V**.

Fe^{2+}, SO_4^{2-}, Cu^{2+} / iron(II), sulfate, copper(II) ions

5 **(a)** Complete Table 5.1.

Table 5.1

chemical name	chemical formula	acidic/basic/neutral/amphoteric
calcium oxide	CaO	basic
lead(II) oxide	PbO	amphoteric
nitrogen monoxide	NO	neutral

[3]

(b) Small pieces of each of the following metals were added to cold water and the volume of gas collected in the first two minutes was recorded in Table 5.2.

Table 5.2

metal	aluminium	barium	calcium	magnesium	potassium
volume of gas/ cm^3	0	60	25	2	90

(i) Use the data in Table 5.2 to place the metals in order of **increasing** reactivity.

aluminium, magnesium, calcium, barium, potassium

(ii) Write an equation, with state symbols, for the reaction between calcium and water.

$Ca\ (s) + 2H_2O\ (l) \rightarrow Ca(OH)_2\ (aq) + H_2\ (g)$

1M – correct balanced equation

1M – correct state symbols

(iii) What would you expect to see if carbon dioxide is passed through the solution remaining from the reaction in **(b)(ii)**?
Give a reason for your answer.

White precipitate forms in the solution
Calcium carbonate is formed

(iv) Explain why aluminium did **not** produce any gas when added to cold water.

It has a layer of oxide which prevents any reaction

6 Table 6.1 below shows the mass of some pollutants found in the exhaust gas when one kilogram of each fuel is burnt.

Table 6.1

	mass of pollutant/ g		
fuel	carbon monoxide	oxides of nitrogen	sulfur dioxide
petrol	27	30	0.8
diesel	11	60	3.9

(a) **(i)** Explain why carbon monoxide is found in the exhaust gas.

Incomplete combustion of carbon containing fuels/petrol

(ii) Explain the effect of carbon monoxide on humans.

It reduces the ability of blood to transport oxygen

(b) Name the element found in both petrol and diesel that is responsible for the presence of carbon monoxide in the exhaust gas.

Carbon

(c) Using the data in Table 6.1, name the fuel which is more harmful to the environment when burnt. Explain your answer.

Diesel
Mass of oxides of nitrogen and sulfur dioxide is larger than that released by petrol

(d) The following shows two molecules of alkenes.

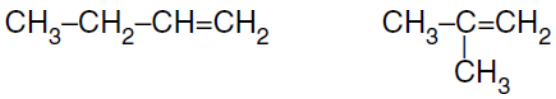


Fig 6.2

With reference to Fig 6.2, suggest one similarity and one difference between the two molecules.

There is a presence of C=C in both molecules
while one is branched while the other is straight

(e) Alkenes can undergo polymerization to form polymers.

(i) Given part of the polymer shown in Fig 6.3, deduce the name of its monomer. Hence draw the structure of the monomer.

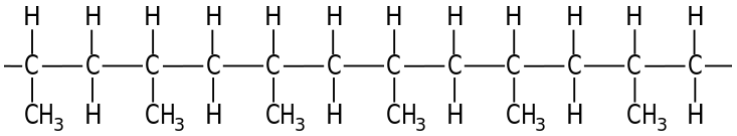
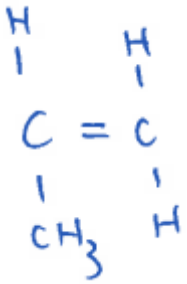


Fig 6.3

Name of monomer: propene

Structure:



[2]

(ii) Describe **one** problem caused by polymers.

It is non-biodegradable and hence will occupy landfills

7 Lavandulol is found in lavender plants. The formula of lavandulol is shown below in Fig 7.1.

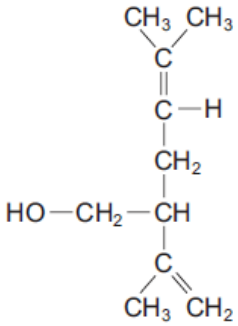


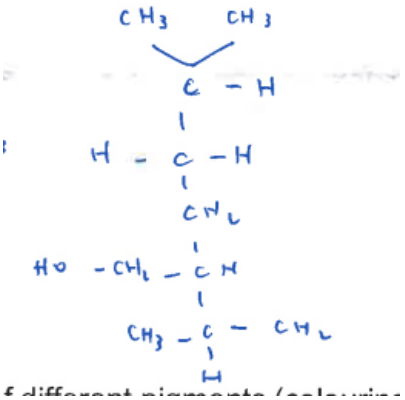
Fig 7.1

(a) Lavandulol can be made saturated by reacting it with hydrogen.

(i) State the conditions required for this reaction.

Nickel catalyst, 200 ^{o}C

(ii) Draw the structure of the compound formed from this reaction.



[1]

(b) Lavender flowers contain a variety of different pigments (colourings). A student separated these pigments using paper chromatography with ethanol as the solvent. The results are shown in the Fig 7.2 below.

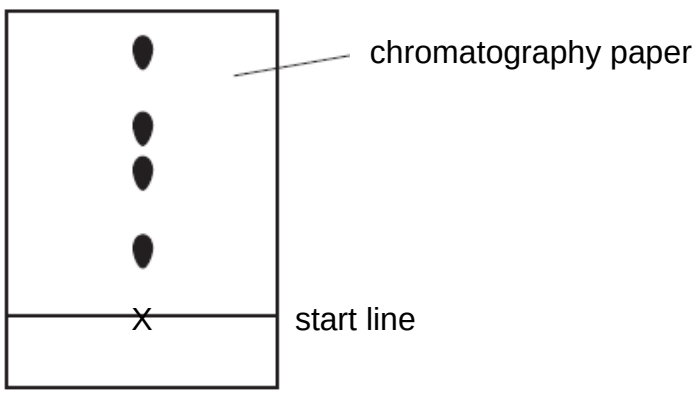


Fig 7.2

(i) How many pigments does lavandulol contain?

4

(ii) During chromatography, the solvent evaporates and then diffuses throughout the chromatography jar.

Describe, in terms of kinetic particle theory, the change in movement and arrangement of the ethanol molecules when they evaporate and diffuse throughout the chromatography jar.

The molecules will change from closely packed in a disorderly manner to far apart and random arrangement

The molecules will move from sliding past one another to moving at fast speeds in different/random direction.

Section B (20 marks)

Answer any **two** questions in the spaces provided.

8 The alcohols form a homologous series. The first member of this homologous series is methanol.

(a) **(i)** Explain what is meant by a homologous series using alcohol as an example.

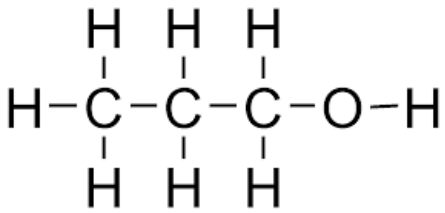
A homologous series is a family of organic compounds with the same function group (-O-H)

with similar chemical properties

(ii) Give the name and draw the structural formula of the third member of this homologous series.

Name: propanol

Structural Formula:



[2]

(b) Name the product(s) formed when the third member is

(i) reacted with an excess of oxygen to produce heat.

carbon dioxide and water

(ii) oxidised by acidified potassium manganate.

propanoic acid

(c) Methanol and ethanoic acid reacts to form a new compound, methyl ethanoate, according to the following equation:

$$CH_3OH + CH_3COOH \rightarrow CH_3COOCH_3 + H_2O$$

(i) What is the mass of methyl ethanoate formed when 3.2 g of methanol reacts with excess ethanoic acid.

no of mol of methanol = 3.2/(12+3+16+1) = 0.100 mol

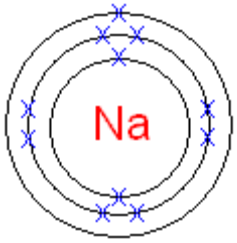
mol ratio of methanol to methyl ethanoate = 1:1

mass of methyl ethanoate = 0.100 x (12+3+12+16+16+12+3)
= 7.40 g

[4]

9 Sodium is an element found in Group I of the Periodic Table.

(a) Use a dot-and-cross diagram to show how the electrons are arranged in a sodium atom.



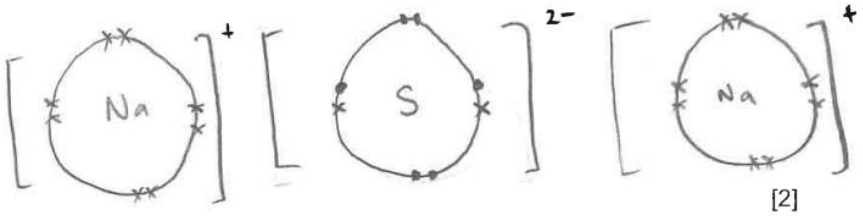
[1]

(b) State **two** physical properties of sodium which is unique to Group I elements.
Soft, low density, lower melting and boiling points

(any 2)

(c) Sodium can react with sulfur to form the compound sodium sulfide. Sodium sulfide has a high melting point of 1176 ^{o}C

(i) Use a dot-and-cross diagram to show the bonding present in sodium sulfide. Show only the valence electrons.



[2]

(ii) Explain, using bonding, why sodium sulfide has a high metling point.
A lot of energy is required to overcome

the strong electrostatic forces of attraction between the oppositely charged ion

(iii) State, with reason, if sodium sulfide can conduct electricity in the solid state.
No,

Ions are held in a fixed position in a crystal lattice structure

(d) A reaction occurred when a piece of sodium metal was added to a beaker of water containing a few drops of Universal Indicator.

State one observation that can be made from this reaction.

Sodium darts around the surface/solution turns purple/ effervescence

10 **(a)** Most atoms of iron has the symbol $^{56}_{26}Fe$.

Explain what the number 56 tell you about the particles in an atom of iron.

It has 30 neutrons and 26 protons in the nucleus

(b) Many parts of a bicycle contain iron. Iron is extracted from iron (III) oxide. One problem with using iron is that it rusts.

Fig 10.1 shows the cycle of changes that happen when iron is extracted and then rusts.

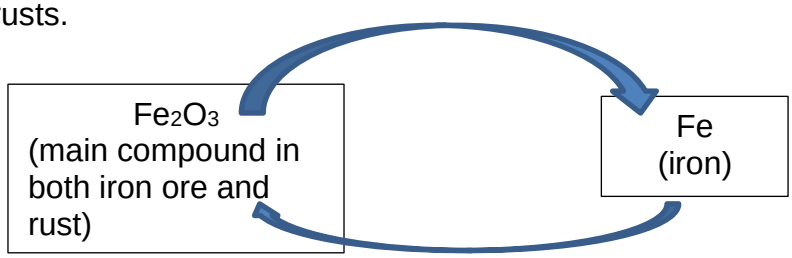


Fig 10.1

Use oxidation states to show which change involves oxidation and which change involves reductions.

oxidation: Fe to Fe_2O_3
The oxidation state increases from 0 in Fe to +3 in Fe_2O_3

reduction: Fe_2O_3 to Fe
The oxidation state decreases from +3 in Fe_2O_3 to 0 in Fe

(c) Iron can be extracted from Iron(III) oxide, Fe_2O_3 using carbon monoxide.

$$Fe_2O_3\,(s) + 3CO\,(g) \rightarrow 2Fe(l) + 3CO_2(g)$$

[Relative atomic mass, A_r: Fe, 56 ; O,16 ; C,12]

(i) Calculate the mass of iron (III) oxide needed to manufacture 5 kg of iron.

no of mol of iron= 5000/56 = 89.29 mol

mol ratio of Fe: Fe_2O_3 = 2:1

mass of Fe_2O_3 = (89.29/2) x (56x2 + 16x3) = 7143.2 g = 7140 g

(ecf will be awarded)

[3]

(ii) Use the equation to calculate the volume of carbon dioxide gas produced at room temperature pressure when 5 kg of iron is manufactured.

[The volume of one mole of any gas is 24 dm^3 at room temperature and pressure]

mol ratio of Fe:CO_2 = 2:3

volume of CO_2 = ((89.29)/2) x 3) x24 = 3214 dm^3 = 3210 dm^3

(ecf will be awarded)

[2]

END OF PAPER

DATA SHEET

The Periodic Table of Elements

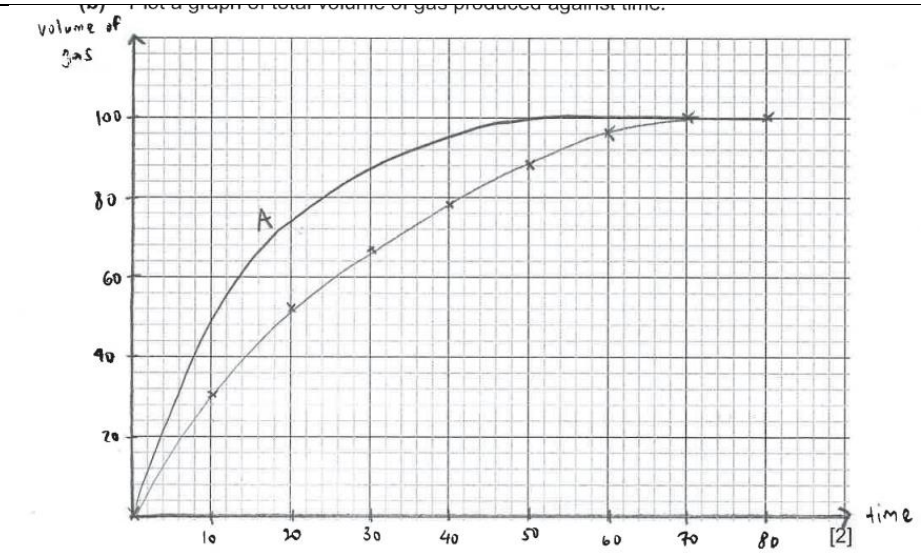
Group																	
I	II											III	IV	V	VI	VII	0
						1 H hydrogen 1											2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key proton (atomic) number atomic symbol name relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na 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 –		

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 –

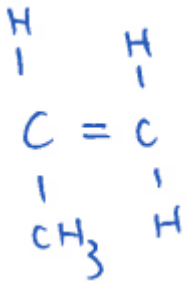
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

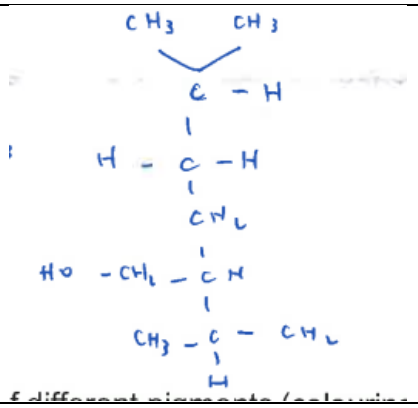
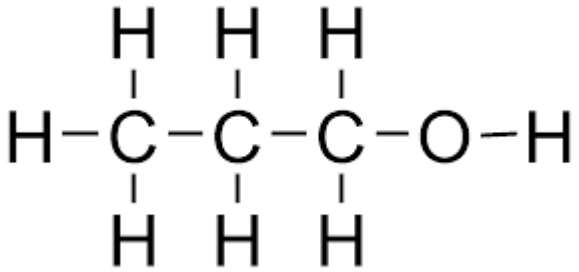
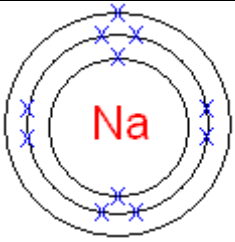
PRESBYTERIAN HIGH SCHOOL
SCIENCE DEPARTMENT
SUGGESTED ANSWERS

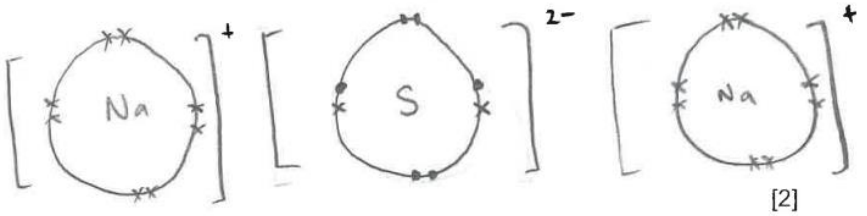
Subject: SCIENCE (CHEMISTRY) Exam: **Prelim Exam**
Setter: Muhd Faeez Year: 2022
Level: **SEC 4 EXP/5N**

SECTION A (45 marks)			
Qn	**Suggested Answer**	**Sub-total**	**Total**
1a	iron/carbon	1	1
1b	sodium/aluminium/iron	1	1
1c	oxygen	1	1
1d	nitrogen	1	1
1e	helium	1	1
			5
2a	It has different boiling points	1	1
2b	Cadmium	1	1
2c	Test the melting point to see if its fixed	1	1
			3
3a	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$	1	**1**
3b	 [2] 1 mark for axes 1 mark for plot and curve drawn	2	**2**
3ci	70 seconds	1	**1**
3cii	All the zinc had reacted	1	**1**
3di	There is an increase in the total surface area Frequency of effective collision increases Speed of reaction increases	1 1	**2**
3dii	See 3(b)	1	**1**
			5
4ai	barium sulfate/$BaSO_4$	1	**1**
4aii	copper(II) hydroxide/ $Cu(OH)_2$	1	**1**
4aiii	iron(II) hydroxide/ $Fe(OH)_2$	1	**1**
4aiv	aqueous ammonia/sodium hydroxide/ aq NH_3/ NaOH	1	**1**

<table>
<tr><td>4b</td><td>Fe^{2+}, SO_4^{2-}, Cu^{2+} / iron(II), sulfate, copper(II) ions</td><td>1</td><td>1</td></tr>
<tr><td></td><td></td><td></td><td>5</td></tr>
<tr><td>5a</td><td>
<table>
<tr><td>chemical name</td><td>chemical formula</td><td>acidic/basic/neutral/ amphoteric</td></tr>
<tr><td>calcium oxide</td><td>CaO</td><td>basic</td></tr>
<tr><td>lead(II) oxide</td><td>PbO</td><td>amphoteric</td></tr>
<tr><td>nitrogen monoxide</td><td>NO</td><td>neutral</td></tr>
</table>
6 correct – 3M
5 correct – 2M
4 correct – 1M
</td><td>3</td><td>3</td></tr>
<tr><td>5bi</td><td>aluminium, magnesium, calcium, barium, potassium</td><td>1</td><td>1</td></tr>
<tr><td>5bii</td><td>$Ca\ (s) + 2H_2O\ (l) \rightarrow Ca(OH)_2\ (aq) + H_2\ (g)$

1M – correct balanced equation
1M – correct state symbols</td><td>2</td><td>2</td></tr>
<tr><td>5biii</td><td>White precipitate forms in the solution
Calcium carbonate is formed</td><td>1
1</td><td>2</td></tr>
<tr><td>5biv</td><td>It has a layer of oxide which prevents any reaction</td><td>1</td><td>1</td></tr>
<tr><td></td><td></td><td></td><td>9</td></tr>
<tr><td>6ai</td><td>Incomplete combustion of carbon containing fuels/petrol</td><td>1</td><td>1</td></tr>
<tr><td>6aii</td><td>It reduces the ability of blood to transport oxygen</td><td>1</td><td>1</td></tr>
<tr><td>6b</td><td>Carbon</td><td>1</td><td>1</td></tr>
<tr><td>6c</td><td>Diesel
Mass of oxides of nitrogen and sulfur dioxide is larger than that released by petrol</td><td>1
1</td><td>2</td></tr>
<tr><td>6d</td><td>There is a presence of C=C in both molecules
while one is branched while the other is straight</td><td>1
1</td><td>2</td></tr>
<tr><td>6ei</td><td>propene
  </td><td>1
1</td><td>2</td></tr>
<tr><td>6eii</td><td>It is non-biodegradable and hence will occupy landfills</td><td>1</td><td>1</td></tr>
<tr><td></td><td></td><td></td><td>10</td></tr>
<tr><td>7ai</td><td>Nickel catalyst, 200 ^oC</td><td>1</td><td>1</td></tr>
</table>

7aii		1	**1**
7bi	4	1	**1**
7bii	The molecules will change from closely packed in a disorderly manner to far apart and random arrangement The molecules will move from sliding past one another to moving at fast speeds in different/random direction.	1 1	**2**
			5
8ai	A homologous series is a family of organic compounds with the same function group (-O-H) with similar chemical properties	1 1	**2**
8aii	propanol 	1 1	**2**
8bi	carbon dioxide and water	1	**1**
8bii	propanoic acid	1	**1**
8c	no of mol of methanol = 3.2/(12+3+16+1) = 0.100 mol mol ratio of methanol to methyl ethanoate = 1:1 mass of methyl ethanoate = 0.100 x (12+3+12+16+16+12+3) = 7.40 g	1 1 1 1	**4**
			10
9a		1	**1**
9b	Soft, low density, lower melting and boiling points (any 2)	2	**2**

9ci	 [2]	2	**2**
9cii	A lot of energy is required to overcome the strong electrostatic forces of attraction between the oppositely charged ion	1 1	**2**
9ciii	No, Ions are held in a fixed position in a crystal lattice structure	1 1	**1**
9d	Sodium darts around the surface/solution turns purple/ effervescence	1	**1**
			10
10a	It has 30 neutrons and 26 protons in the nucleus	1	**1**
10b	Oxidation: Fe to Fe_2O_3 The oxidation state increases from 0 in Fe to +3 in Fe_2O_3 Reducaiton: Fe_2O_3 to Fe The oxidation state decreases from +3 in Fe_2O_3 to 0 in Fe	1 1 1 1	**4**
10ci	no of mol of iron= 5000/56 = 89.29 mol mol ratio of Fe: Fe_2O_3 = 2:1 mass of Fe_2O_3 = (89.29/2) x (56x2 + 16x3) = 7143.2 g = 7140 g (ecf will be awarded)	1 1 1	**3**
10cii	mol ratio of Fe:CO_2 = 2:3 volume of CO_2 = ((89.29)/2) x 3) x24 = 3214 dm^3 = 3210 dm^3 (ecf will be awarded)	1 1	**2**
			10