Name stream.....

CHEMISTRY

PAPER 2

545/2 TIME: 2

HOURS

Instructions to candidates

- This paper consists of two sections A and B
- Section A is compulsory but attempt ONLY TWO questions in section B
- Answers to questions in section A must be written in the spaces provided.
- Answers to questions in B must be written on answer sheets provided.

1 (a) Name the two major components of air. (1mark)

Nitrogen and oxygen

(b)When a sample of dry air was bubbled through potassium hydroxide solution and the residual gas passed over strongly heated copper metal, a gas G was finally obtained.

(i) Identify G. (1 mark)

Nitrogen

(ii) State why air was bubbled through potassium hydroxide solution (1 mark).

to remove carbon dioxide

(c) Write equation

(i) to illustrate your answer in (b) above. (1 1/2 marks)

$2KOH\ (aq) + CO_2\ (g) \rightarrow K_2CO_3(aq) + H_2O(l)$

(ii) for the reaction between the residual gas with copper. (1 1/2 marks)

$2Cu\ (s) + O_2(g) \rightarrow 2CuO\ (s)$

2. When heated, ammonium chloride undergoes sublimation;

(a) (i) State what is meant by the term "sublimation". (1 mark)

Sublimation is conversion of a solid directly to gas

(ii) Write equation to show the effect of heat on ammonium chloride. (1 1/2mk)

$NH_4Cl\ (s) + heat \rightarrow NH_4Cl\ (g)$

(b) (i) Name the compound other than ammonium chloride which can undergo sublimation. (1 mark)

Iron (III) chloride, aluminium chloride

(ii) State one practical application of sublimation. (1/2 mark)

Separation of mixtures

3. Calcium carbonate reacts with dilute hydrochloric acid to produce carbon dioxide according to the following equation.

$CaC0_3(s) + 2\ HCl(aq) \longrightarrow CaC1_2\ (aq) + H_2O\ (1) + CO_2(g)$

(a) Calculate the maximum volume of carbon dioxide in cm^3 that would be produced at room temperature if dilute hydrochloric acid reacted completely with 4.5g of calcium carbonate. (3marks)

(C = 12 0=16, Ca = 40, 1 mole of gas occupies 24.0dm^3 at room temperature)

Formula mass of $CaCO_3$ = 40 + 12 + 16 x 3 = 100g

100g of $CaCO_3$ produce 24,000cm^3 of CO_2

4.5g of $CaCO_3$ produce $\frac{24{,}000\ x\ 4.5}{100} = 1.080$ cm^3 of CO_2

(b) A quantity of dilute sulphuric acid having the same hydrogen ion concentration as that of the hydrochloric acid in (a) above was reacted with 4.5g of calcium carbonate at room temperature.

(i) State how the maximum volume of carbon dioxide produced would compare with your answer in (i) . (1 mark)

it will be less

(ii) Give reasons for your answer in (b) (i). (1 mark)

Dilute sulphuric acid reacts with calcium carbonate to form insoluble calcium sulphate which prevents further reaction

4. When hydrogen is burnt in air, a liquid L is formed which can exist both in solid and gaseous states as well.

(c) (i) write equation for the reaction that leads to the formation of L.($1^1/2$ marks)

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

(b) State what L is called, when it is in the

(i) gaseous state. (1 mark)

vapour /steam

(ii) solid State. (1mark)

ice

(c) State one physical property that can be used to determine the purity of L.(1mrk)

Boils at 100^0C

5 (a) Monoclinic Sulphur and rhombic Sulphur are crystalline allotropes of Sulphur.

(i) Define the term "allotrope" (1 mark)

Allotropy *is the existence of two or more different physical forms in the same state of a chemical element.*

(ii) State one difference between monoclinic Sulphur and rhombic Sulphur. (1mark)

The differences between Rhombic and monoclinic sulphur

Rhombic sulphur	Monoclinic sulphur
Stable below 96^0C	Stable below 96^0C
Octahedral crystals	Needle-shaped crystal
Bright yellow	Pale yellow
M.pt 113^0C	M.pt 119^0C
Density higher ($2.06g/cm^3$)	Density lower (1.98 g/cm^3)

(b). Sulphur was burnt in air form a substance X, which under suitable temperature and pressure conditions in the presence of a catalyst, was converted to gas Q in the contact process.

(i) Identify X and Q. (1mark)

X = SO_2

Q = SO_3

(ii) Name the catalyst that was used for converting X to gas Q. (½ mark)

V_2O_5; vanadium pentoxide / vanadium (V) oxide

(iii) State the temperature and pressure conditions that favored formation of gas Q.

Temperature. (1mark)

420^0C

Pressure.

1 atmosphere

(iv) State the application of the contact process. (1/2mark)

Produces sulphuric acid

6. (a) Zinc was added to a solution containing copper (ll) ions.

Write equation for the reaction that took place. (1marks)

$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

(b). When 0.91g of Zinc was added to 50.0cm ^{3} of solution containing 0.25 moles of copper(ll) sulphate per dm^3, the temperature of the solution rose up by 12.9^{0}C.

(i) Determine the number of moles of zinc which did not react. (Zn=65) (2 marks)

Total moles of Zn added = $\frac{0.91}{65} = 0.014 moles$

Moles of Cu^{2+} that reacted = $\frac{0.25\ x\ 50}{1000}$ *= 0.0125moles*

Moles of Zn that reacted = moles of Cu^{2+} that were present = 0.0125moles

Moles of Zn unreacted = 0.014 – 0.0125= 0.0015moles

(ii). Calculate the enthalpy of the reaction in kJ mol^{-1} (1 ½ marks)
(Heat capacity of the solution =4.2J/g/^{0}C, density of the solution=1.0gcm ^{3}).

Heat produced = mcϑ = 50 x 4.2 x 12.9 = 2709J

0.0125 moles of Zn produce 2709J

1 mole produce $\frac{2709\ x\ 1}{0.0125} = 216720J = \frac{216720}{1000} = 216.72 kJmol^{-1}$

7, (a) Graphite and lead (ll) bromide are good conductors of electricity.

Name the particles which are responsible for conducting electricity in

(i) graphite. (1 mark)
Electrons

(ii) lead(IT) bromide. (1 mark)
Ions

(b) State the conditions under which lead (ll) bromide can conduct electricity. (1mk)
molten or solution form

(c) Lead (II) bromide was electrolyzed using carbon as electrodes;
State what was observed at the

(i) anode (½ mark)
$2I^- - 2e \rightarrow I_2$

(ii) cathode (½ mark)
$Pb^{2+} + 2e \rightarrow Pb$

8. (a) Soap solution was added in magnesium hydrogen carbonate solution.

State what was observed (1mark)
Scum forms on surface of solution

(b) A fresh sample of magnesium hydrogen carbonate solution was heated to boiling point.

(i) State what was observed. (1mark)
White precipitates form

(ii) Write an ionic equation for the reaction that took place (1 ½ marks)
$Mg(HCO_3)_2 + heat \rightarrow MgCO_3\ (s) + CO_2(g) + H_2O(l)$

(c) Soap solution was added to the resultant mixture in (b) above.

State

(i) What was observed? (1/2tnark)
lather forms

(ii) a practical application of the reaction in b (i). (1mark)
Softening of temporary hard water

9. Iron oxide J, is one of the common iron ores. When excess carbon monoxide was passed over 5.8g of a heated sample of J, 4.2g of iron was obtained.

(a) State what is meant by the term "ore." (1 mark)

An ore is a naturally occurring solid material from which a metal or valuable mineral can be extracted profitably

(b) (i) Determine the mass of oxygen in J. (1 mark)

Mass of oxygen = 5.8 – 4.2 = 1.6g

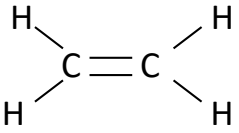
(ii) Calculate the formula of J. (Fe= 56 (3 marks)

Elements	Fe	O
Mass	4.2	1.6
Atomic mass	56	16
Moles	0.075	0.1
Mole ratio	1	1.333
Empirical formula	Fe_3O_4	

(iii) Name J. (1 mark)

magnetite

10. (a) Write the structural formula of ethene, C_2H_4 (1 mark)



(b) A drop of bromine was let into a test tube containing ethene.

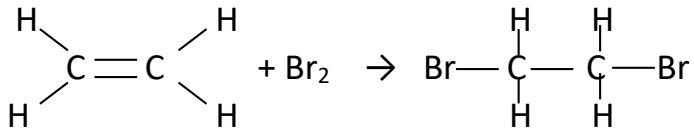
(i) State what was observed. (1mark)

Orange solution becomes colorless

(ii) Write an equation for the reaction that took place. (1mark)

(c) Ethene was burnt in air that contains a small amount of Oxygen.

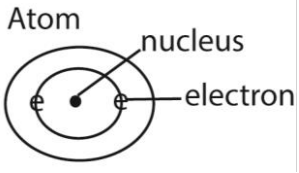
Write equation for the reaction that took place. (1/2mark)



SECTION B

(Attempt only two questions)

11. (a) Draw a labeled diagram to show the structure of an atom. (2 ½ marks)



(b). (i) State how the total number of electrons in an atom compares with the total number of protons. (1 mark)

The number of electrons and protons in an atom are equal

(ii) Explain how the comparison you have stated in (b) (i) affects the stability of an atom. (2 1/2marks)

electrons neutralize the positive charges of an atom

(c) The full symbols of two atoms of an element ${}^{35}_{17}A$ and ${}^{37}_{17}B$.

(i) State the group in the periodic table to which the element belongs. (1 mrk)

Electron configuration of A and B is 2:8:7 thus are in group 7

(ii) Determine the number of neutrons in A and B respectively. (2marks) (iii) State what the atoms A and B are called. (½ marks)

Number of neutrons in A: 35- 17 = 18

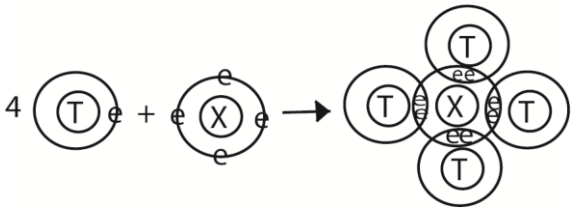
Number of neutrons in B: 37- 17 = 20

(d) The atomic numbers of elements T, X and Y are 1, 6 and 11 respectively. Write the electronic structure of the atom of each of the elements. (1 ½ mk)

T: 1 X:2,4 Y: 2,8,1

(e) T can react with both X and Y to form compounds.

(i) Using outermost energy level electrons only, draw a diagram to show the formula of the compound that can be formed when T react with X (2 mks)



(ii) Suggest a suitable solvent for the compounds that can be formed when T reacts with X and Y respectively; and give a reason for your choice of the solvent in each case. (2marks)

XT_4 – organic solvent such as carbon tetrachloride

YT - water

12. (a) Explain how nitric acid can be prepared in the laboratory. (No diagram is required; but your answer should include equation for reaction leading to formation of nitric acid.)(6 1/2 marks)

By heating potassium nitrate with concentrated sulphuric acid

$H_2SO_4\ (aq) + 2KNO_3\ (s) \rightarrow HNO_3(aq) + KHSO_4(aq)$

(b)(i) Write equation for the reaction of concentrated nitric acid with carbon.

$C(s) + 4HNO_3(aq) \rightarrow CO_2\ (s) + 6NO_2(aq) + 2H_2O\ (l)$

(ii) State one use of nitric acid, other than preparation of nitrates.(1/2 mark)

Preparation of dyes, and explosives

(c). Nitric acid reacts with metals to for metal nitrates.

Write equation to show the effect of heat on;

(i) Silver nitrate. (1 1/2 marks)

$2Ag(NO_3)_2\ (s) \rightarrow 2Ag\ (s) + 2NO_2(g) + O_2\ (g)$

(ii). Sodium nitrate. (1 1/2 marks)

$2NaNO_3\ (s) \rightarrow 2NaNO_2\ (s) + O_2\ (g)$

(d) Calcium nitrate decomposes when heated to produce nitrogen dioxide as shown by the following equation.

$2Ca\ (NO_2)_2 \longrightarrow 2CaO(s) + 4N0_2(g) + O_2(g)$

Calculate the mass of calcium nitrate that when heated; would produce 8.96dm^3 of nitrogen dioxide measured at s.t.p (3 ½ marks) (N = 14, O = 16, Ca = 40; 1 mole of a gas occupies 22.4 dm^3 at s.t.p).

Formula mass of $Ca(NO_3)_2$ = 40 + 2(14 + 16 x 3) = 164

4 x 22.4 dm^3 of NO_2 is produced by 164 x 2 g of $Ca(NO_3)_2$

8.96dm^3 of NO_2 is produced by $\frac{164\ x\ 2\ x\ 8.96}{4\ x\ 22.4} = 32.80g$ *of $Ca(NO_3)$*

13 (a) (i) Name two substances that when reacted can be used to prepare lead (ll) sulphate in the laboratory. (1 mark)

Lead nitrate solution and dilute sulphuric acid

(ii) Explain you have how a pure dry sample of lead (ll) sulphate is prepared from the substances named in (a) (i). ($7^1/2$ marks)

Lead nitrate solution is reacted with dilute sulphuric acid for a white precipitate of lead (II) sulphate.

$Pb(NO_3)_2$ (aq) + H_2SO_4 (aq) → $PbSO_4$ (s) + 2HNO_3 (aq)

The resultant mixture is filtered, the residue of $PbSO_4$ is washed and dried.

(b) (i) Name One laboratory reagent in each case, which can be used to test for the presence of a sulphate ion and lead(ll) ion. (1 mark)

Lead ions are tested with potassium iodide solution while sulphate ions are tested with barium chloride solution

(iii) State in each case, what would be observed if sulphate and lead(ll) ions were treated separately with the reagent you have named in (b) (i) (2 mks)

Lead ions form yellow ppt. with KI solution while sulphate ions form white ppt. with barium chloride solution

(c) Lead (II) carbonate reacts with dilute nitric acid according to the following equation.

$PbCO_3(s) + 2HNO_3(aq) \rightarrow Pb(NO_3)_2(aq) + CO_2(g) + H_2O(l)$

Calculate the volume of a solution contain 0.5 mole of nitric acid dm^{-3} that would react exactly with 5.349 of lead(ll) carbonate.

(Pb -207, O: 16, C 12). (3 1/2 marks)

Formula mass of $PbCO_3$ = 207 + 12 + 16 x 3 = 267

267g of $PbCO_3$ react with 2 moles of nitric acid

5.349 g of $PbCO_3$ react with $\frac{5.349\ x\ 2}{267}$= 0.04 moles

Volume of nitric acid required

0.5mole are found in 1000cm3

0.04 moles are found in $\frac{1000\ x\ 0.04}{0.5}$ = 80cm^3 of 0.5M nitric acid

14. (a) Maize grain contains a compound Y, which can be converted to glucose, fermentation of glucose produces ethanol C_2H_60.

(i) Name compound Y. (1mark)

starch

(ii) Starting from maize grains, outline how a solution of ethanol is prepared in your locality. (No diagram is required) (4marks)

- *to a mixture of maize powder in water yeast is added and left to ferment.*

- *After a few days the mixture is distilled to obtain ethanol as the distillate.*

(iii) Write equation for the fermentation of glucose. (1 mark)

$C_6H_{12}O_6$ + *zymase enzyme* → $2\ C_2H_60 + 2CO_2(g)$

(iv) Name the reaction by which ethene can be obtained from ethanol in the presence of sulphuric acid (1mark)

dehydration

(b) Ethene can react to form a polymer E

Write equation for polymerization of the ethene (1mark)

$$nCH_2{=}CH_2 \xrightarrow{\text{catalyst}} \left(CH_2-CH_2\right)_n$$

(c) Determine the number of moles of ethene molecules that reacted to produce E with relative formula mass of 14,000. (H=l, C=12) (2marks).

Formula mass of ethene, C_2H_4 = 2 x 12 + 1 x 4 = 28

number of moles of ethene = $\frac{14000}{28}$ *= 500*

(d) (i) Other than the polymer of ethene, give one example each of a natural polymer and a synthetic polymer. (2marks).

natural polymers; rubber, silk

synthetic polymers; PVC, nylon

(ii) Distinguish between the terms "thermosetting" plastic; and thermal softening plastic and give one example in each case. (3marks)

Thermosetting polymers are polymers that decompose and cannot be remolded on heating whereas thermal softening polymers are those that soften and can be remolded on heating

END