AFROGRAMS CHEMISTRY E-NOTE

NAME:...
CLASS:................................

FIRST TERM E-LEARNING NOTES

SUBJECT: CHEMISTRY **CLASS: SS3**

WEEK	TOPIC
1.	Quantitative and Qualitative Analysis
2.	Quantitative and Qualitative Analysis
3.	Petroleum or Crude oil
4.	Petroleum or Crude oil
5.	Metals and their Compounds
6.	Metals and their Compounds
7.	Iron
8.	Ethical, Legal and Social Issues
9.	Revision.
10.	Examination.

REFERENCE TEXTS

1. **Comprehensive certificate chemistry for senior secondary schools by G N C Ohia.et al**
2. Chemistry for Senior Secondary Schools 2 by Magbagbeola O, et al; Melrose Books and Publishers.
3. **New school chemistry for senior secondary schools by Osei yaw Ababio**
4. **Revised edition understanding chemistry for schools and colleges by Godwin O. Ojokuku.**

WEEK 1
TOPIC: QUANTITATIVE AND QUALITATIVE ANALYSIS
CONTENT:

1. **Acid/base titration**
2. **Redox titrations**
3. **Test for oxidants and reductants**

Sub-topic 1: Acid/base titration
Importance of acid –base titrations: Acid-base titrations are used for the following purposes:

1. To standardize a solution of an acid or a base (standardization)
2. To determines the molar mass of an acid or base.
3. To establish the molar ratio of acid to base in a neutralization reaction.

4. To determine the percentage purity or impurity of acid or base.
5. To estimate the percentage of water of crystallization in an acid or base.
6. To determine the solubility of a base.

1. STANDARDIZATION OF A SOLUTION

A solution of an acid of unknown concentration can be standardized, i.e. its concentration determined, by the use of a standard solution of a base, vice versa. A balance equation of reaction is required, in order to obtain the mole ratio.

EXAMPLES

1. A is a solution of tetraoxosulphate {vi} acid. B is a solution containing 0.0500 mole of anhydrous Na_2CO_3 per dm3. (a)Put A in the burette and titrate 20.00 or 25.00 cm3 portions of B using methyl orange as the indicator. Record the size of your pipette. Tabulate the burette readings, and calculate the average volume of the acid used. (b) From your result and data provided, calculate:

(i) the amount of Na_2CO_3 in 25.00 cm^3 of B used
(ii) concentration of A in $moldm^{-3}$
(iii) concentration of A in gdm^{-3}
(iv) number of hydrogen ions in 1.00dm^3 of A. {Avogadro number = 6.02x1023 mol1}

The equation of reaction is: $H_2SO_4\{aq\} + Na_2CO_3\{aq\} \longrightarrow Na_2SO_4\{aq\} + H_2O + CO_2$

{H =1,O=16, S=32}

Solution

a. Volume of pipette: $25cm^{-3}$

Titration results {Hypothetical data}

Burette reading	**1cm^3**	**II cm^3**	**IIIcm^3**
Final	24.75	49.15	25.70
Initial	0.00	24.75	1.35
Volume of acid used	24.75	24.40	24.35

Average volume of acid used from titrations II and III:

$$\frac{24.40+24.35}{2} = \frac{48.75}{2} = 24.38cm^3$$

Note: Only the titre values from titrations I and II can be used in averaging, since they are within ± 0.20cm3 of each other. …Rough of first titre can also be used in averaging, if it is within ± 0.20cm3 of any other titre value, and is not crossed.-----Do not round up 24.38cm3 to 24.40cm3

(b)(i). To calculate the amount of Na_2CO_3 in 25.00CM3

Given: conc. of B = 0.050*mol* dm^{-3}; Volume = 25/1000dm^3

Amount = Conc. {*mol* dm^{-3} x Volume {dm^3} = 0.050 x 25/1000 = 0.00125mol.

(ii).To calculate the concentration of A in *mol* dm^{-3}: The various titration variables are:

CA = *x mol* dm^{-3}; VA =24.38cm^3; nA = 1, CB= 0.050*mol* dm^{-3}, VB = 25cm^3: nB =1

Method 1: proportion method {from the first principle}

From the balanced equation of reaction:

1*mol* of Na_2CO_3 = 1 mol of H_2SO_4

.∴ 0.00125*mol* Na2CO = 0.00125*mol* H_2SO_4

i.e. 24.38cm^3 of A contained 0.00125 *mol* H_2SO_4

$\therefore 1000cm3\ of$ A contained {0.00125 x 1000} /24.38 mol = 0.0513mol.Hence, concentration of A is 0.0513*mol* dm^{-3}.

Method 2:

Mathematic formula method: From the data above, it is safe to use the mole ratio expression, in order to calculate the concentration CA of A, which the required variable.

Using CAVA/CBVB = nA/nB

Substituting; CA X 24.38/0.050 X25 =1/1

Making CA the subject of the formula

∴CA =1 X0.050X25 /24.38 X1 = 0.0513 *mol* dm^{-3}

(iii) To calculate the concentration of A in gdm^{-3}

Using conc. {gdm^{-3}} x Molar mass {$gmol^{-1}$}

Concentration of H_2SO_4, *mol* dm^{-3} =0.0513*mol* dm^{-3}

Molar mass H_2SO_4, = 2 {1.0} + 32.0 + 4{16.0

= 2.0 +32.0 +64.0 = 98.0$gmol^{-1}$

Substituting; Mass conc. = 0.0513x98 = 5.0274gdm^{-3}.

$=5.03 gdm^{-3}$ {3 sig fig.}

(Iv) number of hydrogen ions in $1.00 dm^3$ of A

1 dm^3 of A contained 0.0513*mol* of H_2SO_4.

H_2SO_4 ionizes in water completely thus:

$H_2SO_4 (aq) \longrightarrow 2H^+ \; SO_4^{2-}(aq)$

1mol *2mol*

From the equation;

1 mole of H_2SO_4 produces 2 x 0.0513 moles of H^+ = 0.103 *mol* of H^+

But 1 mole of H^+ contains 6.02 x 1023 ions;

Therefore, 0.103 x 6.02 x 1023 ions =6.02 x10 23 ions.{3 sig fig.]

2. DETERMINATION OF RELATIVE MOLAR MASS

In the determination of relative molar mass of an acid or bases by titration, the concentration of both acid and base, at least in gram per dm^3, will be provided together with the balanced equation of reaction so as to establish the mole ratio

EXAMPLES

1. A contains 1.6g of HNO_3 in $250cm^3$of solution. B contains $10 gdm^{-3}$ of $XHCO_3$

$25 cm^3$ portion of B requires an average of $24.90 cm^3$ of A for complete neutralization. Calculate the

(i) Concentration of acid in *mol* dm^{-3}
(ii) Concentration of $XHCO_3$ in B in *mol* dm^{-3}
(iii) Mass of $XHCO_3$
(iv) Value of X

Equation of the reaction: $HNO_{3(aq)} + XHCO_{3(aq)} \rightarrow XNO_{3(aq)} + CO_{2(g)} + H_2O_{(l)}$

$$(H = 1; C = 12; O = 16)$$

Solution

C_a =? Mole *per* dm^3 $V_a = 24.90cm^3$; $n_a = 1$

C_b =? Mole *per* dm^3; $V_b = 25cm^3$; $n_b = 1$

(a) To calculate the molar concentration of A.

The given mass concentration of A is

1.6g of HNO_3 in 250cm^3

i.e. 250cm^3 of the solution contained 1.6g of acid

Therefore, 1000cm^3 of A contained

$$\frac{1.0\times1000}{250} = 6.40gdm^{-3}$$

i.e. the mass concentration of A = 6.40gdm^{-3}

But$molar\ concentration = \frac{mass\ concentration}{molar\ mass}$

Molar mass of HNO_3 = (1x1) + (14x1) + (16x3) = 1+14+48 =63gmol^{-1}

Molar conc. $C_a = \frac{6.4}{63} = 0.102moldm^{-3}$

(b) To calculate the molar concentration of B

Mass conc. Of $XHCO_3$ in B = 10.0gdm^{-3} (given)

Since the value of X in the base $XHCO_3$ is not known, the mole ratio expression must be used in order to find its molar concentration,

$$\frac{C_aV_a}{n_a} = \frac{C_bV_b}{n_b}$$

Substituting

$$\frac{0.102\times24.9}{1} = \frac{C_b\times25}{1}$$

Making C_b the subject of the formula

$$C_b = \frac{0.102\times24.9}{25} = 0.102moldm^{-3}$$

(c) To find the mass of X in $XHCO_3$

$$molar\ mass = \frac{mass\ conc}{molar\ conc} = \frac{10.0gdm^{-3}}{0.102moldm^{-3}} = 98.0gmol^{-1}$$

(d) To find the value of X in $XHCO_3$

Molar mass of XHCO3 =98.0$gmol^{-1}$

i.e X +1 + 12 + (16 x 3) = 98

X + 1 + 12 + 48 = 98

X + 61 = 98

X = 98-61

Relative atomic mass of X is X = 37 (no unit)

3. DETERMINATION OF MOLE RATIO

In order to determine the mole ratio of acid to base (or base to acid) by titration, the solution of the acid and the base provided for the titration must be known concentrations (standard solution). However, the equation of reaction will not be provided.

Example 1

A is a solution of 0.0500*mol* dm^{-3} hydrochloric acid

B is 0.0250*mol* dm^{-3} of a trioxocarbonate (iv) solution

25.00cm^{3} portions of B required an average of 24.60cm^3 of A for complete neutralization, using methyl orange as the indicator

a. calculate:
i. amount of acid in the average volume of A used
ii. amount of trioxocarbonate (IV) in the volume of B used
iii. mole ratio of the acid to trioxocarbonate (IV) solution in the reaction, express your answer as a whole number ratio of one
b. state whether the PH of the following would be equal to 7, greater than 7 or less than 7
i. solution A
ii. solution B
iii. titration mixture of A and B before end point

SOLUTION

a. (i) To calculate the amount of acid in A used

Amount of the acid = molar conc. of A x volume in dm^3.

$= 0.050 \times {}^{24.60}/_{1000}\ mol$

$= 0.00123 mol$

(ii) To calculate the amount of trioxocarbonate (iV) in B used

Amount of Base = molar conc. Of B x volume in dm^3

$= 0.025 \times {}^{25}/_{1000}\ mol.$

$= 0.000625\ mol$

(iii) Mole ratio of acid to trioxocarbonate (iV)

Mole ratio of acid to base, A: B = 0.00123: 0.000625

$A : B = \frac{0.00123}{0.000625} : \frac{0.000625}{0.000625}$

A : B = 2 : 1

b. (i) pH of A is less than 7

(ii) pH of B is greater than 7

(iii) pH is titration mixture before end point is greater than 7

SOLVED PROBLEM 2

In an acid – base titration, $24.80cm^3$ of $0.05000moldm^{-3}$ of a mineral acid Y neutralized $25.00cm^3$ of a solution containing 5.83g of Na_2 CO_3per dm^3.

a. From the information given above calculate:
i. Amount (in moles) of acid Y used
ii. Amount in moles of Na_2CO_3 used
iii. Mole ratio of the acid to Na_2CO_3 I the titration
b. i. What is the basicity of Y?
  ii. Suggest what Y could be. Give reason for your answer.
iv. From your answer, write a balance equation of the reaction

Solution

a. i. amount n_y = conc ($moldm^{-3}$) x volume (dm^3)

$$= 0.0500 \times \frac{24.80}{1000} = 0.00124 mol$$

ii. Amount in mole of Na_2CO_3 used

first, calculate the concentration of Na2CO3 in moldm-3

Molar mass of Na_2CO_3 = 2 (23.0) + 12 + 3 (16)

= 46 + 12 + 48 = $106gmol^{-1}$

Conc of $Na_2CO_3 = \frac{mass\ concentration}{molar\ mass} = \frac{5.83}{106} = 0.0550 moldm^{-3}$

Amount of Na_2CO_3 , $n_z = 0.0550 \times \frac{25}{1000} = 0.00138 mol$

v. mole ratio of the acid to Na2CO3 in the titration

Mole ratio of the acid to Na2CO3 = n_y : n_z = 0.00124: 0.00138

$$n_y : n_z = \frac{0.00124}{0.00124} : \frac{0.00138}{0.00124}$$

n_y: n_z = 1: 1

b. The basicity of Y is 2; Y since one mole of Y requires one mole of Na_2CO_3 .

ii. Y is H_2SO_4. Reason: one mole of the acid Y produces two mole of H^+.

$$H_2SO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + H_2O + CO_2$$

$$C = 12.0. O = 16.0,\ Na = 23.0$$

4. DETERMINATION OF DEGREE OF PURITY

The degree of purity of an acid or a base can be determined by titration. For instance:

Suppose a sample of anhydrous Na_2CO_3 is contaminated by a salt, sodium chloride. A know mass of the impure sample is dissolved in a known volume of solution. The resulting solution of the impure Na_2CO_3 is then titrated against a standard solution of a pure acid.

It should be bore in mind that during the course of the titration, only the pure Na_2CO_3 in the mixture will be neutralized by the standard solution of the acid. The impurity remain in the solution, since it will not react will the acid hence the molar concentration obtained corresponding to that of the pure Na_2CO_3

Generally, the quantity of the *pure* substance is always less than that of the *impure* substance in a given solution, due to the presence of *impurity.*

Mathematically

Mass of pure substance = (mass of impure substance) – (mass of impurity)

- In essence, you need more of an impure substance to complete a chemical reaction, than when the substance is 100% pure.

Example;

A is 0.100$mol\ dm^{-3}$ hydrochloric acid

B contains 6.00g of a mixture of anhydrous sodium trioxocarbonate (iv) and sodium chlorides in 1.00dm^3 of solution.25.00cm^3 portions of B required an average of 22.65cm^3 of A for complete neutralization

From the above data, calculate the

a amount in moles of Na_2CO_3 in one 1dm^3 of B;

b mass of Na_2CO_3 in 250cm^3 of B ;

c percentage by mass of NaCl in the mixture.

Equation of reaction;

2HCl (aq) + $Na2CO_3$ (aq) --------- 2NaCl (aq) + CO_2 (g) + H2O (L)

Solution

A .To calculates the molar concentration of Na_2CO_3 in B.

The molar concentration corresponds to the pure anhydrous Na_2CO_3 that has been neutralized by the acid; hence, the mole ratio expression is to be used:

i.e. (CAVA)/NA = (CBVB)/Nb

The relevant variables are:

CA = 0.100*mol dm*$^{-3}$; VA = 22.65 cm^3; Na = 2 nB= 1; CB =? *mol dm*$^{-3}$; VB = 25.00cm^3;

Substitution: 0.100 x22.65 / 2 = CB X 25.0/1; making CB the subject of the formula;

CB = 0.100 X 22.65/2 X 25 = 0.0453*mol dm*$^{-3}$

b. To calculate the mass of Na_2CO_3 in 250 cm^3 of B.

First, calculate the concentration of B in *g/dm*^{3}:

Mass conc. = molar conc. X molar mass

Molar mass of Na_2CO_3 = (23X2) + (12 X 1) +(16 X 3) = 46+12+48 = 106*gmol*$^{-1}$

Molar conc. of B = 0.046 X 106 = 4.83*gdm*$^{-3}$

i.e. 1000 cm^3 of B contained 4.83g of Na_2CO_3

Therefore, 250cm^3 of B contain 4.83 x 250/1000g = 1.21g of Na_2CO_3

i.e. B contains 1.21g of pure Na_2CO_3 in 250 cm^3 .

c i.e. To calculate the % NaCl in the mixtures

% NaCl in the mixture corresponds to the % impurity.

Mass conc. of impure substance = 6.00*gdm*$^{-3}$

Mass conc. of pure Na_2CO_3 = 4.83*gdm*$^{-3}$.

Therefore, Mass conc. of impurity, NaCl = (6.00 – 4.83) *gdm*$^{-3}$ = 1.17*gdm*$^{-3}$

% impurity NaCl = 1.17/6.00 x 100/1 = 19.50% (3 sig.fig.)

Note; % purity = (100-19.50) % 80.50%

or % purity =4.83/6.00 x 100/1 =80.50% (3 sig.fig.)

5. DETERMINATION OF WATER OF CRYSTALLISATION

When a hydrated substance is used in a volumetric analysis, it is only the anhydrous portion of the hydrate that will take part in the reaction. The water of crystallisation remains in the solution like an impurity.

Worked example

A is a solution containing 6.00g per dm^3 of hydrochloric acid

B contains 12.0g per dm^3 of $Na_2CO_3.xH_2O$.

A student titrated $25cm^3$ of a portion of B with A using a methyl orange indicator, and found the average volume of A required to be $13.10cm^3$. Calculate the;

a. concentration of A in $moldm^{-3}$
b. molar mass of $Na_2CO_3.x\ H_2O$
c. value of x
d. Percentage of water of crystallisation in B. The equation of reaction is

$$2HCl_{(aq)} + Na_2CO_3.xH_2O_{(aq)} \rightarrow 2NaCl_{(aq)} + xH_2O_{(l)} + CO_{2(aq)}$$

Solution

a. to calculate the concentration of a in $moldm^{-3}$

mass concentration of HCl in A = $6gdm^{-3}$.

Molar mass of HCl = 1+35.5 =36.5g per mol

$$molar\ concentration = \frac{mas\ conc}{molar\ mass} = \frac{6}{36.5} = 0.164moldm^{-3}$$

b. to calculate the concentration of andydrous Na_2CO_3 in $moldm^{-3}$

amount of HCL used = molar conc ($moldm^{-3}$) x volume (dm^3)

= 0.164 x $^{13.1}/_{1000}$ = 0.002215 mole

From the equation of reaction:

2 mole of HCl requires 1 mole of Na_2CO_3

1 mole of HCl requires ½ (0.00215 mole) = 0.00108 mol of Na_2CO_3

That is : $25cm^3$ of B contains 0.00108 mol of Na_2CO_3

1000 cm^3 of B contain 0.00108 x $^{1000}/_{25}$ = 0.0432 mol

Hence the concentration of Na_2CO_3 in B is 0.0432 $moldm^{-3}$

Alternative formula method

The relevant variables are

Ca =0.164 $moldm^{-3}$; V_a =13.10 cm^3; n_a =2

Cb =? $moldm^{-3}$; V_b 25.0cm^3 ; n_b =1

Using the relation

$$\frac{C_a V_a}{C_b V_b} = \frac{n_a}{n_b}$$

$$\frac{0.164 \times 13.1}{C_b \times 25} = \frac{2}{1}$$

Making Cb the subject

$$C_b = \frac{0.164 \times 13.1}{25 \times 2} = 0.043\ moldm^{-3}$$

c. to calculate the molar mass of hydrated Na_2CO_3

mass concentration of B = 12.0 gdm^{-3} (given)

molar concentration of B = 0.04320 $moldm^{-3}$

molar mass of hydrated Na2CO3= $^{(mass\ conc)}/_{(molar\ conc.)}$.

$= {}^{12.0}/_{0.0430}$=279 g per mole

d. To find the value of x

Molar mass of Na2CO3.x H2O = 279 gmol-1 (from c above)

106 + 18x =279

18x =279 – 106 = 173

X = $^{173}/_{18}$ =9.61

X = 10 (to the nearest whole number)

(note that the experimental value of x may differ significantly from the theoretical value,as a result of experimental errors, or due to the fact that hydrated substances are efflorescent

e. To calculate the percentage of water of crystallization in B.

Mass concentration of Hydrated Na_2CO_3

= (molar concentration of B) x (molar mass of anhydrous Na_2CO_3)

= 0.0430 x 106 gdm^{-3} = 4.56g dm^{-3}.

$$\%\ watrer\ of\ crystallisation = \frac{conc\ of\ hydrated\ salt - conc\ of\ hydrous\ salt}{concentration\ of\ hydrated\ salt} \times \frac{100}{1}$$

$$\%\ water\ of\ crystallisation = \frac{12.0 - 4.56}{12.0} \times 100 = \frac{7.44 \times 100}{12}$$

$$\%\ water\ of\ crystallisation = 62.0\%$$

6. DETERMINATION OF SOLUBILITY OF A SUBSTANCE BY TITRATION

The solubility of a solid in a liquid is the concentration of the saturated solution. It is defined as the maximum amount of the solid that dissolves in 1 dm3 of the solution at a given temperature. It is expressed in moles/dm3

The solubility of anhydrous substance, such as Na_2CO_3, K_2CO_3, $NaHCO_3$. $KHCO_3$ and $Ca(OH)_2$ can be determine by titration. This is achieved by preparing a saturated solution of the substance at room temperature.

Preparation of saturated solution of Na_2CO_3 at room temperature

Place about 50cm^3 of distilled water in a beaker, add powdered Na_2CO_3 little by little into it, and warm on a Bunsen burner, with stirring. Continue the addition of the salt with stirring and keeping the beaker warm at about 40^{0}C, until the salt can no longer dissolve. Allow the saturated solution to cool to the room temperature, and then filter the mixture. The filtrate is the saturated solution of salt at room temperature.

To determine the solubility of Na_2CO_3 at 25^{0}C;

1. Pipette a known volume, say 25 cm^3 of the saturated Na_2CO_3 solution at 25^{0}C, into a volumetric flask, and dilute it to a volume, say 1000cm^3 with distilled water. Dilution will be necessary, if the saturated solution is of a high concentration
2. Titrate 25 cm^3 portions of the diluted solution with a standard solution of an acid using methyl orange indicator, and find the average volume of the acid used.

Worked examples

A is a solution containing 0.0905 mol dm^{-3} of trioxonitrate (V) acid

B was prepared by diluting 50.0cm^3 of a saturated solution of Na_2CO_3 at room temperature to 1000 cm^3

25 cm ^{3} portion of B were found to require an average of 24.9.0cm^3 of A for complete neutralisation, using methyl orange as the indicator. From the data above, calculate the;

i. Amount of HNO_3 in the average volume of A used
ii. Concentration of B in mole per dm^3
iii. Solubility of Na_2CO_3 in moles per dm^3
iv. Mass of Na_2CO_3 that will be obtained by evaporating 1 dm^3 of the saturated solution to dryness.

The equation of reaction is

$$2HNO_{3(aq)} + Na_2CO_{3(aq)} \rightarrow 2NaNO_{3(aq)} + H_2O_{(l)} + CO_{2(g)}$$

$$[H = 1,\ C = 12,\ O\ 16\ Na = 16]$$

Solution

i. Amount of HNO_3 in the average volume of A used.

1000 cm^3 of A contained 0.0905 mole of HNO_3

Therefore, 24.90 cm^3 of the solution will contain 0.0905 x ${}^{24.90}/_{1000}$ mol HNO_3

= 0.00225 mol

Or amount (mol) = conc. (mol dm^{-3}) x volume (dm^3)

= 0.0905 x ${}^{24.90}/_{1000}$ = 0.00225 mol

ii. To calculate the concentration of B in moles per dm^3

from the equation of reaction;

2 moles of HNO_3 require 1 mole of Na_2CO_3

0.00225 mole will require ½ (0.00225 mol) of Na_2 CO_3 = 0.00113 mol of Na_2CO_3

That is; 25 cm^3 of B contain 0.00113 mol of Na_2CO_3

Therefore, 1000 cm^3 (1 dm^3) will contain 0.00113 x ${}^{1000}/_{25}$ mol = 0.452 mol

Hence, the concentration of B is 0.452 *mole per dm*^{3}

Alternative formula methods

The relevant variables are

C_a = 0.0905 mol dm^{-3}, V_a =24.90 cm^3 ; n_a =2

C_b = ? moldm^{-3} ; V_b = 25.0 cm^3; n_b = 1

$$\frac{C_aV_b}{C_bV_b}3 = \frac{n_b}{n_b}$$

$substituting$

$$\frac{0.0905\times24.9}{C_b\times25} = \frac{2}{1}$$

Making C_b the subject of the formula

$$C_b = \frac{0.0905\times24.9}{25\times2} = 0.0451\, moldm^{-3}$$

iii. To calculate the solubility of Na_2CO_3 in mole per dm^3.

Since B is obtained by diluting $50.0cm^3$ of saturated Na_2CO_3 solution t0 1000 cm^3 then,

50 cm^3 of the saturated solution contained 0.0451 mole.

Therefore $1000cm^3$ of saturated solution contained 0.0451 x $^{1000}/_{50}$ mol = 0.902 mole

Hence, the solubility of $Na\ _2CO_3$ is 0.902 mol dm^{-3}

Alternative method: using diluting principle

$50.0cm^3$ (V_1) of saturated Na_2CO_3 solution of unknown concentration C_1, diluted to $1000cm^3$ (V_2) to obtain solution B, of concentrationC_2, which has been found to be 0.0451 mole per dm^3

$$using\ \ C_1V_1 = C_2V_2\ and\ substituting$$

$$C_1\times25 = 0.0451\times1000$$

$$C_1 = \frac{45.1}{1000} = 0.902 moldm^{-3}$$

$$that\ is\ the\ solubility\ of\ the\ mass\ of\ Na_2CO_3 in\ 0.902 moldm^{-3}$$

iv. To calculate the mass of Na_2CO_3 in $1dm^3$ of the saturated solution

Molar conc = 0.902 $moldm^{-3}$; molar mass of Na_2CO_3 = 106 $gmol^{-1}$.

Mass conc = molar conc x molar mass of Na_2CO_3

Molar concentration = 0.902 x 106 = 95.6 g per dm^3

Therefore, the mass of Na_2CO_3 obtained on evaporating 1 dm^3 of the saturated solution is 95.6 g

SUB-TOPIC 2: REDOX TITRATIONS

Introduction: Redox titrations involve reactions between oxidizing and reducing agents. The solutions used are: acidified $KMnO_4$, acidified $K_2Cr_2O_7$, KIO_3 and I_2. The reducing agents are solutions of: iron (II) salts; ethanoic acid dehydrate, $H_2C_2O_4 . 2H_2O$; sodium ethanate, $Na_2C_2O_4$; and sodium trioxosulphulsulphate (iv), $Na_2S_2O_3$.

All the basic principles involved in acid – base titrations are also applicable to redox reactions. When the mole concept is applied to redox reagents, the amount of substance present in a given solution can be determined.

Worked Example 1

How many moles of $KMnO_4$ are in 250cm^3 of 0.012 moles *per* dm^3 solution?
The calculate amount in moles.
Given: concentration = 0.012$moldm^3$

Formula Method

Volume in dm^3 = $\frac{250}{1000}$ = 0.250dm^3
Using: Amount = conc. (moldm^{-3}) x vol (dm^3)
= 0.102 x 0.250 mol
From the first principle
1000cm^3 (1dm^3) solution contain 0.102mole $KMnO_4$
Therefore, 250cm^3 solutions contain $\frac{(0.102 \, x \, 250)}{1000}$
= 0.0255mol $KMnO_4$

End-point of a Redox titration

Indicators such as methyl orange and phenolphthalein are not used in redox titrations.

- In a redox titration involving $KMnO_4$ solution and a colourless reducing agent, an external indicator is required; $KMnO_4$ acts its own indicator. The end-point is the first permanent pink colour.
- In a redox titration involving iodine solution and a colourless reducing agent, starch solution is used. The end-point is signalled by a change from blue-black to colourless.

At the end-point, the amounts of the oxidizing agent, no_A and that of the reducing agent, nr_A are exactly in the same ratio as that required in the balanced equation of reaction. That is:

$$\frac{Mole\ of\ OA\ used}{Mole\ of\ RA\ used} = \frac{mole\ of\ OA\ \ in\ the\ equation}{mole\ of\ RA\ in\ the\ equation}$$

$$C\,\frac{CoA\,VoA}{CRA} = \frac{noA}{noA} \text{ or } \frac{CoA\,VoA}{nRA} = \frac{CRA\,VRA}{nRA}$$

Worked Example 2

25.0cm^3 of a hot solution of 0.0302moldm^{-3} hydrated ethanoic acid, acidified with dilute H_2SO_4 required an average of 28.75cm^3 of $KMnO_4$ solution to complete the reaction.

a. How many moles of the acid are therein 25.0cm^3 of the acid?
b. How many moles of $KMnO_4$ react with 25.0cm^3 of acid?
c. How many moles of $KMnO_4$ are in 1dm^3 of solution?

The equation of the reactions is;

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 10CO_2 + H_2O$$

Solution

a. To calculate the amount of acid in 25cm^3 of solution:

Given: concentration = 0.0302moldm^{-3}

Volume in dm^3 = $\frac{25}{1000}$ = 0.0250dm^3

Using: Amount = conc ($moldm^{-3}$) x vool (dm^3)

= 0.0302 x 0.0250 = 0.000755*mol*.

b. To calculate the amount of $KMnO_4$

From the balanced equation of reaction:

5 moles of $C_2O_4^{2-}$ ≡ 2 moles of MnO_4^-

∴ 0.000755 *mol* $C_2O_4^{2-}$ ≡ $\frac{0.000755 \; x \; 2}{5} \, mol$ MnO_4^-

= 0.000302 *mol* $KMnO_4$

d. Amount of $KMnO_4$ in 1 dm^3 of solution:

The volume of KMnO4 solution used is 28.75cm^3.

i.e. 28.75cm^3 of solution contain 0.000302 *mol* KMNO$_4$

Therefore, 1000cm^3 (1dm^3) contain $\frac{(0.000302 \; x \; 1000)}{(28.75)}$

= 0.0105 *mol* $KMnO_4$

Sub-topic 3: Test for Redox Reagents

Test for a Reducing agent

An oxidizing agent is used to test for a reducing agent. Any substance that reacts with one or more of the following reactions is a reducing agent:

- To the solid substance in a test tube, add a few drops of bench dilute hydrochloric acid. *There is effervescence; the gas given off is colourless, odourless, has no action on moist red or blue litmus paper, but gives a pop with lighted splint. The gas is hydrogen, while the substance is a metal above hydrogen in the activity series.*
- To the solution of the substance, add a few drops of purple acidified $KMnO_4$. *The* $KMnO_4$ *solution is decolourised.*
- To the solution of the substance, add a few drops of yellow acidified $K_2Cr_2O_7$ solution. *The yellow colour of* $K_2Cr_2O_7$ *solution turns green.*
- To the solution of the substance, add a few drops of yellow or brown solution of $FeCl_3$. *The solution turns green.*

Test for an Oxidizing agent

A reducing agent is used to test for an oxidizing agent. Any substance that reacts in one or more of the following reactions is a oxidizing agent.

- Allow H_2S gas to come in contact with a solution of the substance on a strip of filter paper. *There is a yellow deposit of sulphur on the filter paper.*
- To the solution of the substance, add a few drops of colourless acidified potassium iodide solution. *The solution turns brown, due the evolution of iodide, which turns starch solution blue-black.*
- Heat a little of the substance with conc.HCl. *A greenish-yellow gas with pungent smell is evolved. The gas, which bleaches litmus, is chlorine.*
- Heat the substance strongly in a test tube. *The gas evolved is colourless, odourless, has no action on litmus paper, but relights a glowing splint. The gas is oxygen.*

WEEK 2

TOPIC: QUANTITATIVE AND QUALITATIVE ANALYSIS
CONTENT:

1. **Identification of ions**
2. **Test for gases**
3. **Identification of fats and oils**

Sub-topic 1: IDENTIFICATION OF IONS

IDENTIFICATION OF CATIONS AND ANIONS

CATIONS: Zn^{2+}, Al^{3+}, pb^{2+} , Ca^{2+} ,Fe^{2+} Fe^{3+}, Cu^{2+}, NH_4^+

1 THE USE OF $NaOH_{(aq)}$: If a few drops of $NaoH_{(aq)}$ is added to aqueous solutions of the salts of the above cations the following observations will be made. If it is:

a. Zn^{2+}: There will be formation of a white gelatinous precipitate which will be soluble in excess $NaoH_{(aq).}$

b. Al^{3+}There will be formation of a white gelatinous precipitate which will be soluble in excess $NaoH_{(aq).}$

c. Pb^{2+}:There will be formation of a white precipitate which will be soluble in excess $NaoH_{(aq)}$.

d. Ca^{2+}: There will be formation of a white precipitate which will be soluble in excess $NaoH_{(aq).}$

e. Fe^{2+}: There will be formation of a green gelatinous precipitate which will be insoluble in excess $NaOH_{(aq).}$

f. Fe^{3+} There will be formation of reddish- brown gelatinous precipitate which will be insoluble in excess $NaoH_{(aq).}$

g. $Cu^{2+:}$ There will be a formation of a blue precipitate which is insoluble in excess $NaoH_{(aq).}$

h. NH_4^+: If $NaoH_{(aq)}$ is added to the test solution and warmed, a colourless gas with irritating smell which will turn moist red litmus paper to blue will be evolved. Thus, showing that the test solution is containing NH_4^+ i. e. the test solution is an NH_4^+ salt solution.

ANIONS: Cl^-, NO_3^-, SO_4^{2-}, SO_3^{2-}, CO_3^{2-}:

The following tests help to identify these anions:

a. Cl^- : To the test solution add dilute HNO_3 acid (there will not be visible reaction), followed by $AgNO_{3(aq),}$ (there will be formation of a white precipitate). To the precipitate add $NH_{3(aq)}$ in excess and shake . If the precipitate dissolves then the test solution is containing Cl^- ions.

b. NO_3^- : To the test solution add FRESHLY prepared $FeSO_4$ solution followed by concentrated H_2SO_4 acid. Formation of a brown ring indicates the presence of NO_3^- ions.

c. SO_4^{2-} : To the test solution add dilute HCl acid,(there will not be any visible reaction, this is just to get rid of any other ions that may tamper with the experiment), followed by $BaCl_2(aq)$. There will be formation of a white precipitate which will be insoluble in excess dil.HCl. This shows that SO_4^{2-} is present in the test solution.

d. SO_3^{2-}: To the test solution add $BaCl_{2(aq)}$. There will be formation of a white precipitate which will be soluble in dil. HCl acid

e. CO_3^{2-}: The test for CO_3^{2-}, is also carried out exactly in the same way as in (d) above. The same result is obtained. To differentiate between SO_3^{2-} and CO_3^{2-} , add $MgSO_{4(aq)}$ solution to solutions containing $SO_3^{2-}$and CO_3^{2-} ions in different test tubes. The one that gives a white precipitate is CO_3^{2-} . The example below shows how to report salt analysis.

Worked Example

1. Credit will be given for strict adherence to instructions, for observations precisely recorded and for accurate inferences. All tests, observations and inferences must be clearly entered in your work book, in ink, at the time they are made. C is a mixture of two salts. Carry out the following exercises on C. Record your observations and identify any gas (es) evolved. State the conclusion you draw from the result of each test. (a) Put all of C in a test tube and add about $10cm^3$ of distilled water. Shake thoroughly and filter. Keep both the filtrate and the residue. Divide the filtrate into three portions. (i) To first portion, add $NaOH_{(aq)}$ in drops and then in excess. (ii) To the second portion, add NH_3 solution in drops and then in excess. (iii) To the third portion, $BaCl_{2(aq)}$ followed by dilute HCl. (b) Divide the residue into two portions. (i) Heat the first portion strongly in a test tube. (ii) Add dilute HCl to the second portion.

Solution

TEST	OBSERVATION	INFERENCE
(a)(i) C + H_2O, then filter	Green residue and blue filtrate were observed	C is a mixture of soluble and insoluble salts.
(ii) Filtrate + $NaOH_{(aq)}$ in drops, then in excess	A blue gelatinous precipitate which is insoluble in excess was formed.	Cu^{2+} present
(iii) Filtrate + $NH_{3(aq)}$ in drops, then in excess	A pale blue gelatinous precipitate was formed. The precipitate dissolves or is soluble in excess $NH_{3(aq)}$ to give deep blue solution.	Cu^{2+} is confirmed
(iv) Filtrate + $BaCl_2$ + dil. HCl	A white precipitate, insoluble in dil. HCl was observed.	SO_4^{2-} is present
(b)(i) First portion of residue + heat	The colour changed from green to black powder	
(ii) Second portion of residue + dil. HCl	There was effervescence and a colourless, odourless gas which turn lime water milky was given off	Gas is CO_2 from CO_3^{2-}

EVALUATION

1. Credit will be given for strict adherence to instructions, for observations precisely recorded and for accurate inferences. All tests, observations and inferences must be clearly entered in your work book, in ink, at the time they are made. C is a mixture of two salts. Carry out the following exercises on C. Record your observations and identify any gas(es) evolved. State the conclusion you draw from the result of each test. (a) Put C into a beaker and add about 10cm^3 of distilled water,

stir the mixture and filter. Test the filtrate with litmus papers. Keep the residue and filtrate. (b)(i) To about 2cm^3 of the filtrate, add few drops of aqueous HNO_3 followed by $AgNO_{3(aq)}$.

(ii) Add excess NH_3 solution to the resulting mixture. (c) To about half of the residue from 1(a) above, add about 5cm^3 of dilute HNO_3 in drops. Divide the resulting solution into two equal portions. (d) (i) To the first portion, add ammonia solution in drops and then in excess. (ii) To the second portion, add dilute HCl.

Sub-topic 2: Test for gases

SO_2, H_2S, NH_3, CO_2, NO_2, HCl, O_2, Cl_2 and H_2

GAS	ODOUR	COLOUR	COMFIRMATORY TEST	SUSPECTED SALT
SO_2	Irritating smell	Colourless	Changes acidified $k_2cr_20_7$ solution from orange to green. Change acidified $KMNO_4$ solution from purple to colourless. It turns moist blue litmus paper to red.	SO_3^{2-} of Na or K
H_2S	Rotten egg smell	Colourless	It changes acidified $K_2Cr_2O_7$ solution from orange to green with yellow sulphur deposit. It changes acidified $KMnO_4$ Solution from purple to colourless with yellow sulphur deposits Turns (CH_3 COO_2)Pb solution or paper black. Turns $Pb(NO_3)_2$ paper or solution to black. Turns moist blue litmus paper red.	S^{2-} of metal e.g. FeS
NH_3	Choking smell	Colourless	Turn moist red litmus paper to blue. Gives white fumes with HCl	NH_4^+ salts
CO_2	Odourless	Colourless	Turns moist blue litmus paper red. Turns lime water milky	HCO_3^- and CO_3^{2-} Salts
NO_2	Irritating smell	Reddish-brown	It turns moist blue litmus paper to red. Turns moist starch-iodide paper to blue-black	NO_3^- of heavy metals e.g.$Pb(NO_3)_2$

HCl	Sharp irritating smell	Colourless	Turns moist blue litmus paper red. Form white fumes with ammonia gas.	Cl^- salts
O_2	Odourless	Colourless	Rekindle a glowing splint	$KClO_3$
Cl_2	Pungent smell	Greenish-yellow	Turns moist blue litmus paper to pink then bleaches it. Turns moist starch – iodide paper to dark blue.	Cl^- of Na, Mg
H_2	Odourless	Colourless	Gives a pop sound when ignited in the air.	H_2 is obtained when certain metals e.g. Zn, Sn and Al react with acids, water, steam or hot concentrated NaOH or KOH Solution.

WEEK 3

TOPIC: PETROLEUM OR CRUDE OIL

CONTENT:

1. **ORIGIN AND COMPOSTION OF PETROLEUM (CRUDE OIL)**
a. **NIGERIA AND WORLD CRUDE OIL RESERVES**
2. **EXPLORATION AND DRILLING**
a. **FRACTIONAL DISTILLATION AND MAJOR PRODUCTS**
3. **LOCATION OF NIGERIAN REFINERIES CRACKING AND REFORMING**

SUB-TOPIC 1: ORIGIN AND COMPOSITION OF PETROLEUM (CRUDE OIL)

The origin of petroleum (crude oil) is still not clear but it is generally believed that petroleum has organic origin and it is formed by the gradual decomposition of the remains of marine plants and animals that became incorporated in the sediment and rocks formed at the bottom of the sea.

Petroleum is a dark brown viscous liquid which is a mixture of natural gases and crude oil.

Petroleum is a complex mixture of hydro carbons with various chain lengths, from one to about forty carbon atoms. The three different homologous series of hydrocarbons in petroleum are chiefly alkanes with one to size carbon atoms and small quantity of gas such as $C0_2$, H_2S and water vapour.

EVALUATION

Give three homologous series present in petroleum.

NIGERIA AND WORLD CRUDE OIL RESERVES

Nigeria as well as Asia, Chinese, Indonesia, Russia, North and West Africa, United states, Canada, Venezuela and Australia are the world oil reserves. Also Saudi Arabia, Iran, Kuwait. Crude oil from Nigeria is described as LIGHT CRUDE because it is sulphur free, it is in high demand in the world market.

EVALUATION

State the reason why crude oil from Nigeria is described as light crude.

SUB-TOPIC 2: EXPLORATION AND DRILLING OF CRUDE OIL

It is likely that oil bearing rock layers are located by (a) aerial photography (b) examining the surface rocks (c) core drilling (d) mapping the earth's rock layers

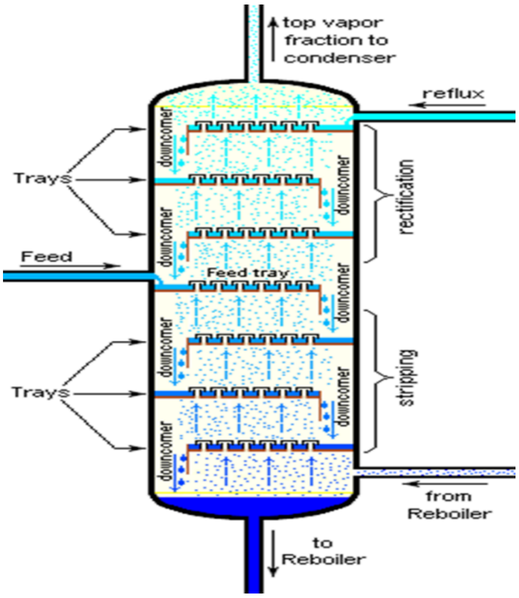
In general, crude oil found in reservoirs several metres beneath the impervious rock, is brought to the surface sue to the pressure of the natural gas. When the pressure of the gas subsides, air pressure is then applied through the pumps to force the oil out of the well.

EVALUATION

Explain briefly how the mapping of the earth's rock layer is done.

FRACTIONAL DISTILLATION AND MAJOR PRODUCTS

Crude oil (petroleum) is separated into various fractions by the physical process of fractional distillation, on a large scale, in a refinery, by the use of a fractionating tower as shown in the diagram below.



Petroleum products are the fractions obtained directly from the fractionating tower where the crude oil has been refined by fractional distillation.

The separation of petroleum fractions is based on the differences in their boiling points. The main products or fractions are as listed below

Refinery gas

Gasoline (petrol and naphtha)

Paraffin oil (kerosene)

Light gas oil (Diesel)

Heavy gas oil (lubricating oil etc)

Asphalt (Bitumen)

EVALUATION

List four products obtained when crude oil is refined.

SUB-TOPIC 3: LOCATION OF NIGERIA REFENERIES

Nigeria refineries are located at Portharcout, Warri, Kaduna

CRACKING AND REFORMING

The quality of petrol obtained from the Fractional distillation of crude oil is about 20% by volume.

Cracking is therefore employed so as to provide more petrol, since its demand is high and as a source of alkenes.

CRACKING: cracking is the process whereby large molecules of heavy oils are broken into smaller molecules (light oils) at high temperature, pressure and in the presence of a catalyst. Usually petroleum fractions with more than eleven carbon atoms in their molecules can be cracked.

During cracking, ethane, C_2H_4 is produced; it is the major raw material in the petrochemical industry.

CRACKING TECHNIQUES

The two main cracking processes are: thermal cracking and catalyst cracking.

There is also a less common cracking known as hydro cracking.

1. **THERMAL CRACKING**: Thermal cracking involves heating heavy oils, such as lubricating oil, diesel oil and kerosene to about 600^0C under pressure; it leads to the decomposition and formation of a mixture of more volatile alkanes, alkenes and hydrogen. The mixture is then separated by fractional distillation. e.g.

$$C_{11}H_{28} \longrightarrow C_8H1_8 + C_3H_6$$

Kerosene petrol Alkene (propane)

CATALYTIC CRACKING: in catalytic cracking, the heavy oil is heated to about 500^0C under reduced pressure and in the presence of natural clay (a mixture of silicon (iv) oxide and aluminium oxide) as the catalyst. Under these conditions, a mixture of alkanes and alkenes, which can be separated by fractional distillation, is obtained e.g

$$C_{18}H_{38} \longrightarrow C_6H_{14} + C_8H_{16} + 2C_2H_4$$

Note: note that the products of cracking depend on the starting material and the reaction conditions, such as temperature, pressure and the nature of the catalyst used.

In hydro cracking, hydrogen is passed into the reaction mixture during the cracking process. Under this condition, only the lower saturated alkanes are obtained.

REFORMING: In reforming the molecules do not crack but are reformed or reshaped. In reforming straight chain alkanes are converted catalytically into branched chain isomers, cycloalkanes and benzene, the purpose is to convert low grade petro to higher grades, i.e. improve the quality. Reforming techniques includes **ISOMERISATION, CYCLIZATION AND AROMATIZATION**

DIFFERENCE BETWEEN CRACKING AND REFORMING

1. Cracking involves breaking large molecules of petrol fractions into smaller molecule, while reforming involves rearrangement of atoms in the molecules of petroleum fraction to obtain branched and cylic hydrocarbons.
2. Cracking can be achieved thermally or catalytically, while reforming is in the presence of a catalyst.
3. Cracking occurs at a temperature higher than that of reforming.
4. Cracking is employed to increase the quantity of petrol, while reforming is to improve its quality.

EVALUATION

1. What does cracking of petroleum product mean?
2. Why is cracking employed?

GENERAL EVALUATION

Objective test

1. A cracking process in petroleum refining can be represented by
   (a) Heptanes to heptanes
   (b) Heptanes to 3- meth hexane
   (c) Heptanes to propane
   (d) Heptanes to 2,3,3-trimethybutane
2. The residual solids from the fractional distillation of petroleum are used as
   (a) Raw material for the cracking process
   (b) Fuel for jet engines
   (c) Fuel for driving tractors
   (d) Coatings for pipes
3. Oil deposits in Nigeria are
   (a) On land and off shore
   (b) Only off shore
   (c) Mainly imported
   (d) Downstream
4. The separation of petroleum fractions depend on the differences in their
   (a) Boiling point
   (b) Molar mass
   (c) Melting points
   (d) Solubility's
5. Which of the following petroleum fractions yields Vaseline and paraffin wax on re-distillation?
   (a) Diesel oil

(b) Lubricating oil
(c) Petrol
(d) Kerosene

ESSAY QUESTIONS

1. (a) Give one example of a fuel that contains significant armour of sulphur as an impurity

(b) State one environmental disadvantage of using fuel that has high sulphur content.

2. (a) Name the process by which petroleum fractions are obtained from crude oil.

(b) State the role of concentrated H2SO4 acid in the petroleum refining process.

3. Which of the fractions of crude oil is likely to contain each of the following hydrocarbons? (a) C_6H_4 (b) $C_{12}H_{26}$ (c) $C_{22}H_{46}$

4. (a) what are the products of combustion of candle wax? (b) what are the residual solids from the fractional distillation of petroleum used as? (b) When the vapour of an alkane was passed through a combustion tube containing small pieces of broken is X in accordance with equation.

$$C_{17}H_{36(l)} \longrightarrow 3C_2H_4(g) + C_8H_{18(l)} + X$$

(a) What type of reaction does the equation represent?
(b) Determine the formula of X and the homologous series to which it belongs.
(c) State the function of the pieces of broken pot in the experiment.
(d) Calculate the volume of ethane at S.T.P that would be obtained from 0.100mole of $C_{17}H_{36}$ in the reaction [1 mole of a gas occupies $22.4dm^3$ at STP]

5. (a) Name two types of cracking (b) what name is given to the process in which atoms are arranged into different molecular structures in the petroleum refining process

WEEKEND ASSIGNMENT

Read about fractions of crude oil and their uses on page 508 of New School chemistry by Osei Yaw Ababio

PRE READING ASSIGNMENT

Read about petrochemicals from page 511 of New School chemistry by Osei Yaw Ababio

WEEKEND ACTIVITY

From the internet, get the pictures of eight petrochemical products.

WEEK 4

TOPIC: PETROLEUM ON CRUDE OIL

CONTENT:

1. **PETROCHEMICALS AS STARTING MATERIALS OF ORGANIC SYNTHESIS**
2. **QUALITY OF PETROL: MEANING OF OCTANE NUMBER**
3. **NATURAL GAS OCCURENCE, PACKAGING AS LIQUEFIED NAATURAL GAS (LNG), USES AND ECONOMIC IMPORTANCE OF PETROL**

SUB-TOPIC 1: PETROCHEMICALS AS STARTING MATERIALS OF ORGANIC SYNTHESIS

Petrochemicals are substances manufactured from by-products of petroleum.

Petroleum products are the staring raw materials used in the production of petrochemicals.

They are never produced directly from petroleum or crude oil. For instance Ethanol is a petrochemical. It is obtained by the catalytic hydration of ethane, which is a by-products-as shown in the following conversion scheme.

Crude oil $\xrightarrow{\textit{fractional distillation}}$ petroleum products

$\xrightarrow{\textit{Cracking}}$ Ethene $\xrightarrow{\textit{hydration}}$ Ethanol

Petrochemicals serve as the raw materials for the production of plastics, artificial rubber, soaps, perfumes, nylon, Terylene, dye, pharmaceutical products etc

EVALUATION

1. What are petrochemicals?
2. Starting from crude oil explain how you will obtain ethanol.

SUB-TOPIC 2: QAULITY OF PETROL

Meaning of Octane Number

Octane number or octane rating is the proportion of the straight chain heptane $C_{17}H_{16}$ to the branched –chain 2,2,4 –tri methyl pentane, an isomer of C_8H_{10} in petrol.

The octane number of heptane is set at zero (the lowest petrol grade) while that of 2,2,4 –tri methyl pentane is 100 (the highest grade petrol grade) A50:50 (or 1:1) mixture of heptane and 2,2,4- –tri methyl pentane gives petrol an octane number of 50 (a medium grade petrol)

The percentage of 2,2,4- –tri methyl pentane in the mixture determines the octane number of petrol.

When petrol with high proportion of straight chain heptane (low grade petrol) is used in the engine of a vehicle, the combustion will not be smooth and can knock the engine. i.e. damage the engine, while petrol with a high proportion f the branched chain 2,2,4-–tri methyl pentane burns smoothly and does not cause knocking in engines. The higher the octane numbers of petrol the lower the knocking tendency.

Generally, branched –chain alkanes give higher octane number than the straight – chain isomers .An increase in the octane number of petrol leads to an increase in its energy value.

In order to increase the octane number of a low grade petrol and reduce engine wear an addictive known as tetraethyl lead (iv) $Pb(C_2H_5)_4$ called anti-knock together with calculated amounts of cycloalkanes and benzene are usually added to the petrol. However, the presence of anti-knock additive in petrol is responsible for the pollution of the atmosphere by lead compounds from the exhaust fumes of motor vehicles.

Note: octane number of 2,2,4-–tri methyl pentane is 100, while that of heptane is zero. The percentage of 2,2,4 –tri methyl pentane in petrol determines the octane number.

EVALUATION

1. List two processes involved in the production of high grade petrol from crude oil
2. What is octane number?
3. Name the undesirable paraffin in the petroleum industry, which is particularly prone to knocking.

SUB-TOPIC 3: NATURAL GAS: OCCURENCE, PACKAGING AS LIQUEFIED NATURAL GAS (LNG), USES AND ECONOMIC IMPORTANCE OF PETROLEUM PAGE 510 OF PICTURE

Natural gas is formed alongside with crude oil from the remains of marine and animals which gradually settle on the sea beds after their death as a result of decomposition under high and temperature.

Natural gas consists of gaseous hydro carbons, mainly methane. Most of it is piped for industrial and domestic use. Components like butane and propane which liquefy readily under pressure are sold as bottled gas.

USES: In Nigeria, natural gas is used as fuel for heavy duty vehicles and engines. The gas power stations Ughelli and Sapele use natural gas to generate electricity.

Economic importance: Nigeria proposes to set up a liquefied natural gas plant. This will enable Nigeria not only to increase its natural gas consumption at home, but also to express the gas.

Petroleum and natural gas are now used in increasing amounts to produce many organic compounds e.g. Ethanol, ethane, propane 1,2,3-triol, benzene, toluene. These are in turn used to make large- molecule organic compounds like plastics, synthetic rubber, insecticides, detergents, synthetic fibres like nylon and dacron. The oil industry has provided employment in various aspects at the industry.

EVALUATION

1. Discuss the origin and the formation of natural gas.
2. Name the component of natural gas

GENERAL EVALUATION

OBJECTIVE TEST:

1. Which of the following petroleum fractions yields Vaseline and paraffin was on re-distillation? (a) diesel oil (b) lubricating oil (c) petrol (d) kerosene
2. Which of the following is a petrochemical (a) methane (b) Ethanol (c) propane (d) butane
3. It is not desirable to use lead tetraethyl as an antiknock agent because. (a) it is expensive (b) of pollution effects from the exhaust fumes (a) it lower the octane rating of petrol (d) it is explosive
4. A given fuel has an octane number of 100. This means that . (a) the knocking tendency of the fuel is low (b) the fuel is a mixture of several hydro carbons (c)

a large amount of alkanes is present in the fuel (d) the fuel need to be cracked before use

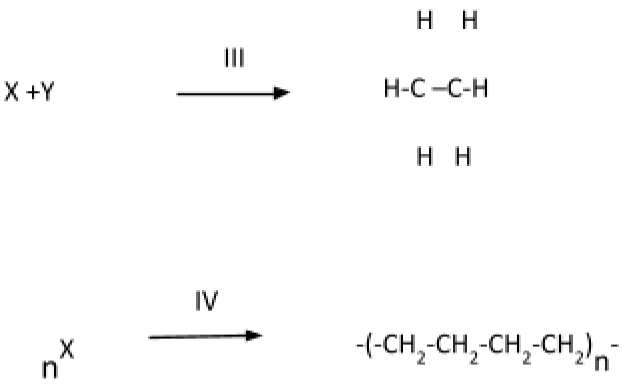
5. Nigeria earns money from (a) petroleum gas and liquids only (b) petroleum liquids and solids only (c) petroleum liquids like petrol and kerosene oil (d) petroleum gases, liquids and solids.

ESSAY QUESTIONS :

1. Consider the following reactions schemes:

Petroleum $\xrightarrow{I}$ petroleum fractions

Higher petroleum fractions $\xrightarrow{II}$ petrol + X



(a) State the type of reaction involved in each of the stages labelled I to IV
(b) Identify X and Y
(c) Give the IUPAC name of the product obtained in stage III
(d) What are the reaction conditions for stage IV?

2. Describe the process of fractional distillation of petroleum and the uses of some petrochemicals and the uses of each fraction.
3. (a) What do you understand by the octane number of petroleum? (b) Name one addictive use to improve the octane rating of petrol.
4. Write short notes on (a) occurrence of natural gas and it uses (b) petrochemicals and their uses.

WEEKEND ASSIGNMENT

Read the topic ‘octane number’ and petrochemicals from page 131 of comprehensive certificate chemistry by G.O Ojokuku and J.O Ajagbe and summarize them.

PRE READING ASSIGNMENT

Read about the Principle of metal extraction from page 446 of New certificate chemistry by Osei Yaw Ababio

WEEK ACTIVITY

Write out at least five economic importance of petroleum from the internet.

WEEK 5

TOPIC: METALS AND THEIR COMPOUNDS

CONTENT:

1. **Relative abundance and chemical characteristics of metals**
2. **Compounds of metals and principles of extraction of metals**
3. **The alkaline metals (general properties) sodium**

SUB TOPIC: Relative Abundance of metals and chemical characteristics

Relative Abundance

Metals are widely distributed in the earth's crust either as compounds or in the free metallic form. More than 80 of the known elements are metals except for metals like silver, gold, and platinum, most metals are not found free in nature. They are rather too reactive to exist as free elements. They are more often found as compounds in the form of ores. These ores can exist either as the oxides, hydroxides, trioxocarbonates, sulphates, sulphides, chlorides or nitrate of the metals. Some of the metals are also found in the form of solutions because their stable compounds are stable.

The very reactive metals for example sodium and potassium usually found combined with other elements. For example they are found as chlorides or carbonates which are very stable compounds. Moderately reactive metals, such as zinc and lead, are usually found as oxides or sulphide while the least reactive metals are usually found in un combined state, for example, gold which is found almost entirely as the free metals.

CHEMICAL CHARACTERISTICS OF METALS

a. When metals react, they ionize by loss of electrons to form cations such as Na+, Ca^2+ and Al^{3+}, hence they are reducing agents.

b. A metal reacts with oxygen to form one or more oxides e.g Na_2O, MgO, FeO, Fe_2O_3, Fe_3O_4, CuO, Cu_2O etc. Oxides of metals are generally basic.

c. Metals react with dilute mineral acids, such as Hcl and H_2SO_4, to liberate hydrogen (except metals that are below hydrogen in the reactivity series. $Zn(s) + H_2SO_4 \longrightarrow Zn\ SO_{4(aq)} + H_2$

d. They form electrovalent (ionic) compounds with non-metals such as chlorine. $Ca(s) + Cl_2(g) \longrightarrow CaCl_{2(s)}$

Activity Series of Metals

The reactivity of a metal depends on the ease with which its atoms lose electrons; the ease varies from one metal to another. When common metals are arranged in the order of their ability to lose electrons and act as reducing agents, the activity series is obtained.

K	
Na	
Ca	Very Reactive
Mg	
Al	
Zn	
Fe	
Sn	Moderately Reactive
Pb	
(H)	
Cu	
Hg	
Ag	Least Reactive
Pt	
Au	Least reactive (weakest reducing agent)

Of all the metals listed above, potassium K is the most electro positive and hence the strongest reducing agent, white fold, an is the weakest.

The activity series arranges the metals in the order of their ability to react and displace the ions of one another from the solutions of their salts. Generally a metal higher up in the series will displace the ions of metals lower down the series from the solutions of their salts. For instance Zn metal will displace or replace ions of copper in a solution of a copper II salt.

$$Zn(s) + CuSO_{4\ (aq)} \longrightarrow Cu(s) + ZnSO_{4(aq)}$$

EVALUATION

1. What name is given to the arrangement of metals in order of their ability to lose electrons?
2. From the periodic table, write out 30 elements that are metals.
3. Arrange the following metals in order of increasing reactivity Pb, Al, Sn, Q, Au, and Mg.

SUB TOPIC 2: Compounds of Metals and Principles of Extracting of Metals

Metals form different compounds such as oxides, hydroxides, trioxocarbonates(iv), trioxonitrates(v), chloride and sulphides.

Principles of Extraction of Metals

The method of extraction of metals from its ore depends on the metals reactivity. The reactivity of a metal depends on its readiness to lose electrons since they react by forming positivity charged ion. Very reactive metals such as sodium, calcium and aluminium are extracted by electrolysis.

Use table 3.3 Melrose chemistry page 21 as a guide.

Other metals down the activity series are not so strongly electropositive and their compounds are not stable. They can be extracted from their ores by reduction with coke or carbon few metals e.g. gold occurs freely in nature.

Various methods used in the extraction of metals electrolysis – this is a reduction and oxidation process that is often used for the extraction of very strongly electropositive metals (Na, K Q, Mg).

During electrolysis, metallic ions from the electrolytic solution are deposited as atoms on the cathode by accepting electrons from the cathode.

Reduction of oxides: This is basically a reduction process. These metals exist in their ores as metallic ions which must take up the required number of atoms. This method is used for the extraction of less electropositive metals occur as oxides (Fe_2O_3, Fe_3O_4, SnO_2) and are extracted by the reduction of these oxides with coke or carbon II oxides.

$Zn^{2+} O^{2-} + C \longrightarrow Zn + CO$

$(Zn^{2+} + e- \longrightarrow Zn)$

$ZnO + C \longrightarrow Zn(s) + CO(g)$

$(Fe^{3+})_2^S (O^{2-})_3 + 3CO \longrightarrow 2Fe + 3CO_2$

Reduction of Sulphides

Some of the less electropositive metals e.g. lead occurs as sulphides e.g Feline (Pbs), the sulphide is roasted in air to convert it to the oxide which is reduced to metallic lead by heating with coke in a blast furnace.

$2Ps(s) + 3O_2(s) \longrightarrow 2PbO(s) + 2SO_2(g)$

$2PbO(s) + C(s) \longrightarrow 2P(s) + CO_2(g)$

Reduction of Chlorides

Some metals especially alkaline metals are formed as chlorides with their ores (Na^+CL^-) and are extracted by electrolysis of the chlorides. Sodium collect at the cathode which supplies the electrons, chlorine is formed at the anode.

$NaCl \longrightarrow Na^+ + Cl^-$

At the Anode:

$Na^+ + e^- \longrightarrow Na$

At the Cathode

$Cl^- - e \longrightarrow Cl_2$

EVALUATION

1. Give two methods of extraction of metals.
2. Explain any of the methods.

SUB TOPIC 3: (ALKALINE METALS (GENERAL PROPERTIES)

There is group 1 element: All except Hydrogen are metals. The following are their general properties.

1. They have one electron on their valence shall, hence they ionize to form univalent position ion $M \longrightarrow M^+ + e$
2. They are reducing agents
3. They tend to be soft and light with relatively 100 melting points.
4. First ionization energy decreases down the group.
5. They all burn in air with characteristics flame colours which are used to identify them.
6. They react with water to form alkaline hence the name alkaline metals sodium react vigorously, potassium vigorously and lithium readily.

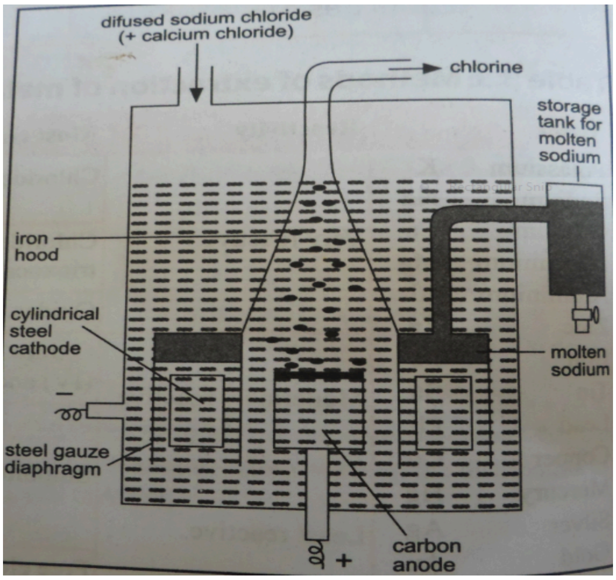
SODIUM (Na)

This is the second member of the group I metals. It is very reactive and hence not found free in nature. Sodium occurs in sea water, as chloride, bromide or iodide i.e NaCl, NaBr, NaI.

It occurs as rock salt, NaCl in deposits. Sodium trioxonitrate(v) $NaNo_3$ is found abundantly in Chile and often called chile salt. It is also found in clay soil as complex trioxosilicate(iv)

EXTRACTION OF SODIUM

Sodium is extracted (in commercial quantity) from fused sodiumchloride by electrolysis. The electrolytic cell used is called down cell as shown below:



The anode is a graphite rod, while cathode is a steel cylinder round the anode together with the electrolyte are contained in a regular steel tank lined inside with fine bricks. The electrolyte i.e. fused sodium chloride with melting point 80 1^{0}C is kept melting in the cell by electrical heating. The melting point of sodium chloride can be reduced to about 600^{0}C by adding calcium chloride. A cylindrical steel gauze separates the cathode and the anode so that sodium and chloride which are the products of electrolysis can be obtained separately.

At the Cathode

Na^+ ions takes up an electron each and are reduced to metallic sodium

$Na^+ + e^- \longrightarrow Na$

At the Anode

Cl- ions release an electron each and gets oxidized to atomic chlorine which pair up to form chlorine gas molecules.

$Cl^- \longrightarrow Cl + e^-$

$Cl^- + Cl^- \longrightarrow Cl_2$

$2Na + 2Cl^- \longrightarrow 2Na(s) + Cl_2(g)$

Physical Properties of Sodium

1. It is a silvery metallic solid
2. Relative density is 0.98, it therefore floats on water.
3. It is soft and very malleable
4. Melting point is rather low for a metal (97^{0}C)
5. It is a good heat and electricity.

Chemical Properties

1. With Air: Sodium tarnishes readily and gets oxide by air to form sodium oxide.

$4Na(s) + O_2 \longrightarrow 2Na_2O$

The sodium oxide reacts with water vapour in air to form sodium hydroxide

$Na_2O(s) + H_2O(g) \longrightarrow 2NaOH(aq)$

NaOH(aq) slowly absorbs carbon (iv) oxide (CO_2)

In the atmosphere to form crystals of hydrated sodium trioxocarbonate(iv)

$2NaOH(aq) + Co_2(g) \longrightarrow Na_2Co_3 + H_2O_{(L)}$

Due to this great affinity of sodium for atmospheric gases it is always stored in a paraffin oil, toluene or naphtha.

If heated in air, sodium burst with golden yellow flame to form Na_2O_2 (sodium peroxide) and Na2O (sodium oxide) in limited supply of air and oxygen

$2Na(s) + O_{2(g)} \longrightarrow Na_2O_2(s)$

$4Na(s) + O_{2(g)} \longrightarrow 2Na_2O_2$

2. With Water:

Sodium reacts silently with cold water releasing a lot of heat. It darts in water and melts to a silvery bell because of the heat liberated.

$2Na(s) + 2H_2O_{(L)} \longrightarrow 2NaOH(aq) + H_2(g)$

3. With non – Metals

Sodium reacts on heating with hydrogen, halogens, sulphur, phosphorous and most other non-metals except boron, carbon and nitrogen

$2Na(s) + H(g) \longrightarrow 2NaOH(s)$

$3Na(s) + P \longrightarrow Na_3P(s)$

$2Na(s) + S(s) \longrightarrow Na_2S(s)$

$2Na(s) + Cl_2 \longrightarrow 2NaCl(s)$

It dissolves in mercury to give sodium amalgam

$Na(s) + H(g) \longrightarrow NaH(g)$

4. With Acid

Sodium reacts explosively with dilute acids to form hydrogen and salt (dangerous reaction should not be carried out in the laboratory)

$2Na(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H2(aq)$

5. With Ammonia

Sodium reacts with ammonia to form sodium and hydrogen

$2Na(s) + 2NH_3(aq) \longrightarrow 2NaNH_2(s) + H_2(g)$

Test for Sodium

Flame test: compounds containing sodium ions burn with a golden yellow flame in non-luminous flame.

Uses of sodium

1. Sodium is used in manufacturing compounds like sodium peroxide, sodium cyanide, sodium as well as lead (iv) tetraethyl which is an anti-knock agent in petrol.
2. Liquid sodium is used as coolant in nuclear reactors
3. Mixtures of sodium amalgam and water or sodium and ethanol are useful reducing agents in organic chemistry. Sodium is used in reducing titanium tetrachloride to a metal in the extraction of titanium.
4. Sodium vapour lamps are used in lighting highways and airports because they give bright orange yellow light.

EVALUATION

1. Enumerate the general properties of alkaline metals
2. Briefly explain the extraction of sodium metal.

GENERAL EVALUATION
OBJECTIVE TEST:

1. Most reactive metals are extracted from their ore through electrolysis except (a) Na (b) Ca (c) Al (d) Mg.
2. Group 1 metals are good reducing agents becomes (a) they are soft (b) they are light (c) they easily form unipositive ions (d) they have low melting points.
3. In down's cell used for the extraction of sodium metal, the anode and the cathode are screened with gauze diagram in order to: (a) obtain screened products (b) obtain chop products (c) separate the products from reacting (d) obey conventional rule electrolysis
4. Which of the components is not an alkali? (a) sodium hydroxide (b) aqueous ammonia (c) magnesium hydroxide (d) potassium hydroxide (e) none of the above.
5. Metals react with oxygen to form any of these oxide except (a) acidic oxides (b)basic oxides (c) peroxides (d) amphoteric oxides

ESSAY TEST:

1. (a) Discuss the reasons why some metals occur as free elements in nature while others occur in combined forms. Give two examples each type.
2. Draw the electrolytic cell for the extraction of sodium from sodiumchloride
3. Describe and explain the reactions take place at the electrodes.
4. How is metallic sodium usually stored? Explain why it is thus store.
5. Outline the uses of sodium.

WEEKEND ASSIGNMENT

Read about compounds of sodium

PRE-READING ASSIGNMENT

Read about Alkali earth metals.

WEEKEND ACTIVITY

Highlight all the compounds of sodium and discuss the uses of any two of them.

WEEK 6

TOPIC: METALS AND THEIR COMPOUNDS

CONTENT:

1. **The alkali: earth metals {general properties} and calcium-extraction of calcium, properties of calcium and calcium compound and uses of calcium.**
2. **Aluminium-extraction of aluminium and uses of aluminium, Tin extraction of tin and use of tin.**
3. **Transition metals-properties of transition metals, {the first transition series only}, copper- extraction of copper, and uses of copper.**

SUB-TOPIC 1: The alkali earth metals

The group 2 elements are all metals. They are known as the alkaline earth metals and include magnesium, calcium, strontium and barium. The alkaline earth metals are reactive but less than the alkali metals.

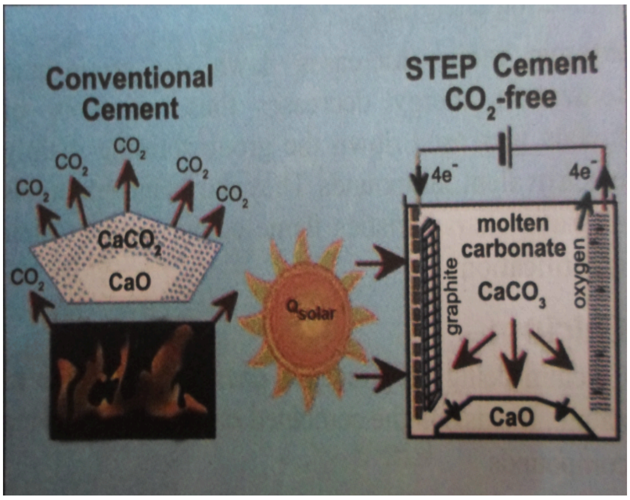
CALCIUM

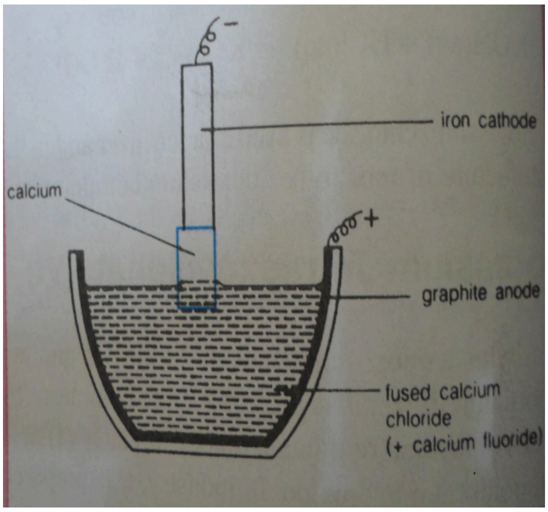
Calcium is too reactive to occur as free metals in nature. Instead it occurs abundantly in the state as Calcium trioxocabonate (iv) ($CaCo_3$), in limestone marble, chalk, aragonite, calcite and coral; as calciumtetraoxosulphate (vi) ($CaSo_4$) in gympsum and anhydrite, as dilute trioxocarbonate (iv) $CaCO_3$. $MgCO_3$. In dilute dolomite; as calcium fluoride CaF_2, in fluorspar and as various trioxosilicates (iv). Bones and teeth contain calcium tetraoxo-sulphate (v).

Extraction of calcium;

Since calcium compounds are very stable, metallic calcium is commonly extracted electronically from fused calcium chloride, a fluoride is usually added to the fused calcium chloride to lower the melting point from 850ºc to about 650ºc. The mixture is place in a crucible, lined on the inside with graphite which serves as the anode of the cell. The cathode consists of an iron rod which just touches the surface of the electrolyte. As electrolysis proceeds, metallic calcium collects on the cathode which is gradually reused so that an irregular st of calcium is formed on it.

Chlorine is liberated at the anode.





Chemistry of the reaction: Fused calcium chloride consists of calcium and chloride ions.

At the cathode: the calcium ions receive two electrons each to become reduced to the metal.

$Ca^{2+} + 2e \longrightarrow Ca$ [Reduction]

At the anode: two chloride ions give up an electron each to become atomic chloride. The two atoms the combine to become liberated as a gaseous molecule

$Cl^- \longrightarrow Cl + e^-$ (oxidation)

$Cl + Cl \longrightarrow Cl_2$

Overall electrolytic reaction:

$Ca^{2+}_{(l)} + 2Cl^- \longrightarrow Ca_{(s)} + Cl_{2(g)}$

PHYSICAL PROPERTIES

Appearance	Silvery-grey solid
Relative density	1.55
Malleability and ductility	Malleable and ductile
Tensile strength	Relatively low tensile strength
Melting point	85.1^{0}C
Conductivity	Good conductor of heat and electricity.

CHEMICAL PROPERTIES

Reaction with air: calcium is a very electropositive and reactive metal. On exposure to air, it rapidly tarnishes and loses its metallic lustre due to the formation of a white film of calcium oxide or quick lime on the surface of the metal. In the presence of atmospheric moisture and carbon (IV) oxide, some calcium hydroxide and calcium-trioxocarbonate (IV) may also be formed.

When calcium is heated in air, it burn with a brick-red flame calcium oxide.

$2Ca_{(s)} + O_{(g)} \longrightarrow 2Ca_{(s)}$

$CaO_{(s)} + H_2O \longrightarrow Ca(OH)_{2(g)}$

TEST FOR CALCIUM IONS

Flame test: calcium compound give an orange-red colour to a non-luminous flame. And produce brick-red flame which appears green if through a blue glass.

Note: Barium gives a pale green flame while strontium gives a bright red flame.

2. with dilute hydroxide: And a few drops of sodium hydroxide solution to a solution of unknown salt. The formation of white precipitate, which is insoluble in excess sodium hydroxide, indicates the presence of sodium hydroxide ions.

$2NaOH_{(aq)} + Ca^{2+} \longrightarrow Ca(OH)_{2(s)} + 2Na_{(aq)}$

With ammonium ethandioate: add a solution of ammonium ethandioate to a solution of the unknown salt. The formation of a white precipitate, which is soluble in dilute hydrochloric acid but insoluble in ethanoic acid, indicates the presence of calcium ions,

$(NH_4)_2C_2O_4 + Ca^{2+}_{(aq)} \longrightarrow CaC_2O_{4(s)} + 2NH_{4(aq).}$

Ammoniumtrioxocarbonate (iv) may be used instead of using ammoniumethandioate i.e.

$(NH_4)_2CO_{3(aq)} + Ca^{2+}_{(aq)} \longrightarrow CaCO_{3(s)} + 2HN^{+}_{4(aq)}$

Note: Barium and strontium salt undergo similar reactions with ammonium ethandioate and ammonium trioxocarbonate (iv)

USES OF CALCIUM

(a) It is used as oxidant in still casting and copper alloys.

(b) It is used in the manufacture of calcium fluoride.
(c) It is used in the extraction uranium.

EVALUATION

1. List the physical properties of calcium.
2. Outline the general properties of alkaline earth metals.
3. Discuss the chemical properties of calcium.

READING ASSIGNMENT

Read about compounds of calcium.

SUB-TOPIC 2: Aluminium and Tin

Aluminium- This is the third most plentiful element in the earth crust, being found abundantly as trioxosilicate (iv) in rocks and clays.

The main source of aluminium is the mineral called banxite, $Al_2O_3.2H_2O$. other important mineral includes:

Kaolin $Al_2O_3 . 2SiO_2 . 2H_2O$

Cryolite $NaAlF_6$

Corunculum, $K_2O, Al_2O_{3,} 6SiO_2$

Extraction of Aluminium

Aluminium is electrolysis of bauxite [$Al_2O_3.2H_2O$]. Two stages are involved in the extraction.

1. Purification of bauxite: This involves heating the bauxite with NaOH solution (caustic soda) sodium aluminate (III) NaAl(OH) which is soluble.
   $Al_2O_{3(s)} + 2NaOH + 3H_2O \longrightarrow NaAl(OH)_{4(aq)}$
   The ore impurities e.g. Iron III oxide, trioxosilicate (iv) can be filtered off as a sludge since they neither soluble nor react with NaOH.
   Precipitation of hydroxide is made possible by feeding the filtrate with aluminium hydroxide cyotels.
   $NaAl(OH)_{4(aq)} \longrightarrow Al(OH)_{3(s)} + NaOH_{(aq)}$
   $Al(OH)_3$ crystals is filtered OH . Washed dried and heated strongly to give pure aluminium oxide Al_2O_3 (aluminium). The NaOH left is concentrated and reused.

2. Electrolysis of aluminium (Al_2O_3): An iron container line with graphite (which serves as cathode) and graphite rods dipping into the electrolyte (serving as anode) constitutes the electrolytic cell. A solution of pure alumina in molten cryolite by $NaAlF_6$ is the

electrolyte. Temperature of about 950°c maintain by the electrolyte is made possible by the heating effect of the large current supplied making the process very expensive. Oxygen is given off at the anode which in turn burns away gradually as carbon (iv) oxide (CO_2) hence the anode is replaced continuously during the process; increasing the cost.

Aluminium (molten form) which settles at the bottom of the cell is collected at intervals.

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REACTION

At cathode

$Al^{3+} + 3e^- \longrightarrow Al$ (reduction)

At anode

$O^{2-} \longrightarrow O + 2e^-$

$O + O \longrightarrow O_2$

Overall reaction

$4Al^{3+} + 6O^{2-} \longrightarrow 4Al_{(S)} + 3O_{2(g)}$

Physical properties

Appearance	Silvery white solid
Relative density	2-7 (100)
Malleability and ductility	Very malleable and ductile. Can roll into foil
Tensile strength	Moderate but high in alloys
Melting point	660°c
Conductivity	Very poor conductor of heat and electricity.

CHEMICAL PROPERTIES

1. Reaction with air

   When a piece of aluminium sheet is expose to moist air, a thin, continuous coating of aluminium oxide is formed which present further attack of the metal by atmospheric oxygen and water or steam under normal conditions. Aluminium sheets are said to be corrosion free. If the aluminium sheet is heated to 800°c and above, the remaining aluminium metal will react with air to form aluminium oxide, Al_2O_3 and the aluminium nitrite, Al

   $4Al_{(s)} + 3O_{2(g)} \longrightarrow 2Al_2O_{3(s)}$

$2Al_{(s)} + N_{2(s)} + \longrightarrow 2AlN_{(s)}$

2. Reaction with non-metal: Heated aluminium combines directly with the halogen, sulphur, nitrogen, phosphorus and carbon, with the evolution of heat.

   For example

   $2Al_{(s)} + 3Cl_{2(s)} \longrightarrow 2AlCl_{3(s)}$

3. Reaction with acid: Aluminium reacts slowly with dilute hydrochloric acid but more rapidly with the concentrated acid to displace hydrogen.

   $2Al_{(s)} + 6HCl_{(aq)} \longrightarrow 2AlCl_{3\,(aq)} + 3H_{2\,(g)}$

   Aluminium does not react with trioxosulphatate (vi) acid, However, the hot concentrated acid oxidizes it to liberate sulphate (iv) oxide.

   $2Al_{(s)} + 6H_2SO_4 \longrightarrow Al_2(SO_4)_{3(aq)} + 6H_2O_{(L)} + 3SO_{2(s)}$

   Aluminium does not react with trioxonitrare (v) acid at any concentration due to the formation of protective layer of aluminium oxide. As a result, aluminium containers are frequently used to transport the acid.

4. Reaction with alkali- Aluminium dissolves in both sodium and potassium hydroxides to form a soluble aluminate (III) with evolution of hydrogen. For example

   $2Al_{(s)} + 2NaOH_{(aq)} + 6H_2O \longrightarrow 2NaAl[OH]_{4(aq)} + 3H_{2(g).}$

   Thus, washing soda is never used to clean aluminium vessel

REACTION WITH IRON III OXIDE

Aluminium reduces iron III oxide to molten iron. This is the reaction used in the thermal process.

$2Al_{(s)} + fe_2O_{3(s)} \longrightarrow Al_2O_{3(S)} + 2fe_{(s)}$

With aqueous ammonia: Acid a few drops of aqueous ammonium to the unknown salt solution. The formation of white gelatinous precipitate which is insoluble ib aqueous ammonia confirms the presence of aluminium ions.

$Al^{3+}_{(aq)} + 3OH^-_{(aq)} \longrightarrow Al(OH)_{3(s)}$

Note: lead II and zinc salt give similar reactions. However, lead II salt gives a white precipitate with concentrated hydrocloric acid, white aluminium salt do not. Zinc salt gives a white precipitate with but then precipitate with aqueous ammonia but the precipitate dissolves in an excess of the reagent.

USES OF ALUMINIUM

Aluminium is used:

1. As an alloy such as duralumin (a mixture of Al, Cu, Mg and Mn) aluminium bronze (a mixture of Cu, Al). These alloys are used in cars, ships, air craft and moving parts of machine. Duralumin is used in the construction of aircraft due to its light weight.
2. For cooking utensils
3. In manufacturing electrical cables
4. As a component of paint and
5. In making foils for packing.

Reading Assignment: Read about components of aluminium

TIN

Tin does not occur naturally as free element, the main source is the mineral cassiterite or tinstone. SnO_2.
Tin stone is found in Malaysia, Indonesia and Bolivia. In Nigeria, tin was mined in jos plateau in 1903 Nigeria is the current largest producer of tin and is present exporting most of the 13000 tonnes produced yearly.

EXTRACTION OF TIN

The stages involved in the extraction of tin are as follows

1. The ore SnO_2 is first concentrated by crushing and washing with water.
2. Impurities like volatile oxides, sulphur, arsenic and antimony are removed by roasting the concentrated ore in air.
3. The molten tin is impure and, can be refined to about 99.9% purity by heating gently it on a sloping surface. The impurities which are exposed to air as molten tin flows are converted to oxides left behind as a scum.

PHYSICAL PROPERTIES

Appearance	Silvery-white solid with lustre
Relative density	Varies for different allotropes
Malleability	Very malleable metal soft enough to be cut with knife
Ductility	Not ductile enough to be drawn into wires
Tensile strength	Fairly strong
Melting point	232°c
Conductivity	Good conductor of heat and electricity.

Tin exists in three allotropic forms, which have different densities. At room temperature, tin exists as white tin.

Grey tin $\xrightarrow{13.2^0C}$ white tin $\xrightarrow{13.2^0C}$ rhombic tin

CHEMICAL PROPERTIES

1. Reaction with oxygen: Tin is reactive and only combines with oxygen above 1200°C. it does not combine with nitrogen and carbon.
   $Sn_{(s)} + O_2 \longrightarrow SnO_{2(s)}$
   Reaction with non-metals: Tin combines chlorine when heated to give tin(iv)chlorine
   $Sn_{(s)} + 2Cl_{2(g)} \longrightarrow Sn\ Cl_{4(s)}$
   Reaction with acids: Tin reacts slowly with dilute hydrochloric acid rapidly with the concentrated acid give tin (ii)chloride
   $Sn_{(s)} + 2HCl_{2(aq)} \longrightarrow Sn\ Cl_{2(s)} + H_{2(g)}$

With dilute tetraoxoculphate(vi) acid hardly any reaction is observed, but with the hot concentrated acid, sulphate(iv) oxide is evolved

$Sn_{(s)} + 2H_2SO_{4(aq)} \longrightarrow Sn\ SO_{4(aq)} + SO_{2(g)} + 2H_2O_{(g)}$

The reaction of tin with trioxonitrate(v) acid depends on the concentration and temperature of the acid.

Reaction with alkalins: Tin dissolves in concentrated solution of alkalis to give trioxostannate(iv) salts and hydrogen.

$Sn_{(s)} + 2NaOH_{4(L)} + H2O_{(L)} \longrightarrow Na_2SO_{3(aq)} + 2H_{2(g)}$

Uses of Tin

This is used

(a) In alloys and (b) to present iron from corrosion.

SUBTOPIC 3: TRANSITION METALS

Transition metals are between groups 2 and 3 on the periodic table. They occupy 3 rows i.e. period 4 to period 6. There are 10 elements in each row. They are also called the block elements because they occupy the block on the periodic table.

The first transition series ranges from scandium to zinc. They are ten in number and their atoms have 1 or 2 elections in the 4s. They all have partially filled 3d-block orbital's which accounts for their special properties zinc (Zn) and copper (Cu) have completely filled 3-d orbits and Sc^{3+} ions does not.

1st Transition series	Sc	Ti	V	Cr	Mu	Fe	Co	Ni	Cu	Zn
Number of d electron	1	2	3	4	5	6	7	8	10	10

Physical Properties

They are all metals with high densities, high melting points, high tensile strength and sonority. Mercury Hg is of the 3rd transition series. It is a liquid at room temperature. The properties above are due to the strong metallic bonds existing between the atoms of transition metals. The 45 electrons and 3d electrons provided strong bonding in the atoms. Atomic size of transition metals is smaller than those of the s-block elements because though both S and D block elements have same number of shells.

Element	K, Q, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zu	
Property	s-block	→ d-block ←
Atomic Number	19, 20	21, 22, 23, 24, 25, 26, 27, 28, 29, 30

Relative atomic mass	391.40.1	47.9
Melting point ^{0}C	63.5, 8.50	
Boiling point ^{0}C	77.5,14.90	
Density/gcm^{-3}	0.86, 1.55	
Colour of M^{2+} (in solution)		
Valences commonest in bond	+1, +2	
Atomic radius /mm	0.27, 0.17	
Ionic radius/mm		
M+	0.130	
M^{2+}	0.0094	
M^{3+}		

Chemical Properties

Transition metals have the following characteristic properties

1. Variable Valency: Transition metals exhibit more than one valency or oxidation states. Some of them are having up to 3 different oxidation states. This is due to the electrons in the d-orbital which are available for bond formation. E.g chromium has atomic number 24. Its electronic configuration is $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $3d^5$, $4s^2$. It can therefore form +6 oxidation state by losing one 4s and fire 3d electron as in K_2,Cr_2, O and +3 oxidation state by losing one 4s and two 3d electron as in Cr_2 O_3. Also, the atomic number of manganese is 25 and its electronic configuration $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $3d^5$, $4s^2$.

a. +2 oxidation state as in MnO by losing two 4s electrons.
b. +4s and two 3d electrons.
c. +6 oxidation state as in MnO_4^{2-} by losing two 4s and four 3d electrons.
d. +7 oxidation state as MnO_4^- by losing two 4s and five 3d electrons.

2. Para Magnetism

Substances that are weakly repelled from a strong magnetic field are called diamagnetic substances while those weakly attracted to it are called paramagnetic substance. Ferromagnetic substances have very great force of attraction for magnetic field. E.g. Iron, cobalt, and nickel. Most transition metals are paramagnetic due to the unpaired electrons in the atom, molecule or ion of the metals. The number of unpaired electrons determines the intensity of this effect.

3. Catalytic – activity: Catalysts are found among transition elements as nickel, iron, platinum, chromium and manganese. The presence of the valence electrons and d-orbital in atoms of transition metals make them appreciate catalysts.

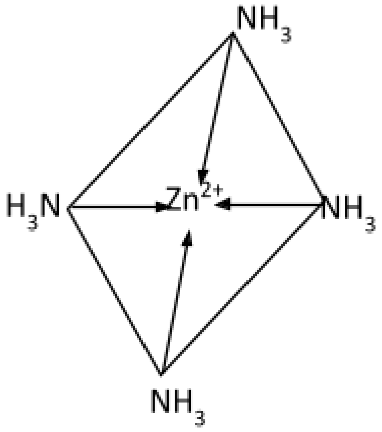
4. Complex ion formation

Transition metals have an outstanding ability to form complex ions. A complex ion has a central position ion linked to several other atoms, ions, or molecules called liquids. The bonding between the central metal ion and the liquids may be either predominantly electrovalent or co-ordinates.

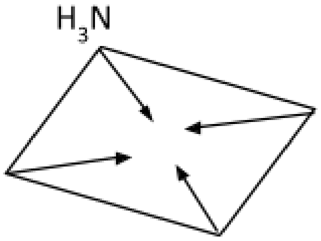
An example of a complex ion is the blue tetrammine copper(ii)ion. $\{Cu(NH_3)_4\}^{2+}$ in which the central copper(ii)ion is linked by co-ordinate bonding to four ammonia molecules.

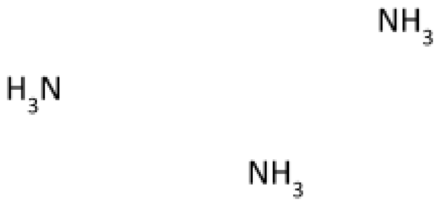
Transition metal complexion has six liquids, the liquids are arranged octahedrally around the central metal ion as in the case of hexacyanforate(iii)ion $[Fe(Cn)_6]^{3-}$ when four liquids are present, they may be arranged tetrahedrally.

Examples of Complex ion



Tetramine ZincII ion





TetraminecopperIIion

The electrons donated by the liquids usually up the incomplete D-orbital and the 4s and 4p orbital. All transition metal ions tend to from complex ions with water.

5. Colour of transition metal ion

Transition metallic ions are usually coloured which serve as a useful guide in identifying a compound. The colours are associated with partially filled 3d orbital. Zinc and scandium ion are colourless since they do not have partially filled 3d orbital.

6. Chemical Reactivity: Transition metals are moderately reactive. The reactivity decreases across the series because of the corresponding increase in values of their ionisation energy.

Chemical properties of transition ionisation Energy: Chemical properties of transition metals does not vary from left to right as in the s-block and p-block element because electrons are added to the inner d-orbitals not the outermost orbital as in s and p block elements.

Copper (Cu)

Copper is one of the transition series. It is relatively uncreative, like silver and gold it is also called noble metals. It is found as a free metal in some places due to stability in air. The major source of copper is copper pyrites, $CuFeS_2$, other compounds of copper are Cu_2O cuprite, malachite $CuCO_3$ $Cu(OH)_2$

Extraction of Copper

Copper is extracted from any of its sulphide ores e.g copper pyrite, $CuFeS_2$. The extraction procedures are as follows:

1. The ore is first concentrated by floatation and then roasted in a limited supply of air. The iron and some of the sulphur in the ore are oxidised to iron(ii)oxide and sulphur(iv)oxide respectively
   $CuFeS_{2(s)} + 4O_{2(s)} \longrightarrow Cu_{2(s)} + 2FeO_{(g)}\ 3SO_{2(g)}$
2. After adding silicon(iv)oxide (SiO_2) to the mixture, it is heated in the absence of air and the iron(ii) concentrated to iron(ii) trioxosulphate(iv) which floats on copper(i) sulphate as slag and is removed.
   $FeO_{(s)} + SiO_{(s)} \longrightarrow FeSiO_{3(s)}$
3. Copper(i)sulphide is left and it is heated in controlled quantity of air to produce copper which is about 97-99% pure.
   $CuS_{2(s)} + O_{2(g)} \longrightarrow 2Cu_{(s)} + SiO_{(g)}$

The copper can be further purified (to 99.95% purity) by electrolysis whereby the impure copper is made anode and pure copper is made cathode while copperIItetraoxosulphate(vi) solution is the electrolyte. Metallic copper (the anode) ionises and migrate to the cathode accepts electrons and get deposited on the cathode. Impurity like silver and gold are collected as anode slime.

Physical Properties

1. It is a soft, red solid with metallic lustre with relative density 8.95 and melting point 1080^0C
2. It is very malleable and ductile with excellent heat and electrical conductivity.

Chemical Properties

1. Copper is stable in pure air but copper reacts with moist air and gradually gets covered with green coating of basic copper(ii)tetraoxosulphate(vi), $CuSO_4$ 3Cu $(OH)_2$ and trioxocarbonate(iv). If exposed to moist sea air a coating of basic chloride is formed. Copper is readily oxidised to block copper(ii)oxide if heated with air.
   $2Cu(s) + O_{2(s)} \longrightarrow 2CuO_{(L)}$
2. Copper does not displace hydrogen from dilute acids because it is lower than hydrogen in the electro chemical series. It neither react with dilute hydrogenchloride or tertaoxosulphate(vi)acid but with hot concentrated H_2SO_4 sulphur(iv) is liberated
   $Cu_{(s)} + 2H2SO4_{(g)} \longrightarrow CuSO_{4(aq)} + 2H_2O_{(L)} + SO_{2(s)}$
   With dilute trioxonitrate(v)acid (HNO_3), nitrogenIIoxide (No) is given OH and nitrogen(iv)oxide NO_2 is liberated with hot concentrated HNO_3
   $3Cu(s) + 8HNO_{3(aq)} \longrightarrow 3Cu(NO_3)_{(aq)} + 4H_2O + 2NO_{(s)}$
   $Cu(s) + 4HNO_{3(aq)} \longrightarrow Cu(NO_3)_{2(aq)} + 2H_2O + 2NO_{(s)}$
3. Most metals displace copper from solution of its salts because it is almost at the base of the activity series.
4. It is used in making alloys like bronze (Cu and $Su)_2$ brass (Cu, Zu) and cupronickel (CuN)
5. Copper is used in making cooking utensils and colorimeters.

EVALUATION

1. Explain briefly paramagnetic and diamagnetic substance.
2. Outline the chemical properties of copper.
3. What are transition metals?

TEST FOR COPPER (I) ION

1. Flame Test: Cu_2^+, salts give a characteristics bluish colour to a non-luminous flame.

2. Copper (i) ions give blue precipitate of copper(ii)hydroxyle chloride dissolves in excess aqueous ammonia to give a deep blue solution on addition of a few drops of aqueous ammonia to the solution of the unknown compound.
   $Cu_2^+(aq) + 2OH-(aq) \longrightarrow Cu(OH)_{2(s)} + 2Na+(aq)$
   $Cu(OH)_{2(s)} + 4NH^+_4 + 4OH-(aq) \longrightarrow Cu(NH_3)_{(aq)} + 2OH-(aq) + 4H_2O_{(L)}$
3. On addition of few drops of sodium hydroxide solution to the Cu^{2+} salt solution a blue gelatinous precipitation insoluble in excess sodium hydroxide is formed.
   $Cu^{2+}(aq) + 2NaOH(aq) \longrightarrow Cu(OH)_{2(s)} + 2Na+(aq)$

USES OF COPPER

1. Copper has the best electrical condition properties after silver. It is used for making electric wires because of its excellent ductility.
2. It is used in plumbing and roofing and also in other metal works due to its attractiveness.

GENERAL EVALUATION

OBJECTIVE TEST:

1. In the extraction of calcium, some calcium fluoride is introduced to (a) obtain pure products (b) stabilize the electrodes (c) check the calcium from reacting with chloride (d) act as a temperature depressant.
2. Calcium react directly with nitrogen to form (a)Ca_3 (b) Ca_2N_3 (c) Ca_3N_2 (d) Ca_3N
3. Orbitals acquire special stability when they (a) contain a single election (b) they contain two electrons in their entire orbits (c)they are simply or doubly filled (d) have a vacant orbital.
4. The following are characteristics of the transition metals with the exception of :
   (a) Variable oxidation states
   (b) Coloured ions
   (c) Complex ion formation
   (d) High tendency to cote note.

5. Unreactive nature of copper is as a result of having.
   (a) Partly filled orbitals
   (b) Partly filled orbitals and contains some inert impurities
   (c) Completely filled 3 d orbitals
   (d) A low position in the ECS

ESSAY QUESTIONS

1. Describe the essential features of transition metals and their compounds. Using examples from the first transition series.
2. The oxidation number of copper with compounds is either +1 or +2. Give the name and formula of a compound in which copper has
   - (i) +1 oxidation state
   - (ii) +2 oxidation state
3. What are alloys? Explain why alloys are usually used in preference to the pure metals (b) Give the composition and uses of the following. (i) duraln min (ii) soft solder (iii) Type metal
4. (a) what is the main source of aluminium is nature

(b) using a diagram and equations, explain how pure aluminium is extracted from the above source

(i) state the use of the following

(ii) sodium hydroxide (NaOH)

(iii) Calcium dioxide ($Ca(OH)_2$)
(iv) Tin (Su)

WEEKEND ASSIGNMET

Read about Compounds of calcium (reference text Ababio page 458 – 450)

WEEKEND ACTIVITY

Write short note on $CaCO_3$ and $Ca(OH)_2$

WEEK 7

TOPIC: IRON

CONTENT:

1. **EXTRACTION**
2. **TYPES AND USES**
3. **RUSTING OF IRON AND METHODS OF PREVENTION**

IRON

Iron is a 3-d, block metal and transmission element with atomic number 26. It has the symbol F_e with electronic configuration of 2,8,8,8. Iron is the second most abundant metal found in the earth crust. It is often found as iron ore. Examples include haematite (F_e O_4) the commonness magnetite (F_e O_4), pyrites (F_e S_3) , spathic or siderite iron ore ($Fe\ CO_3$), limonite (FeO_3. H_2O). It is present as trioxosilicates (iv) in clay soils. It is found in animal haemoglobin and plant chlorophyll. It can be found in Nigeria Anambra, Kogi and Edo state.

SUB TOPIC 1: EXTRACTION

Iron ore is first roasted in air in a steel blast furnace so that iron(III) oxide is produced. The iron (III) oxide is then mixed with coke and limestone and heated to a very high temperature in the furnace. The ingredients are loaded into the furnace from the top while a blast of hot air is introduced from the bottom to the top through small pipes. The temperature inside the furnace varies from about 2000^0C near the bottom to about 200^0C at the top.

(a) The oxygen in the hot air moving up oxides the hot coke coming down to Carbon(iv) oxide

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

(b) The $CO_{2(g)}$ is forced up to meet more hot coke which radius it to carbon II oxide.

$$CO_{2(g)} + C_{(s)} \longrightarrow 2CO_{(g)}$$

(c) The CO then reacts with Fe2Os, reducing it to Fe

$$Fe_2O_3(g) + 3CO_{(g)} \longrightarrow 2Fe_{(l)} + 3CO_{2(g)}$$

The molten fe formed sinks to the bottom of the furnace, and is tapped off. The limestone present decomposes at high temperature to yield calcium oxide, which then combines with temperature to yield calcium oxide. Which then combines with the silicon (iv) oxide (impurity) to form calcium trioxosilicated (iv)

$$Ca\ CO_3 \qquad Ca(s) + CO_{2(g)}$$

$$SiO_{2(s)} + CaO_{(s)} \qquad CaSiO_{3(s)}$$

$$Ca\ CO_3 \longrightarrow Ca(s) + CO_{2(g)}$$

$$SiO_{2(s)} + CaO_{(s)} \qquad CaSiO_{3(s)}$$

$$\longrightarrow$$

EVALUATION

1(a) what is the major impurity in iron ore haematite

(b) State the raw material used in the blast furnace to remove the impurity in (a) above.

2. State the specific function or use of coke in the extraction of iron

SUB TOPIC 2: TYPES AND USES

(a) Pig Iron: It is obtained direct the blast furnace and is quite impure. It contains 5% of carbon FE_3C together with impurities like phosphorus, silicon etc. The presence of impurities lowers the melting point from 1530^0C to about 1200^0C. Dig iron is hard and brittle and can be used for industrial purposes.

(b) Cast Iron: this is obtained from pig iron which has been re-melted with some scrap iron and then cooled. It has lower impurities compared to pig iron. It is brittle and cannot be forged or welded. it is used for making objects such as cookers. Stoves, radiators, lamp posts, railing, base of Bunsen burners etc

(c) Wrought Iron: this is the purest form of commercial iron containing about 0.1% carbon. It is obtained by heating cast iron in a furnace with haematite, Fe2O3. Carbon and sulphur are oxidized and removed as gaseous oxides during this process.

$$2Fe_2O_{3(s)} + C_{(s)} \longrightarrow 3CO_{2(g)} + 4Fe_{(s)}$$

$$2Fe_2O_{3(s)} + S_{(s)} \longrightarrow 3SO_{2(g)} + 4Fe_{(s)}$$

EVALUATION

1. State the different types of iron
2. List the uses of each type of iron

SUB TOPIC 3; RUSTING OF IRON AND METHOD OF PREVENTION

Rusting of iron resulted from the combined action of atmospheric oxygen and water. If the rusted surface is scraped off or removed, the exposed part will also begin to corrode (rust) if left exposed to moist.

PREVENTION

1. Coating or alloying with another metal like chromium that will not rust or corrode quickly. Coating of iron with zinc is called galvanization of iron
2. Putting grease or oil on iron and steel parts of machine
3. Painting exposed parts of machine and vehicles.
4. Using of cheaper parts for water of vehicles and ships.

GENERAL EVALUATION

OBJECTIVE TEST:

1. In the extraction of iron from its ore, coke, (a) acts as catalyst (b) production (c) reduces the ore to iron (d) reduces the amount of heat (e) production of SiO_2
2. The most common ores of iron include (a) haematite, malachite and limonite (b) chalcocute, calamine and bornite (c) malachite, challocite and bornite (d) limonite, bornite and haematite (e) haematite, limonite and magnetite
3. Wrought iron is the (a) most impure (b) purest form of iron (c) form of iron containing (d) most brittle (e) form of iron containing 5% carbon
4. Corrosion in iron is called (a) rusting (b) galvanization (c) tarnishing (d) dimerization (e) neutralization
5. The main reducing agent in the extraction of iron is (a) coke (b) carbon(iv) oxide (c) carbon (ii) oxide (d) graphite

ESSAY QUESTIONS:

1. Write short notes on the following (i) cast iron (ii) Wrought iron (iii) pig iron
2. (a) Give three(3) everyday uses of iron (b) write an equation to show the removal of earthly impurities in the best furnace during iron extraction

3.(a) Name the substance added to the blast furnace to remove impurities during extraction of iron. (b) state the specific function or use of limestone in the extraction of iron the extraction of iron and the removal of impurities in the blast furnace.

4. List two methods of preventing iron rust. (b) What is rusting? (c) Name three (3) raw materials used in blast furnace for the extraction of iron.

WEEKEND ASSIGNMENT

Read new school chemistry for senior secondary schools by Osei Yaw Ababio, pages 483-485

PRE READING ASSIGNMENT

Read up chemical wastes and industrial pollutants

WEEKEND ACTIVITY

1. What is the role of government in preventing chemical degradation legislation

WEEK 8

TOPIC: ETHNICAL, LEGAL AND SOCIAL ISSUES

CONTENT:

1. **CHEMICAL WASTE**
2. **INDUSTRIAL POLLUTANTS**
3. **ROLES OF GOVERNMENS IN PREVENTING CHEMICAL DEGRATION REGULATION ETC**

ETHNICAL, LEGAL AND SOCIAL ISSUES

Human activities and industrialization have led to the occurrence of wastes in our environment today. These wastes pollute the air and negatively affect respiration and photosynthesis process. Water and land are also affected by the generation of chemical wastes resulting in various health hazards and at times death. Mostly affected are cities and highly industrialised environment. It is therefore important for government to put to check environmental pollution by laws regulations that will guide industries and individuals in waste generation disposal and management. These laws and regulations should be enforced to the letter so as to have environment and healthy citizens.

SUB TOPIC 1: CHEMICAL WASTE

Unwanted materials that are generated from homes, offices industries, factories and are chemical in nature are called **Chemical Waste**. They are categorized into two namely: waste from combustion (ii) wastes from other sources.

(i) **Waste from combustion**. This includes:

(a) Tobacco smoke produced by smoking tobacco products.
(b) Combustion of coal and solid fuel which generates, SO_2 and polycyclic aromatic hydrocarbon as smoke.
(c) Combustion of liquid petroleum generating CO, oxides of nitrogen etc
(d) Industry and incineration can generate oxides of sulphur and nitrogen.
(e) Home generated combustion products such as NO_2 (from gas cookers, formaldehyde (from building materials)

(ii) **Wastes from other sources**. They include:

(a) Fluoride addition to water. This has an unwanted effect like mottling of the teeth.
(b) Leaching of lead from pipes by soft water.

(c) Fertilizer leaching by water which increases the risk of methemoglobinemia (blue babies) due to the presence of nitrates in water.
(d) Deposition of solid hazardous waste.

EVALUATION

1. (a) what is a chemical waste? (b) list the two categories of chemical waste you know.
2. Enumerate the sources of chemical waste.

SUB TOPIC 2: INDUSTRIAL POLLUTANTS

Industrial pollutants are agents of pollution generated from different industries. These pollutants include: CO, NO_2, CO_2, ground level, Ozone (O_3), particulate matter, SO_2, hydrocarbon and lead.

(a) **CO**: Carbon monoxide is a colourless and poisonous. About 80% of the gas is generated from road transport. It affects oxygen transportation round the body by the blood thus, resulting in heart diseases
(b) **NO_2:** Oxides of nitrogen omitted from vehicle exhaust gases to form NO_2 which is harmful to the health. NO_2 at high levels, causes irritation and inflammation on the lungs airways. NO_2 dissolves rain water to form acid rain.
(c) **LEAD:** Petrol combustion is the main sources of lead in the air is however been reduced by the phasing out of leaded petrol lead dust causes lead poisoning
(d) **GROUND LEVEL OZONE:** ground level ozone is harmful to health unlike the upper level ozone which protects the earth. High level of the ground level irritate and inflame the lungs; it causes migraine and coughing and attack rubber, pigments and vegetation.
(e) **PARTICULATE MATTER:** sources of particulate matter in the air include sand, sea spray, construction dust or soot, coal burning etc. The presence of finer particles in the atmosphere poses more danger than larger particles because it is easily and deeply breathed into the lungs thus, having more toxic effect.
(f) **SO_2**: this gas results from burning materials or fuel containing sulphur. It dissolves in rain water in the atmosphere form acid rain causes skin irritation and attack buildings. A short term exposure to high level SO_2 may cause coughing, tightening of the chest and lung irritation.
(g) **HYDROCARBONS**: there are compounds of hydrogen and carbon such compounds include: 1,3 butadiene(primarily from vehicle exhaust) and beneze (from the combustion of petrol. Longer term exposure to these compounds has been linked to leukemia and other form of cancer.

EVALUATION

1. Mention at least five (5) industrial pollutants and their respective harmful effect on the environment

SUB TOPIC 3: ROLES OF LOCAL GOVERNMENT IN PREVENTING CHEMICAL DEGRADATION

The following measures are taking by government to prevent chemical degradation.

1. Legislation by law makers by examining various degration forms and suggesting possible way.
2. Setting of minimum standards, minimum standards of waste generation and management are set for citizens and industries by government bodies.
3. Government should also ensure the passage into law of the minimum standards set for citizens and, the legislation and, their subsequent enforcement. Industries and citizens should be made to abide by these laws.

GENERAL EVALUATION

OBJECTIVE TEST:

1. The following are major industrial pollution except. (a) CO_2 (b) CO (c) SO_2 (d) NO_2 (e) lead
2. The following diseases are caused by industrial pollutants except. (a) cancer (b) lead poisoning (c) leukemia(d) skin irritation (e) polio
3. Which of the following gases can cause blood poisoning? (a)NO_2 (b) CO_2 (c) SO_2 (d) CFC (e) CO
4. The un covered raw food that is sold along major road is likely to contain some amounts of. (a) lead (b) copper (c) Argon (d) Sodium (e) Iron
5. The gas that is most useful in protecting humans against solar radiation is (a) Chlorine (b) Ozone (c) CO_2 (d) H_2S (e) NO_2

ESSAY QUESTIONS

1. Name three (3) industrial pollutants and suggest one way of reducing these pollutants in our environment.
2. Give 2 examples of industrial pollutants which cause acid rain.
3. Mention two gaseous and one solid impurity in the atmosphere.
4. Explain briefly, the term chemical wastes.

5. Outline any three (3) sources of wastes with accompany pollutants.

WEEKEND ASSIGNMENT

Read new school chemistry for senior secondary schools by Osei Yaw Ababio pages 292-293

PRE READING ASSIGNMENT

Read about water vapour in the air

WEEKEND ACTIVITY

How would you demonstrate that rain water contains dissolved air?

WEEK 9
Revision
WEEK10
Examination