233/1
CHEMISTRY
Paper 1
THEORY

SET 2
MARKING SCHEME

1. (a) State graham's law of diffusion. (1 mk)

At standard pressure & temperature the rate of diffusion of a gas is inversely proportional to the square root of its density.

(b) 48cm^3 of an oxide of Nitrogen diffused through a porous plug in the same time it took 159 cm^3 of helium to diffuse through the same plug under similar conditions. What is the molecular mass of the oxide? (He = 4, N = 14) (2 mks)

$\frac{R_{NOx}}{R_{He}} = \sqrt{\frac{M_{He}}{R_{NOx}}}$ | $\frac{48}{T} = \sqrt{\frac{4}{x}}$ | $\frac{159}{T}$ | $x = \frac{4 \times 159^2}{48^2}$ | $= 43.89$

2. 3.1 of an organic compound containing Carbon hydrogen and oxygen only produced 4.4g of Carbon (IV) oxide and 2.0g of water on complete combustion.

(a) Calculate its empirical formular. (2 mk)

Mass of $O_2 = 3.1 - (1.2 + 0.22) = 1.68$

$CO_2 = 44$ | $H_2O \Rightarrow 18$

12g $\Rightarrow$ 44g | 2g = 18

Xg $\Rightarrow$ 4.4g | $X = \frac{4}{18}$

X = 1.2g | $= 0.22g$

C	H	O
1.2	0.22	1.68
12	1	16
0.1	0.22	0.105
1	2	1

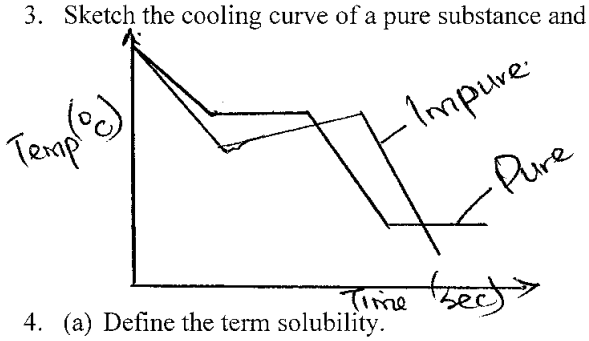
CH_2O.

(b) Calculate in molecular formula if its formula mass is 62 (1 mk)

$(CH_2O) \Rightarrow 62$

$30n \Rightarrow 62$ $\quad n = 2$ $\quad \therefore C_2H_4O_2$

3. Sketch the cooling curve of a pure substance and impure substance in the sane axis. (2 mks)



4. (a) Define the term solubility. (1 mk)

Maximum mass of solute that can dissolve in 100g of water at a given temperature

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(b) The mass of a solution of salt of sodium chloride is 70 grams. This solution has 10 grams of sodium chloride dissolved in it. The solubility of this salt is 30 grams / 100 grams of water at 25^0C. 65 grams of sodium chloride salt are added to the solution at 25^0C. How much sodium chloride will remain undissolved. (2 mks)

Mass of $H_2O \Rightarrow 70 - 10 = 60g$

$30g \Rightarrow 100g$ of water

$Xg \Rightarrow 60g$

$X = \frac{30 \times 60}{100} = 18g$

$65 - 8 = 57g$ of NaCl undissolved

5. Study the table for certain properties of substances A, B, C and D.

	Melting point ^{0}c	Solubility in water	Electrical conduct
A	-119^0c	Soluble	Solution does not conduct
B	1020^0c	Soluble	Solution conducts
C	1740^0c	Insoluble	Doest not conduct
D	1600^0c	Insoluble	Conducts at room temperature

Which of the substances A, B, C and D: (4 mks)

(i) Is a metal ..... D .....

(ii) Has a simple molecular structure..... A .....

(iii) Has a giant ionic structure..... B .....

(iv) Has a giant covalent structure..... C .....

6. The table below gives percentages of a radioactive isotope of Bismuth that remain after decaying at different times.

Time	0	6	12	22	38	62	100
% of Bismum	100	81	65	46	29	13	12

(i) Plot a graph of the percentage of remaining vertical axis against time. (3 mks)

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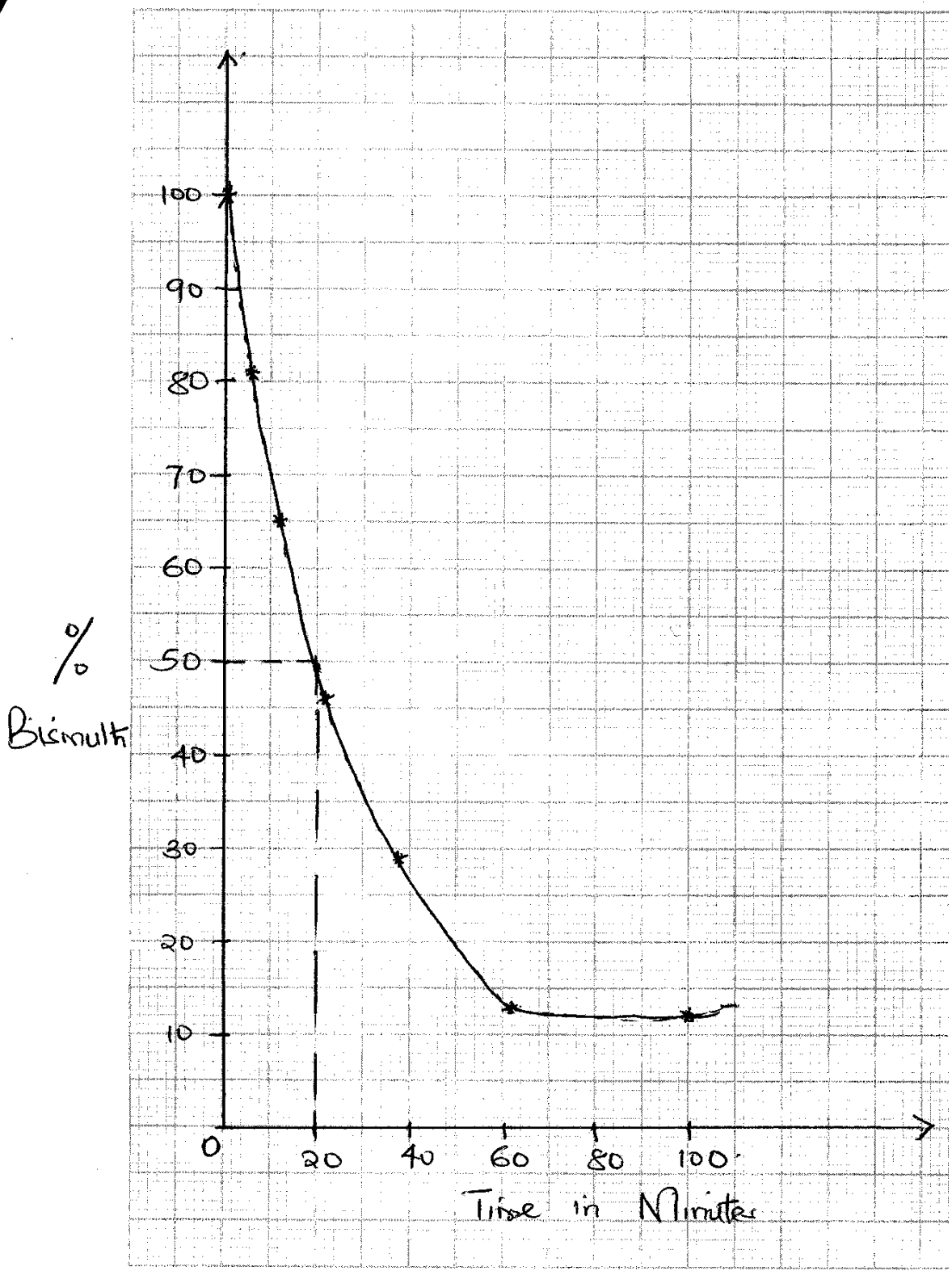
%
Bismuth
100
90
80
70
60
50
40
30
20
10
0
20
40
60
80
100
Time in Minutes

4

(ii) Use your graph to determine the half life of the Bismuth isotope. (1 mk)

20 minutes

7. An equilibrium exists between the reaction of chromate ion ($cro_4 2^-_{(aq)}$) and dichromate ions ($Cr_2O_7^{2-}$)

$2cro_4^{2-}{}_{(aq)} + 2H+_{(aq)} \rightleftharpoons cr_2O_7^{2-} + H_2O$

Yellow Orange.

State and explain observations made when aqueous Hcl is added to the above system at equilibrium. (2 mks)

Orange Colour intencifies - Hcl introduces H+ into the system which makes equilibrium to shift to the right.

8. The table below gives factors which affect the rate of the reaction.

Factor	Effect on rate of reaction	Explanation
Using zinc powder instead of zinc granules	Rate of Reaction Increases. ½ mk	Increase in temp increases the kinetic energy which makes pasticles to collide faster & frequently. 1 mk
Heating the reaction	Rate of Reaction Increases ½ mk	*Area of contact of pasticles is increased. 1 mk

Complete the table to show how the factors given affect the rate of reaction and give an explanation for each effect.

9. (a) Name two cations making water hard. (1 mk)

Magnesium ions
Calcium ions

(b) By use of an ionic equation, shows how sodium carbonate makes permanent hard water soft. (1 mk)

$Na^+_{(aq)} + MgCO_{4(aq)} \rightarrow NaCO_{4(aq)} + Mg^{2+}_{(aq)}$

$Na^+ + MgCO_{3(s)} \rightarrow NaCO_{3(aq)} + Mg^{2+}_{(aq)}$ solid

10. Describe a chemical test which can be used to differentiate between sodium carbonate and sodium sulphate. (2 mks)

- Add solid sodium carbonate to a solution of each. Effervescence occurs in Carbonate and no effervescence in Sulphate

11. Explain the observation using equation made when two to three drops of aqueous ammonia are added to zinc ions until in excess. (2 mks)

A white precipitate is formed which dissolves in excess Ammonia to form a colourless solution.

12. A gas of mass 1.8g was found to have a density of 1.12g / litre at 25°C and 745 mmHg. Find its molecular weight at r.t.p. molar gas volume = 24 litres, Temperature 20°C (3 mks) Pressure = 760mm

Volume $= \frac{M}{D}$ | $V_2 \Rightarrow ?$ | $V_2 = \frac{745 \times 1.60714 \times 293}{298 \times 760}$

$= \frac{1.8}{1.12}$ | $T_2 \Rightarrow 293K$ | $V_2 = 1.5491$ litres

$V_1 = 1.60714$ | $P_2 = 760$ mmHg. | At r.t.p.:

$T_1 = 25°C = 298$ | $V_2 \Rightarrow \frac{P_1 V_1 T_2}{T_1 P_2}$ | 1.5491 litres = 1.8g

$P_1 = 745$ mmHg | | 24 litres $= \frac{24 \times 1.8}{1.549} = 27.889$

13. Hydrogen burns in air to form steam.

(i) Write the chemical equation involved in the reaction. (1 mk)

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

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(ii) Use the bond energies in the following table to calculate ΔH for the reaction. (2 mk)

Bond	Bond energy Kj mol^{-1}
H – H	436
O = O	489
O – H	464

Bond Breaking
2(H-H) = 2x436.
O=O = 1x489.
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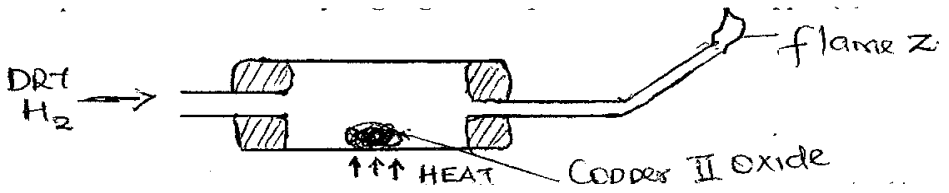
Bond Formation
4(O-H) = 4x464
= 953.

ΔH ⇒ Energy released in bond formation − Energy needed to break bonds.
= 953 − 1361
= −408 kJ mol^{-1}.

14. The set up below indicate how hydrogen gas I was passed over heated copper (ii) oxide.



State one mistake in the set up and rectify. (1 mk)

The combustion tube should be slanted.

(i) Write the chemical equation for the reaction taking place in the combustion table. (1 mk)

$CuO_{(s)} + H_{2(g)} \rightarrow Cu_{(s)} + H_2O_{(l)}$

(ii) Before heating is stopped, a stream of hydrogen gas is passed continuously through the combustion tube until it has cooled explain why. (1 mk)

To avoid re-oxidation of the metal - copper formed.

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15. Musau was stung by a wasp while on his way to the market, he felt a lot of pain. How would you treat Musau to relieve him of the pain? (2 mks)

Apply a base such as Na_2CO_3 / NH_4OH to neutralize the acid produced by wasp sting

16. (a) Hydrogen Sulphide is a strong reducing agent. Explain the observations made when this gas is bubbled through a solution of Iron (iii) chloride. (2 mks)

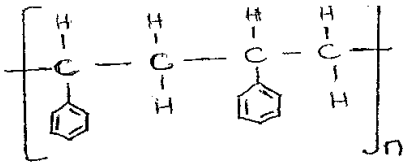
Fe^{3+} is reduced to Fe^{2+} and H_2S is oxidised to Sulphur

Iron III Chloride changes colour from yellow to green. Yellow powder is deposited.

(b) Write the chemical equation involved in the reaction. (1 mk)

$2FeCl_{3(aq)} + H_2S_{(g)} \longrightarrow 2FeCl_{2(aq)} + 2HCl_{(aq)} + S_{(s)}$

17. The formula given represents a position of a polymer.



(a) Give the name of the polymer. (1 mk)

Polyphenylethene / polystyrene

(b) One disadvantage of continued use of this polymer. (1 mk)

Pollutes the environment since its non-biodegradable.

18. Describe how the percentage of mass of copper in copper carbonate can be determined. (3 mk)

- Weigh $CuCO_3$ accurately
- Heat the $CuCO_3$ to constant mass to obtain CuO
- Reduce CuO using a suitable reducing agent CO / H_2
- Allow it to cool and weigh the mass of Cu.

$\% = \frac{\text{Mass of Cu}}{\text{Mass of } CuCO_3} \times 100$

19. Copper is listed on the periodic table as having a relative atomic mass of 63.55. Reference books indicate two isotopes of copper, with relative masses of 62.93 and 64.93. Find the percent abundance of each isotope (2mks)

$63.55 = \frac{(62.93 \times x) + (64.93 \times 100 - x)}{100}$

$62.93 \Rightarrow 69\%$

$64.93 = 31\%$

10% $63.55 = \frac{62.93x + 6493 - 64.93 \times 100}{100}$

$X = 69\%$

20. A form 4 student of Supamo High school was told to prepare a pure sample of Copper (II) Carbonate salt starting with Copper metal. Describe how the student prepared the salt in the laboratory. (3mks)

- Heat Cu to form CuO
- Add excess CuO to dilute H_2CO_4
- Filter the excess CuO
- Add Na_2CO_4 / K_2CO_4 / $(NH_4)_2SO_4$ solution
- Heat to concentrate
- Cool and filter to form crystals

21. How many cubic centimeters of hydrogen chloride gas at s.t.p would be required to to precipitate all silver ions from $32cm^3$ of 0.08M silver nitrate solution? (Molar Gas Volume at s.t.p $=24dm^3$) (3mks)

$HCl_{(aq)} + AgNO_3 \longrightarrow AgCl_{(s)} + HNO_{3(aq)}$

moles of $HNO_3 = \frac{32 \times 0.08}{1000} = 0.00256$ moles

moles of $HCl = 0.00256$

Vol of $HCl = 0.00256 \times 24 = 0.06144 dm^3$.

22. The following half equations refer to half-cells A and B and their electrode potentials measured at standard states.

A: $2H^+_{(aq)} + O_{2(g)} + 2e^- \longrightarrow H_2O_{2(l)}$ $E^\theta = 0.68V$

B: $Ag^+ + e \longrightarrow Ag_{(s)}$ $E^\theta = +0.80V$

a) Calculate the e.m.f of the cell formed from A and B. (2mks)

E.m.f $= 0.80 - 0.68$

$= +0.12V$.

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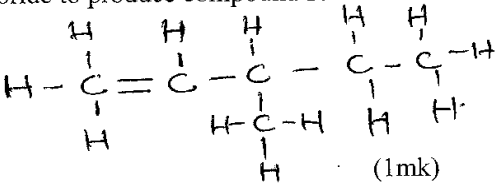
b) Explain why potassium chloride is not suitable salt for the bridge of this cell (1mk)

Cl^- in KCl reacts with Ag^+ forming a precipitate Hence not conducting current.

23. Compound Q was reacted with hydrogen chloride to produce compound R whose structural formula is shown below

$CH_3CH_2CH(CH_3)CHClCH_3$



a) Give the structural formula of Q (1mk)

b) Which type of reaction takes place in the reaction above? (1mk)

Addition Reaction

c) The boiling point of R is slightly higher than that of Q. Explain (1mk)

Cl being more electronegative makes Q to be polar which enhances attraction between molecules.

24. State and explain one effect of sulphur (iv) oxide causes environmental pollution. (2mks)

Causes Acid Rain - when Sulphur IV oxide is released to the atmosphere. It dissolves in water to form Sulphurous acid.

25. A mixture contains sodium chloride, sugar and camphor. The table below shows the solubility of these solids in different liquids. Explain how sugar can be separated from the mixture.

Liquid / Solid	Water	Ethanol	Ether
Sodium chloride	Soluble	Insoluble	Insoluble
Camphor	Soluble	Insoluble	Very soluble
Sugar	Soluble	Soluble	Insoluble

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Explain how sugar can be obtained from a mixture of sodium chloride, camphor and sugar. (3 mks)

- Place the mixture in a beaker and add ether and stir Camphor dissolves. Filter to obtain a mixture of sugar and sodium Chloride as residue. Place residue in a beaker add ethanol and stir sugar dissolves. Filter to obtain Sodium Chloride as residue. Leave the filtrate in the sunlight for ethanol to evaporate

26. The table below gives the first ionization energies of the alkali metals.

Element	1st ionization energy kJ mol^{-1}
A	494
B	418
C	519

a) Define the term ionization energy. - This is the minimu (1mk) minimum energy required to remove an electron from an atom in gaseous state-

b) Which of the three metals is the least reactive? Give a reason. (2mks)

C - It requires a lot of energy for an electron to be removed.

27. Nitrates of metals A, B, C were heated and the products of the reactions recorded in the table bellow.

Nitrate of metal	Products
A	Metal nitrate and oxygen
B	Free metal, nitrogen (IV) Oxide and oxygen gas
C	Metal oxide, nitrogen (IV) oxide and oxygen gas

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a) Name two possible identities of metal A. (1mk)

- Sodium
- Potassium

b) Name the two possible identity of metal B (1mk)

- Mercury
- Silver

c) Calcium nitrate is one of the nitrate which forms the products in C. Using chemical equation show how the products are formed. (1mk)

$2Ca(NO_3)_{2(s)} \xrightarrow{\Delta} 2CaO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

28. When magnesium ribbon is burnt in air two possible products are formed and when the products are dissolved in distilled water and warmed slightly, smell of ammonia gas is observed.

(i) Write the formulae of the product responsible for the production of ammonia. (1 mk)

Mg_3N_2

(ii) Write a balanced chemical equation which occurs when the product is dissolve in distilled water. (1 mk)

$Mg_3N_{2(s)} + H_2O_{(l)} \longrightarrow Mg(OH)_{2(aq)} + NH_{3(g)}$

29. Explain why iron III chloride is fairly soluble in methylbenzene while Magnesium chloride is insoluble. (2 mks)

Iron III chloride is molecular and methylbenzene is also molecular. $MgCl_2$ is ionic while methylbenzene is molecules

30. In the industrial preparation of oxygen, state:

(a) How dust particles are removed from air. (1 mk)

- Electrostatic precipitation

(b) Why CO_2 is removed before the mixture is cooled to -25^{0}C. (1 mk)

At -25°C CO_2 solidifies and can block the pipes.

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