CHAPTER 1
Chemistry

BASIC CONCEPTS "1"

GIVE SHORT ANSWERS TO FOLLOWING QUESTIONS.

Q NO: 1:- WRITE CLASSICAL AND MODERN DEFINATION OF ATOM.

ANS:- CLASSICAL CONCEPT:- According to Democritus the smallest particle of matter which cannot be further subdivided is called atom. (Atomos ⟹ Indivisible).

MODERN CONCEPT:- Atom is the smallest particle of element which can take part in a chemical reactio. It may or may not exist independently.

Atoms which can exist independently = He, Ne, A
Atoms which cannot exist independently = H_2, N_2, C

2:- WRITE IMPORTANT FUNDAMENTAL PARTICLES OF ATOM.

ANS:- Atom is further compised of more than 100 particles called sub-atomic particles. Most imporatan. are protons, electrons, neutrons, neutrino, antineutrino, hypron, etc.

WRITE MAIN POSTULATE OF ATOMIC THEORY?

ANS: All matter is compsed of atoms of differe elements which differ in their properties.

Law of conservation of mass and law of defi. proportions can be explained on the basis of ato.

WHAT IS CONTRIBUTION OF J. BERZELIUS IN CHEMIS.

J. Berzelius determined atomic masses of eleme. He assigned symbols to different elements.

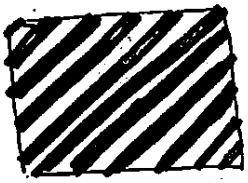
WHY ATOMS CANNOT BE SEEN WITH OPTICAL MICRO.

Optical microscope makes use of visible light wi. wavelength is 400nm — 800nm. An object of 5. 500nm or above can be seen with optical micros.

DIAMETER OF FAR LESS THAN "λ" OF LIGHT. HENCE VISIBLE LIGHT IS NOT REFLECTED BY ATOM AND IT CANNOT BE OBSERVED EVEN WITH POWERFUL OPTICAL MICROSCOPE.

WHAT IS ELECTRON MICROSCOPE?

A MICROSCOPE WHICH MAKES USE OF HIGH ENERGY ELECTRON BEAM INSTEAD OF VISIBLE LIGHT IS CALLED ELECTRON MICROSCOPE. THE WAVELENGTH OF ELECTRON BEAM IS LESS THAN VISIBLE LIGHT.



A ELECTRON MICROSCOPE PHOTOGRAPH OF LAYER OF GRAPHITE IS SHOWN. DARK LINES ARE EMPTY SPACE BETWEEN ATOMS AND BRIGHT LINES ARE LAYERS OF ATOMS.

WHAT IS DIAMETER AND AVERAGE MASS OF ATOM?

X-RAY WORK HAS SHOWN THAT DIAMETER OF ATOM IN THE RANGE OF 0.2nm (2×10^{-10} m)

MASS OF ATOM = 10^{-27} ——— 10^{-25} kg. MASSES OF ATOMS ARE EXPRESSED IN "amu" (1amu = 1.661×10^{-27} kg)

WHAT IS MOLECULE? WRITE ITS TYPES?

ANS: THE SMALLEST PARTICLE OF PURE SUBSTANCE WHICH CAN EXIST INDEPENDENTLY IS CALLED MOLECULE. THE NO. OF ATOMS IN A MOLECULE IS CALLED ATOMICITY

MONOATOMIC: MOLECULES WHICH CONSIST OF ONE ATOM FOR EXAMPLE He, Ne, Ar, etc

DIATOMIC:- H_2, O_2, N_2, etc

TRIATOMIC: CO_2, H_2O, etc. POLYATOMIC = MANY ATOMS S_8

HOMOATOMIC:- A MOLECULE IN WHICH ALL ATOMS ARE IDENTICAL H_2, S_8, N_2, O_2.

HETEROATOMIC: A MOLECULE WHICH CONSIST OF DIFFERENT KINDS OF ATOMS HCl, H_2O, CO_2, etc

MACROMOLECULES:- V. LARGE MOLECULES COMPOSED OF A LARGE NO. OF ATOMS. e.g HAEMOGLOBIN.

HAEMOGLOBIN IS COMPOSED OF ABOUT 10000 ATOMS AND IT MOLECULER WEIGHT IS 68000 TIMES GREATER THAN "H

WHAT IS ION? GIVE EXAMPLES OF DIFFERENT I

ION: - THE SPECIES HAVING POSITIVE OR NEGATIVE CHARGE IS CALLED ION. THERE ARE TWO TYPES OF IONS.

POSITIVE ION: IT IS FORMED BY REMOVAL OF ELECT FROM NEUTRAL ATOM. IT IS ALSO CALLED CATION.

$$A \longrightarrow A^{1+} + e^- \quad (\Delta H = +ve)$$

THE FORMATION OF POSITIVE ION IS ENDOTHERMIC PROC

A CATION MAY BE

UNIPOSITIVE :- FORMED BY REMOVAL OF $1e^-$ (Na^{1+}, K^{1+}, H

DIPOSITIVE :- FORMED BY REMOVAL OF $2e^-$ (Mg^{2+}, Zn^{2}

TRIPOSITIVE :- FORMED BY REMOVAL OF $3e^-$ (Al^{3+} Fe

NEGATIVE ION IT IS FORMED BY ADDITION OF ONE MORE ELECTRONS IN NEUTRAL ATOM. IT ALSO CALL ANION:-

$$B. + e^- \longrightarrow B^{1-} \quad (\Delta H = -ve.$$

FORMATION OF UNINEGATIVE ION IS EXOTHERMIC PROCESS. A NEGATIVE ION MAY BE

UNINEGATIVE ION: FORMED BY ADDITION OF $1e^-$ TO A NEUTRAL ATOM. Cl^{1-}, Br^{1-}, F^{1-} etc.

DINEGATIVE ION FORMED BY ADDITION OF TWO ELECTRON TO NEUTRAL ATOM. O^{-2}, S^{-2} etc

THE PROPERTIES OF IONS ARE DIFFERENT FROM ATOM

GIVE EXAMPLES OF IONS FORMED BY GROUP O ATOMS. WHICH ONE ARE MORE ABUNDAN

SOME IONS ARE FORMED BY GROUP OF ATOMS. FOR EXA $SO_4^{2-}, NO_3^{1-}, PO_4^{3-}, CO_3^{2-}, HCO_3^{1-}, MnO_4^{1-}, CrO_4^{2-}$ etc. NEGATIVE IONS FORMED BY GROUP OF ATOMS ARE MORE ABUNDANT THAN POSITIVE ION HAVING GROU OF ATOMS e.g NH_4^{1+}, CARBOCATIONS CH_3^+.

WHAT ARE MOLECULER IONS? HOW ARE THEY GENERATED? WRITE THEIR SIGNIFICANCE?

WHEN A NEUTRAL MOLECULE GAINS OR LOSES ELECTRON A MOLECULER ION IS FORMED. e.g CH_4^{1+}, CO^{1+}, N_2^{1+}

GENERATION. THEY ARE GENERATED BY PASSING (i) HIGH ENERGY ELECTRON BEAM (ii) X-RAYS (iii) α-PARTICLES THROUGH A GAS.

SIGNIFICANCE:- MOLECULER IONS ARE HIGHLY UNSTABLE THE BREAKDOWN OF MOLECULER ION IS USED TO DETERMINE STRUCTURE OF SOME NATURAL PRODUCTS

WHY DO WE USE RELATIVE ATOMIC MASS UNITS? DEFINE 1 amu.

ANS: MASSES OF ATOMS ARE EXTREMELY SMALL. WE DONOT HAVE ANY BALANCE TO MEASURE THEIR EXACT MASSES. THAT IS WHY WE USE RELATIVE ATOMIC MASSES

RELATIVE ATOMIC MASS:- MASS OF ONE ATOM OF AN ELEMENT AS COMPARED TO MASS OF ONE ATOM OF CARBON TAKEN AS "12" IS CALLED RELATIVE ATOMIC MASS

1 ATOMIC MASS UNIT:- $\frac{1}{12}$TH OF MASS OF ONE ATOM OF CARBON IS CALLED 1 amu $= \frac{1}{12}$th OF C-12

ON CARBON SCALE MASS OF CARBON = 12.0000 amu
MASS OF HYDROGEN = 1.008 amu.

WHAT ARE ISOTOPES? WRITE SIMILARITIES AND DIFFERENCES B/W ISOTOPES OF SAME ELEMENT?

ANS:- ATOMS OF THE SAME ELEMENT HAVING SAME ATOMIC NO. BUT DIFFERENT ATOMIC MASSES ARE CALLED ISOTOPES.

DISCOVERY:- IT WAS DISCOVERED BY SODDY AND STUDY OF ISOTOPES IS CALLED ISOTOPY.

SIMILARITIES:- ISOTOPES HAVE SAME NO. OF PROTON
SAME NO OF ELECTR

SAME ELECTRONIC CONFIGURATION
SAME CHEMICAL PROPERTIES.
SAME POSITION IN MODERN PERIODIC TABLE.

DIFFERENCES:- ISOTOPES DIFFER IN NO. OF NEUTRON
THEY HAVE DIFFERENT MASS NO. (A)
THEY HAVE DIFFERENT PHYSICAL PROPERT.

EXAMPLE:- HYDROGEN HAS FOLLOWING THREE ISOTOP.

		PROTON	ELECTRON	NEUTRON	MASS NO.
i) PROTIUM	$_{1}^{1}H$	1	1 ($1s^1$)	ZERO	1
(ii) DEUTERIUM	$_{1}^{2}H$	1	1 ($1s^1$)	1	2
(iii) TRITIUM	$_{1}^{3}H$	1	1 ($1s^1$)	2	3

CARBON HAS THREE ISOTOPES $_{6}^{12}C$ $_{6}^{13}C$ $_{6}^{14}C$.

OXYGEN HAS 3 ISOTOPES CALCIUM HAS 6 ISOTOPES
NICKAL HAS 5 ISOTOPES PALLADIUM HAS 6 ISOTOPE
CADMIUM HAS 9 ISOTOPES TIN HAS 11 ISOTOPES.

NATURAL RELATIVE ABUNDANCE OF ISOTES:-
THE NO. OF ISOTOPES AND THEIR RELATIVE ABUNDANCE IS DETERMINED BY MASS SPECTROMETERY. SOME IMPORTA GENERALIZATIONS ABOUT NO. OF ISOTOPES ARE GIVEN:-

MONOISOTOPIC ELEMENTS:- ARSENIC, FLOURINE, GOLD, IODIN.

ODD ATOMIC NUMBER: ELEMENTS HAVING ODD ATOM. NO. DO NOT HAVE MORE THAN TWO STABLE ISOTOPE

EVEN ATOMIC NUMBER:- ELEMENTS HAVING EVEN ATOMIC HAVE MORE NUMBER OF ISOTOPES. ELEMENTS HAVING EVEN ATOMIC NO. AND MASS NO. MULTIPLE OF FOUR HAVE MAX. NO. OF ISOTOPES. FOR EXAMPLE $_{8}^{16}O$, $_{12}^{24}Mg$, $_{20}^{40}Ca$, $_{26}^{56}Fe$, $_{14}^{28}Si$ FORM 50% OF EARTH.

AT PRESENT TOTAL 280 NATURALLY OCCUR ISOTOPES HAVE BEEN DISCOVERED. THEY INCLUDE 40 RADIOACTIVE UNSTABLE ISOTOPES. OUT OF 280, 154 HAVE EVEN ATOMIC NO. AND MASS NO.
BESIDES THERE ARE 300 MAN MADE ISOTOPES

WRITE BASIC PRINCIPLE OF MASS SPECTROMETER:

ANS. MASS SPECTROMETER IS AN INSTRUMENT USED TO MEASURE
(i) NO. OF ISOTOPES OF AN ELEMENT
(ii) EXACT MASS OF EACH ISOTOPE
(iii) % ABUNDANCE OF EACH ISOTOPE.

BASIC PRINCIPLE:- THE SAMPLE IS VOLATALIZED. THE VAPOU
ARE IONIZED WITH HIGH ENERGY ELECTRON BEAM. TH
POSITIVE IONS ARE SEPARATED ON THE BASIS OF $\frac{m}{e}$ VALUE
IN MAGNETIC ANALYZER. THE RESULTS ARE RECORDED AS
THE FORM OF PEAKS. THE NO. OF PEAKES IN MASS
SPECTRUM INDICATE NO. OF ISOTOPES AND THEIR POSITIO
INDICATES EXACT MASS OF ISOTOPE. INTENSITY OF PEA
(HEIGHT) INDICATE ITS % ABUNDANCE.

ASTONS MASS SPECTROGRAPH. IT WAS THE FIRST MAS
SPECTROGRAPH USED TO MEASURE EXACT MASSES OF ISOTOP

DEMPSTER MASS SPECTROMETER:. IT WAS DESIGNED TO
DETERMINE NO. OF ISOTOPES OF ELEMENTS WHICH EXIST I
SOLID STATE.

CONSTRUCTION AND WORKING OF MASS SPECTROMETE

THE WORKING OF MASS SPECTROMETER INVOLVES FOLLOWING ST

1. VOLATALIZATION:. THE SAMPLE IS CHANGED INTO VA
THE PRESSURE OF THESE VAPOURS IS KEPT V. LOW 10^{-6} TO

IONIZATION CHAMBER:. IN THIS CHAMBER VAPOURS
ARE BOMBARDED WITH HIGH ENERGY ELECTRON BEAM.
ARE CONVERTED INTO POSITIVE IONS, OF DIFFERENT MAS

ACCELERATION POTENTIAL "E" THE POSITIVE IONS AR
ACCELERATED FROM IONIZATION CHAMBER TO MAGNETIC AN
YZER BY APPLYING POTENTIAL DIFFERENCE "E" O
500 — 2000 VOLTS BETWEEN ACCELERATION PLATES.

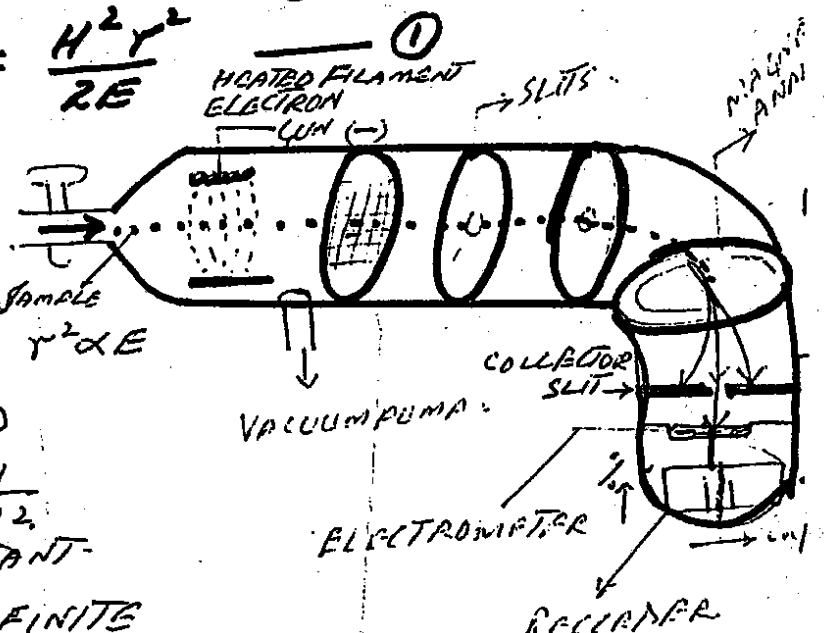
MAGNETIC FIELD "H": MAGNETIC FIELD MAKES THE IO
TO MOVE IN CIRCULAR PATH. IT SEPARATES IONS ON

THE BASIS OF THEIR $\frac{m}{e}$ VALUE. IONS HAVING DEFINITE $\frac{m}{e}$ VALUE MOVE IN THE FORM OF GROUP AND FALL ON COLLECTOR SLIT ONE AFTER ANOTHER.

MATHEMATICAL RELATION FOR $\frac{m}{e}$

$$\frac{m}{e} = \frac{H^2 r^2}{2E} \quad \text{---------- (1)}$$

THE RADIUS OF POSITIVE IONS CAN BE ADJUSTED EITHER BY CHANGING ACCELERATION POTENTIAL OR BY CHANGING APPLIED MAGNETIC FIELD $r^2 \propto \frac{1}{H^2}$ AND KEEPING 'E' CONSTANT. IN THIS WAY IONS OF DEFINITE $\frac{m}{e}$ VALUE CAN BE MADE TO FALL ON SAME COLLECTOR SLIT.



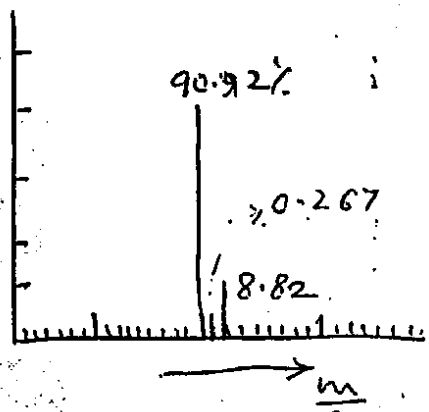
ELECTROMETER OR ION COLLECTOR:-

IONS OF DEFINITE $\frac{m}{e}$ VALUE ARE MADE TO FALL ON ELECTROMETER. IT DEVELOPS AN ELECTRIC CURRENT. THE STRENGTH OF CURRENT PROPORTIONAL TO RELATIVE ABUNDANCE OF EACH ISOTOPE.

RECORDER:- THE CURRENT GENERATED BY COLLISION OF IONS ON ELECTROMETER IS AMPLIFIED AND FED TO RECORDER. THE RECORDER MAKES A GRAPH BETWEEN $\frac{m}{e}$ ALONG X-AXIS AND % ABUNDANCE ALONG Y-AXIS. IT IS CALLED MASS SPECTRUM.

MASS SPECTRUM OF CARBON.

THE SAME EXPERIMENT IS PERFORMED WITH C-12 ISOTOPE AND CURRENT STRENGTH IS COMPARED. PEAK FOR C-12 IS AT $\frac{m}{e}$ VALUE 12.000 AND ITS % IS 100%.



MASS SPECTRUM OF NEON.

BY COMPARING POSITION AND INTENSITY OF OTHER PEAKS, THE EXACT POSITION MASSES AND % ABUNDANCE OF EACH ISOTOPE CAN BE DETERMINED.

Q. WRITE SOME METHODS OTHER THAN MASS SPECTRUM TO DETERMINE NO. OF ISOTOPES AND THEIR MASSES.

ON THE BASIS OF PHYSICAL PROPERTIES OF ISOTOPES SOME OTHER METHODS USED FOR SEPARATION OF ISOTOPES ARE :-

(i) GASEOUS DIFFUSION (ii) THERMAL DIFFUSION (iii) DISTILLATION (iv) ULTRACENTRIFUGE (v) ELECTROMAGNETIC SEPARATION (vi) LASER SEPARATION

WHY MASSES OF ISOTOPES HAVE FRACTIONAL VALUE?

ANS. THE AVERAGE ATOMIC MASS OF AN ELEMENT DEPEND UPON NUMBER OF ISOTOPES AND THEIR % ABUNDANCE. FOR

EXAMPLE: NEON HAS THREE ISOTOPES $^{20}_{10}Ne$, $^{21}_{10}Ne$, $^{22}_{10}Ne$ WITH % ABUNDANCE 90.92%, 0.26% AND 8.82%. THE AV. MASS OF NEON $= \frac{20 \times 90.92 + 21 \times 0.26 + 22 \times 8.82}{100} = 20.18$ amu.

NO INDIVIDUAL ATOM IN A SAMPLE HAS 20.18 amu

IT IS NOT MASS OF ONE ATOM BUT IT IS AVERAGE ATOMIC MASS WHICH DEPEND UPON NO. OF ISOTOPES AND THEIR % ABUN

$\therefore$ AVERAGE ATOMIC MASS $= \frac{\text{MASS OF ISOTOPE} \times \% \text{ ABUNDANCE} + \text{MASS OF ISOT}}{100}$

NUMERICAL NO. 6. 7 TEXT BOOK.

WHAT IS % OF AN ELEMENT IN A COMPOUND? FIND OUT % OF EACH ELEMENT IN $Fe_2(SO_4)_3$.

ANS. NUMBER OF GRAMS OF AN ELEMENT IN 100g OF COMPOUN. IS CALLED % OF THAT ELEMENT.

$$\% \text{ OF ELEMENT} = \frac{\text{MASS OF THAT ELEMENT}}{\text{MASS OF COMPOUND}} \times 100$$

THERE IS ANOTHER METHOD TO DETERMINE % OF ELEMENT

$$\% \text{ OF AN ELEMENT} = \frac{\text{MASS OF ELEMENT IN ONE MOLE COMP.}}{\text{MOLAR MASS OF COMPOUND}} \times 100$$

NUMERICAL:-

$Fe_2(SO_4)_3$

$$\text{MOLAR MASS} = (56)_2 + (32+64)_3$$
$$= 112 + 96 + 192$$
$$= 400$$

$$\% \text{ OF Fe} = \frac{112}{400} \times 100$$
$$= 28\% \text{ AN}$$

$$\% \text{ OF S} = \frac{96}{400} \times 100$$
$$= 24\% \text{ AI}$$

$$\% \text{ OF O} = \frac{192}{400} \times 100$$
$$= 48\% \text{ ANS.}$$

DEFINE EMPIRICAL FORMULA. GIVE EXAMPLE.

ANS:- IT INDICATES SIMPLEST RATIO OF ATOMS OF DIFFEREN ELEMENTS PRESENT IN A CHEMICAL COMPOUNDS.

EXAMPLE:- EMPIRICAL FORMULA OF GLUCOSE = CH_2O

BENZENE = CH

EMPIRICAL FORMULA OF GLUCOSE INDICATES GLUCOSE CONTAINS C, H, O ATOMS IN 1:2:1 RATIO.

WHAT IS MOLECULER FORMULA? GIVE EXAMPLE?

ANS:- THE FORMULA OF COMPOUND WHICH IS BASED UPON ACTUAL MOLECULE IS CALLED MOLECULER FORMULA. IT GIVES TOTAL NUMBER OF ATOMS OF DIFFERENT ELEMENTS PRESENT IN ONE MOLECULE OF COMPOUN

EXAMPLE:- MOLECULER FORMULA OF GLUCOSE is $C_6H_{12}O_6$

IT INDICATES THAT ONE MOLECULE OF GLUCOSE CONTAINS SIX C 12-H ATOMS AND SIX OXYGEN ATOMS.

- RELATIONSHIP BETWEEN EMPIRICAL FORMULA AND MOLECULER FORMULA.

ANS:- MOLECULER FORMULA IS SIMPLE MULTIPLE OF EMPIRICAL FORMULA. THIS MULTIPLE MAY BE 1 OR ANY OTHER NO.

MOLECULER FORMULA = (EMPIRICAL FORMULA) $\times n$

$$n = \frac{\text{MOLAR MASS}}{\text{EMPIRICAL FORMULA MASS}}$$

Q. WHAT ARE COMBUSTION ANALYSIS? WHICH TYPE OF COMPOUNDS ARE SUBJECTED TO COMBU

ANS:- **COMBUSTION ANALYSIS:** IN THIS TYPE OF ANALYSIS A COMPOUND IS BURN. IN STREAM OF OXYGEN. ORGANIC COMPOUNDS CONTAI ING C, H, O ARE SUBJECTED TO COMBUSTION. "C" I CONVERTED INTO CO_2, H IS CONVERTED INTO WATE CO_2 AND H_2O ARE COLLECTED IN DIFFERENT ABSORB

EXPERIMENTAL PROCEDURE ORGANIC COMPOUND IS PLAC IN COMBUSTION TUBE AFTER WEIGHING. IT IS PLAC IN FURNANCE. COMPOUND IS BURNT IN PRESENCE OF OXYGEN. "C" IS CONVERTED INTO CO_2 AND HYDROGE INTO WATER. CO_2 IS ABSURBED IN PREWEIGHED SO KOH SOLUTION AND H_2O IS ABSORBED IN PREWEIGHED $Mg(ClO_4)_2$. INCREASE IN WT OF KOH, $Mg(ClO_4)_2$ IND EQUAL WT OF CO_2 & WATER PRODUCED DURING COMBU

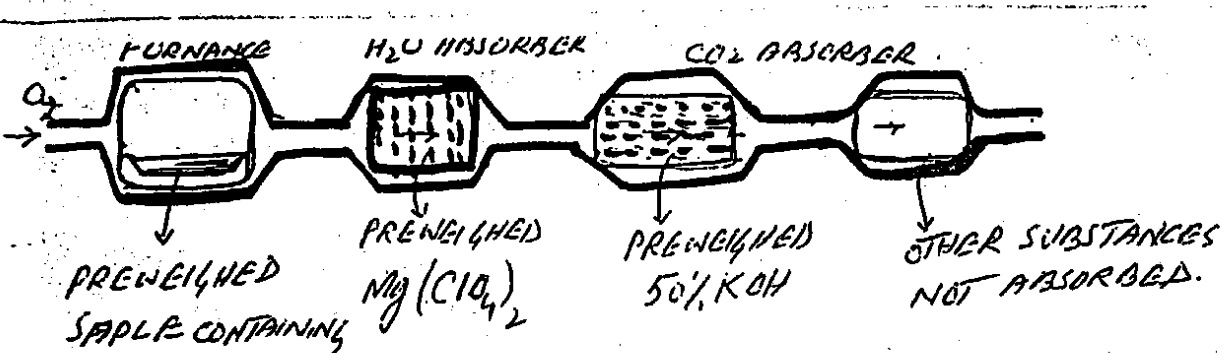
$$\% \text{ OF CARBON IN O.C} = \frac{\text{WT OF } CO_2}{\text{WT OF O.C}} \times \frac{12}{44} \times 100$$

$$\% \text{ OF OXYGEN IN O.C} = \frac{\text{WT OF } H_2O}{\text{WT OF O.C}} \times \frac{2}{18} \times 100$$

SINCE OXYGEN DOES NOT BURN SO THERE IS NO DIRECT METHOD OF DETERMINATION OF IT'S %. IT IS CALCULATED BY DIFFERENCE METHOD.

$$\% \text{ OF OXYGEN} = 100 - (\% \text{ OF C} + \% \text{ H})$$

FOLLOWING DIAGRAM EXPLAINS THIS METHOD.



NOTE:- SOLVE EXAMPLE NO. 2, 3, 4, 5
NUMERICAL NO. 15, 16.

DEFINE:

GRAM ATOM: THE ATOMIC MASS OF AN ELEMENT EXPRESSED IN GRAMS IS CALLED GRAM ATOM. IT IS ALSO CALLED 1MOLE OF THAT ELEMENT.

$$\text{GRAM ATOMS OF ELEMENT} = \frac{\text{MASS OF ELEMENT IN GRAMS}}{\text{ATOMIC WT OF THAT ELEMEN}}$$

EXAMPLES:- 1g ATOM OF CARBON = 12.0000 g CARBON
1 gram ATOM OF OXYGEN = 16.00g OXYGEN.
1 gram ATOM OF URANIUM = 238 g.

ONE GRAM ATOMS OF DIFFERENT ELEMENTS HAVE DIFFE MASSES.

GRAM MOLECULE: MOLECULAR MASS OF SUBSTANCE EXPRESSED IN GRAMS IS CALLED GRAM MOLECULE O 1MOLE OF SUBSTANCE.

$$\text{GRAM MOLECULE OF SUBSTANCE} = \frac{\text{MASS IN GRAMS}}{\text{MWT OF SUBSTANCE.}}$$

1 GRAM MOLECULE OF WATER = 18.0 g. (MWT OF H_2O = 1
1 GRAM MOLECULE OF GLUCOSE = 180 g. (MWT OF $C_6H_{12}O_6$ =
1 GRAM MOLECULE OF SUCROSE = 342 g (MWT OF SUCROSE=

GRAM FORMULA: IONIC COMPOUNDS AR REPRESENTED BY FORMULA UNIT. THE FORMULA UNIT MASS AN IONIC COMPOUND EXPRESSED IN GRAMS IS CALLED GRAM FORMULA OR MOLE OF THAT SUBSTANCE.

$$\text{GRAM FORMULA} = \frac{\text{MASS OF IONIC COMPOUND IN GRA}}{\text{FORMULA WT OF COMPOUND}}$$

MOLE: ATOMIC MASS, MOLECULER MASS OR FORMULA MASS OR IONIC MASS OF A SUBSTANCE EXPR IN GRAMS IS CALLED MOLE.

$$\text{MOLES OF SUBSTANCE} = \frac{\text{MASS OF SUBSTANCE IN GRAMS}}{\text{ATOMIC WT/MWT/MWT/IONIC WT.}}$$

AVOGADRO'S NUMBER: "N_A" A CONSTANT NO. ONE MOLE OF ANY SUBSTANCE CONTAINS A CONSTANT NO. OF ATOMS/IONS/MOLECULES/FORMULA UNITS. THIS NUMBER IS CALLED AVOGADRO'S NO. IT IS EQUAL TO 6.022×10^{23}.

1 MOLE OF SODIUM = 23 g = 6.022×10^{23} ATOMS OF Na
1 MOLE OF WATER = 18 g = 6.022×10^{23} MOLECULES OF H_2O
1 MOLE OF SODIUM CHLORIDE = 58.5 g = 6.022×10^{23} FORMULA UNIT
1 MOLE OF Cl^- IONS = 35.5 g = 6.022×10^{23} Cl^- IONS.

HENCE IT IS CONCLUDED THAT 6.022×10^{23} NUMBER OF PARTICLES ARE EQUAL TO 1 MOLE.

$$\text{MOLE} = \frac{\text{NUMBER OF PARTICLES (ATOMS, IONS, MOLEC}}{\text{"}N_A\text{"}}$$

INTERRELATIONSHIP: BETWEEN MASS AND NO. OF PARTICLES.

$$\text{MOLE} = \frac{\text{MASS OF SUBSTANCE IN GRAMS}}{\text{AT WT/ MWT/ FORMULA WT/ IONIC WT.}} \quad \text{——(1)}$$

$$\text{MOLE} = \frac{\text{NUMBER OF PARTICLES (ATOMS, IONS, MOLECUL}}{N_A} \quad \text{——(2)}$$

SINCE L.H.S = L.H.S
∴ R.H.S = R.H.S.

$$\frac{\text{MASS OF SUBSTANCE}}{\text{AT WT/MWT/F.WT/IONIC WT}} = \frac{\text{NO. OF PARTICLES}}{N_A} \quad \text{——(3)}$$

$$\frac{\text{MASS IN GRAMS}}{\text{MOLAR MASS}} \times N_A = \text{NO. OF PARTICLES.} \quad \text{——(4)}$$

MOLAR VOLUME: ONE MOLE OF ANY GAS AT STP. OCCUPY A VOLUME OF 22.414 dm^3. THIS CALLED MOLAR VOLUME. FOR EXAMPLE

1 MOLE H_2 AT S.T.P = 22.414 dm^3 = 2.016 g = 6.022×10^{23} MOLECU

1 MOLE OF O_2 AT S.T.P = 22.414 dm^3 = 32 g = 6.022×10^{23} MOLECU

AVOGADROS' LAW:- FROM ABOVE EXAMPLES IT IS CLEAR THAT EQUAL VOLUMES OF DIFFERENT GASES UNDER SAME CONDITIONS OF TEMPERATURE AND PRESSURE CONTAIN EQUAL NUMBER OF MOLECULES.

REASONING QUESTION WHY SAME NUMBER OF MOLECU HAVE DIFFERENT MASSES BUT SAME VOLUME?

ANS:- AVOGADROS NO. OF MOLECULES OF DIFFERENT GAS HAVE DIFFERENT MASSES BECAUSE OF DIFFERENT WT/ MWTS AND DIFFERENT SIZES. HOWEVER THEIR VOLUME IS 22.414 dm^3. THE SIZE AND MWT. OF DOES NOT EFFECT ITS TOTAL VOLUME DUE TO LA EMPTY SPACES BETWEEN THEM. (DISTANCE BETWEEN MOLECULES IS 300 TIMES THEIR DIAMETER).

RELATIONSHIPS: MOLE, VOLUME, MASS, AND NUMBER OF PARTICLES ARE RELATED BY FOLLOWING RELATIONSHIPS.

$$\text{MOLE} = \frac{\text{VOL. OF GAS IN } dm^3 \text{ AT STP}}{22.414\ dm^3} \quad \text{——(1)}$$

$$\text{MOLE} = \frac{\text{MASS IN GRAMS}}{\text{MOLAR MASS.}} \quad \text{——(2)}$$

$$\text{MOLE} = \frac{\text{NUMBER OF MOLECULES}}{N_A} \quad \text{——(3)}$$

Q: NO. 9: JUSTIFY:.

(a) ANS. BOTH THESE QUANTITIES ARE EQUAL TO 1 MOLE. SO BOTH CONTAIN AVOGADROS' NUMBER OF ATOMS = 6.022×10^{23} ATOMS.

23 g Na = $\frac{23}{23}$ = 1 MOL Na = 6.022×10^{23} ATOMS OF Na.

238 g U = $\frac{238}{238}$ = 1 MOLE U = 6.022×10^{23} ATOMS OF "U"

b) ANS:- EACH CARBON ATOM HAS SIX PROTON, AND SIX NEUTR. IN NUCLEUS - SO ITS MASS IS 12.0 amu. EACH ATOM OF Mg HAS 12 PROTON, 12 NEUTRONS - HENCE ITS MASS IS 24.0 amu. THEREFARE MASS OF EACH ATOM OF "Mg" IS TWICE THE MASS OF C

c) 180 g GLUCOSE = 1 MOLE GLUCOSE = 6.022×10^{23} MOLECULES =

342 g SUCROSE = 1 MOLE SUCROSE = 6.022×10^{23} MOLECULES

BUT 1 MOLECULE OF GLUCOSE CONTAINS 24 ATOMS AND 1 MOLECULE OF SUCROSE CONTAINS 45 ATOMS ($C_{12} H_{22} O_{11}$)

THEREFARE 1 MOLE GLUCOSE CONTAINS ATOMS = $N_A \times 24$

1 MOLE SUCROSE CONTAINS ATOMS = $N_A \times 45$

THUS NO. OF ATOMS ARE NOT EQUAL.

d) 4.9 g H_2SO_4 = $\frac{4.9}{98}$ = 0.05 MOLE H_2SO_4

EACH MOLE OF H_2SO_4 PRODUCES 2.0 MOLE OF H^+. THEREFARE 0.05 MOLE H_2SO_4 WILL PRODUCE 0.1 MOLE H^+ AND 0.05 MOLE SO_4^{2-} IONS.

$H_2SO_4 \rightleftharpoons 2H^+ + SO_4$

1 MOLE 2 MOLE

0.05 $\rightleftharpoons$ 2 × 0.05

0.05 $\rightleftharpoons$ 0.1 MOLE 0

EACH H^{1+} HAS ONE POSITIVE CHARGE.

THEREFARE TOTAL POSITIVE CHARGES = 0.1 MOLE (+ve)

EACH SO_4^{2-} ION HAS "2−" CHARGE.

THEREFARE NEGATIVE CHARGES ARE TWICE THE NO. OF SO_4^{2-} IONS NEG. CHARGE = 0.05 × 2

HENCE CHARGES ARE EQUAL. = 0.1 MOLE (−ve)

(6) IT IS BECAUSE K_2CrO_4 IONIZES AS FOLLOWS

EACH FARMELA UNIT OF K_2CrO_4 $\quad K_2CrO_4 \rightarrow 2K^{\oplus} + CrO_4^{2-}$

∴ PRODUCES TWO K^{1+} IONS AND ONE CrO_4^{2-} ION. THUS TH NO. OF IONS PRODUCED ARE THREE TIMES THE NO. OF FORMULA UNITS OF K_2CrO_4.

(7):- ALL THESE QUANTITIES ARE EQUAL TO 1 MOLE. HENCE THEY POSSESS SAME VOL. ($22.414\ dm^3$) AND SAME NO OF MOLECULES (6.022×10^{23}). TOTAL VOLUME IS NOT EFFEC BY THE SIZE OF MOLECULES BECAUSE THERE ARE LARGE EMPTY SPACES BETWEEN MOLECULES. THERE IS ALMOST 30 TIMES EMPTY SPACE BETWEEN MOLECULES AS COMPARED TO THEIR DIAMETER.

10:. CALCULATE:-

a) MASS IN GRAMS OF 2.74 MOLE OF $KMnO_4$

$\text{MOLE} = \frac{\text{MASS IN GRAM}}{\text{MOLAR MASS}}$ OR MASS IN GRAM = MOLE × MOLAR M.

∴ MASS IN GRAMS = $2.74 \times 158 = \boxed{432.92\ g.}$ ANS.

b) MOLES OF OXYGEN ATOMS IN 9.0 g $Mg(NO_3)_2$.

ANS:- MOLES OF $Mg(NO_3)_2 = \frac{9}{148} = 0.0608$ MOLE

1 MOLE $Mg(NO_3)_2$ CONTAINS OXYGEN = 6 MOLE ATOM

0.0608 MOLE $Mg(NO_3)_2$ CONTAIN OXYGEN = 6×0.0608

ANS $= \boxed{0.365 \text{ MOLE ATO}}$

(C) NO. OF OXYGEN ATOMS IN 10.037 g $CuSO_4 \cdot 5H_2O$

ANS. MOLES OF $CuSO_4 \cdot 5H_2O = \frac{10.037}{249.5} = 0.0402$ M

1 MOLE $CuSO_4 \cdot 5H_2O$ CONTAIN OXYGEN = 9 MOLE ATOMS

0.0402 MOLE $CuSO_4 \cdot 5H_2O$ CONTAIN OXYGEN = 9×0.0402

$= 0.362$ MOLE A

NO. OF OXYGEN ATOM = $0.362 \times 6.022 \times 10^{23}$ ATOMS

∴ NO. OF OXYGEN ATOMS = 1.100×10^{-3} ATOMS

d) MASS IN KILOGRAM 2.6×10^{20} MOLECULE OF SO_2.

MOLES OF $SO_2 = \frac{2.6 \times 10^{20}}{6.022 \times 10^{23}} = 0.432 \times 10^{-3}$ MOLE

MASS OF SO_2 IN GRAMS = MOLE × MOLAR MASS

$= 0.432 \times 64 \times 10^{-3}$

$= 2.76 \times 10^{-2}$ g

MASS IN KILOGRAM $= \frac{2.76 \times 10^{-2}}{10^3} = 2.76 \times 10^{-5}$ kg

(e) MOLES OF CHLORINE ATOMS IN 0.822 g $C_2H_4Cl_2$

SOLUTION :- MOLES OF $C_2H_4Cl_2 = \frac{0.822}{99} = 8.3 \times 10^{-3}$ MOLE

1 MOLE $C_2H_4Cl_2$ CONTAINS CHLORINE = 2 MOLE ATOM

8.3×10^{-3} MOLE WILL CONTAIN CHLORINE = $2 \times 8.3 \times 10^{-3}$

$= 16.6 \times 10^{-3}$ MOLE ATOM

(f) MASS IN GRAMS 5.136 MOLE Ag_2CO_3.

MASS = MOLE × MOLAR MASS OF Ag_2CO_3 $((108)_2 + 12 + 1$

276

$= 5.136 \times 276 = 1417$ g

g) MASS IN GRAMS OF 2.78×10^{21} MOLECULES OF CrO_2Cl_2

MOLES OF $CrO_2Cl_2 = \frac{2.78 \times 10^{21}}{6.022 \times 10^{23}} = 0.461 \times 10^{-2}$ MOLE

MASS OF CrO_2Cl_2 = MOLE × MOLAR MASS OF CrO_2C

$= 0.461 \times 10^{-2} \times 155$

$= 71.55 \times 10^{-2}$ g $= 0.7155$ g

h) NUMBER OF MOLES AND FORMULA UNITS IN 100 g $KClO_3$.

MOLES OF $KClO_3 = \frac{100}{122.5} = 0.816$ MOLES

FORMULA UNITS OF $KClO_3 = 0.816 \times 6.022 \times 10^{23}$

FORMULA UNITS OF $KClO_3$ = 4.91×10^{-1} FORMULA UNITS

(c) NO. K^{1+} IONS. ClO_3^{1-} IONS. "Cl" ATOM. "O" ATOMS.

$KClO_3$ IONIZES AS FOLLOWS IN WATER $KClO_3 \rightarrow K^{1+} + Cl$

SO EACH $KClO_3$ PRODUCES K^{1+} = 1

4.91×10^{23} $KClO_3$ K^{1+} = 4.91×10^{23} IONS

ClO_3^{1-} = 4.91×10^{23} IONS.

ONE FORMULA UNIT OF $KClO_3$ CONTAIN "Cl" = 1

4.91×10^{23} FORMULA UNITS CONTAIN Cl = 4.91×10^{23} ATOM

ONE $KClO_3$ FORMULA UNIT CONTAIN OXYGEN = 3 ATOM

4.91×10^{23} FORMULA UNITS CONTAIN OXYGEN = $3 \times 4.91 \times 10^{23}$

= 14.7×10^{23} ATOM

Q: NO. 11 :- ASPARTAME = $C_{14}H_{18}N_2O_5$

a) MASS OF 1 MOLE OF ASPARTAME = $(12)_{14} + (1)_{18} + (14)_2 + (16)_5$

= 294 g/MOLE.

(b) MOLES OF ASPARTAME IN 52 g ASPARTAME

MOLES OF ASPARTAME = $\frac{52}{294}$ = 0.177 MOLE.

(c) MASS IN GRAMS = MOLES x MOLAR MASS.

= 10.122 x 294 = 2975.87 g.

(d) NO. OF H. ATOMS IN 2.43 g ASPARTAME.

MOLES OF ASPARTAME = $\frac{2.43}{294}$ = 8.26×10^{-3} MOLES

1 MOLE ASPARTAME CONTAINS H = 18 MOLE ATOM

8.26×10^{-3} MOLE " CONTAIN H = $18 \times 8.26 \times 10^{-3}$

= 0.1488 MOLE ATO

NUMBER OF H-ATOMS = 0.8958×10^{23} ATOM.

= 8.958×10^{22} ATOMS

WHAT IS STOICHIOMETRY? WRITE ITS IMP... AND TYPES OF RELATIONSHIPS INVOLVED?

The branch of chemistry which deals with quantitative relation between reactants and products involved in a balanced chemic equation is called STOICHIOMETRY.

LIMITATIONS of CHEMICAL EQUATION:-

1) The chemical equations do not tell about conditions and ra of chemical reactions.
2) A chemical equation can be written to describe a chemical change that don't occur.

ASSUMPTIONS OF STOICHIOMETRY:-

(1) All reactants are converted into the products.
2) No side reactions take place.
3) The law of conservation of mass and law of definite proportions is obeyed.

With the help of the following relationships can be studied stoichiometry.

MASS - MASS RELATIONSHIP:- If we are given mass of one substance we can calculate mass of other substance.

MASS - MOLE AND MOLE - MASS RELATIONSHIP:- If we are given mass of one substance we can calculate mole of other, and vice-versa.

MASS - VOLUME RELATIONSHIP:- If we are given the mass of one substance we can calculate volume of other substance and vice versa.

"See Examples at No. (11, 12)

WHAT IS LIMITING REACTANT? HOW TO CALCULATE LIMITING REACTANT?

When reactants are not mixed in stoichiometric amo. one of the reactant is consumed earlier. This reactant i called LIMITING REACTANT. The other reactant is left un. reacted after completion of reaction. This reactant is called EXCESSIVE REACTANT.

Since the limiting reactant is consumed earlier and reaction stops due to its consumption. Therefore amou of product depend upon limiting reactant.

DETERMINATION The Limiting reactant is determined as,

1) The amounts of reactants are converted into moles
2) The amount of products are calculated from moles of reactants by using balanced chemical equation.
3) The reactant which produces least amount of product is called LIMITING REACTANT.

The amount of products depends upon limiting reactan

EXAMPLE:- SODIUM THIOSULPHATE IS PRODUCED BY REACTION INDICATED BELOW

$$2Na_2S + Na_2CO_3 + 4SO_2 \longrightarrow 3Na_2S_2O_3 + CO_2$$

If 100g of each of reactant is mixed calculate amount o produce thiosulphate produced.

SOLUTION:- 1) Moles of each reactant = $\frac{\text{Wt of substance}}{\text{Mwt of substance}}$

[Mwt of Na_2S = 78, Na_2CO_3 = 106, SO_2 = 64]

Moles of $Na_2S = \frac{100}{78} = 1.28$ moles.

Moles of $Na_2CO_3 = \frac{100}{106} = 0.943$ moles

Moles of $SO_2 = \frac{100}{64} = 1.56$ moles.

2) AMOUNT OF PRODUCTS FROM EACH REACTANT.

Given equation shows that

2 mole Na_2S produces $Na_2S_2O_3$ = 3 mole

1 mole Na_2S produces $Na_2S_2O_3 = \frac{3}{2}$ mole

1.28 mole Na_2S will produce $Na_2S_2O_3 = \frac{3}{2} \times 1.28$.

Amount of $Na_2S_2O_3$ produced from $Na_2S = \frac{1.92 \text{ moles}}{1}$

ii) 1 mole of Na_2CO_3 produces $Na_2S_2O_3$ = 3

0.94 moles of Na_2CO_3 produce $Na_2S_2O_3$ = 3×0.94

= **2.82 moles**

(iii) 4 mole of SO_2 produce $Na_2S_2O_3$ = 3

1 " " " " = $\frac{3}{4}$

1.56 moles of SO_2 produce $Na_2S_2O_3$ = $\frac{3}{4} \times 1.56$

= **1.17 mole**

Since SO_2 produce least amount of products hence it is limiting reactant.

Thus $Na_2S_2O_3$ produced = 1.17 moles

= No. x m. wt of $Na_2S_2O_3$

weight of $Na_2S_2O_3$ = 1.17×158 = **184.86 g**

Q WHAT IS THEORETICAL YIELDS. WHY IS ACTUAL YIELD LESSER THAN THEORETICAL YIELD.

The amount of products expected to be formed from given amount of reactants, using balanced chemical equation is called Theoratical yield.

OR

"Amount of products calculated from stoichiometric calculations is called Theoratical yield."

However amount of products actually obtained after the completion of chemical reaction is less than theoratical yield. It may be due to following reasons.

(i) Formation of by-products due to side reactions.

(ii) The reaction may be reversible. Thus it does not go to completion.

(iii) mechanical loss of products during filteration, crystallization etc.

So yield is generally expressed in terms of %.

$$\% \text{ yield} = \frac{\text{Actual yield}}{\text{Theoratical yield}} \times 100$$

(SEE EXAMPLE 14 P-14)

Q.11 Aspartame, the artificial sweetner, has a molecular formula of $C_{14}H_{18}N_2O_5$.

a) What is the mass of one mole of aspartame.
b) How many moles are present in 52 g of aspartame.
c) What is the mass in grams of 10.122 moles of aspartame.
d) How many hydrogen atoms are present in 2.43 g of aspartame.

(a) MOLECULER WT OF ASPARTANE = $C_{14}H_{18}N_2O_5$

$= (12)_{14} + (1)_{18} + (14)_2 + (16)_5$

THUS MASS OF 1 MOLE ASPARTANE = 294 g/MOLE.

(b) MOLE OF ASPARTAME IN 52 g = $\frac{52}{294} = 0.177$ MOL

(c) MASS IN GRAMS = MOLE × MOLAR MASS

$= 10.122 \times 294 = 2975.9$ g.

(d) MOLES OF ASPARTAME = $\frac{\text{MASS IN g.}}{\text{MOLAR MASS}} = \frac{2.43}{294} = 8.26 \times 10^{-3}$

1 MOLE CONTAIN HYDROGEN = 18 MOLE ATOM

8.26×10^{-3} MOLE CONTAIN H = $18 \times 8.26 \times 10^{-3}$

$= 0.149$ MOLE ATOM

NO. OF HYDROGEN ATOMS = MOLE × AVOGADROS NO.

$0.149 \times 22 \quad 6.022 \times 10^{23}$

$= 8.96 \times 10^{}$ ATOMS

Q.12 A sample of 0.600 mole of a metal M reacts completely with excess of fluorine to form 46.8 g MF_2.

a) How many moles of F are present in the sample of MF_2 that forms.
b) Which element is represented by the symbol M?

SOLOTION:- EQUATION $M + F_2 \longrightarrow MF_2$

(a) SINCE 1 mole of M produces MF_2 = 1 MOLE

0.6 MOLE M will produce MF_2 = 0.60 mole

1 mole MF_2 contains F = 2 mole atom

0.600 mole MF_2 contain F = $2 \times 0.600 = 1.20$ MOLE A.

(b) SINCE 0.60 MOLE MF_2 IS PRODUCED AND ITS MASS IS GIVEN 46.8 g. THUS MOLE = $\frac{\text{MASS IN GRAM}}{\text{FORMULA WT}}$

FORMULA WT = $\frac{\text{MASS IN g}}{\text{MOLE}}$

FORMULA WT $= \frac{46.8}{0.60} = 78$ g/mole

FORMULA WT. OF MF_2 $= M + 2(F) = 78$

$M + 2(19) = 78$

$M = 78 - 38$

$M = 40$ " "

This is atomic wt of "Ca". Thus $M =$ "Ca"

Q No. 14 CALCULATE % OF NITROGEN IN FOLLOWING FERTILIZER

(a)

FERTILIZER	MOLECULER WT	% N = WT OF NITROGEN / MOL WT
NH_3	$14+3 = 17$	$= \frac{14}{17} \times 100 = 82.$
NH_2CONH_2	$14+2+12+16+14+2 = 60$	$= \frac{28}{60} \times 100 = 46.$
$(NH_4)_2SO_4$	$28+8+32+64 = 132$	$= \frac{28}{132} \times 100 = 21.$
NH_4NO_3	$14+4+14+48 = 80$	$= \frac{28}{80} \times 100 = 3$

(b)

	MOLECULER WT.	% P	% N
$NH_4H_2PO_4$	$14+4+2+31+64 = 125$	$\frac{31}{125} \times 100 = 26.06$	
$(NH_4)_2HPO_4$	$28+8+1+31+64 = 132$	$\frac{31}{132} \times 100 = 23.48$	
$(NH_4)_3PO_4$	$42+12+31+64 = 149$	$\frac{31}{149} \times 100 = 20.8$	

Q No. 15

Q.15 Glucose $C_6H_{12}O_6$ is the most important nutrient in the cell for generating chemical potential energy. Calculate the mass % of each element in glucose and determine the number of C, H and O atoms in 10.5 g of the sample.

MOLAR MASS OF GLUCOSE $= C_6H_{12}O_6$

$= 72 + 12 + 96 = 180$

% CARBON $= \frac{\text{WT OF CARBON}}{\text{M. WT OF GLUCOSE}} \times 100 = \frac{72}{180} \times 100 = 40\%$

% OXYGEN $= \frac{96}{180} \times 100 = 53.4\%$

% HYDROGEN $= \frac{12}{180} \times 100 = 6.6\%$

MOLES OF GLUCOSE $= \frac{\text{MASS IN GRAMS}}{\text{MOLAR MASS}} = \frac{10.5\text{ g}}{180} = 0.058$ MOLE

MOLES OF CARBON = 6 × 0.058 = 0.35 MOLE ATOM

MOLES OF OXYGEN = 6 × 0.058 = 0.35 MOLE ATOM

MOLES OF HYDROGEN = 12 × 0.058 = 0.70 MOLE ATOM

ATOMS OF CARBON = MOLE × AVOGADRO'S NUMBER

$= 0.35 \times 6.022 \times 10^{23}$

$= 2.11 \times 10^{23}$

ATOMS OF OXYGEN = $0.35 \times 6.022 \times 10^{23} = 2.11 \times 10^{23}$ ATOM.

$= 0.70 \times 6.022 \times 10^{23} = 4.22 \times 10^{23}$ ATOM

Q.16 Ethylene glycol is used as automobile antifreeze. It has 38.7% carbon, 9.7 % hydrogen and 51.6% oxygen. Its molar mass is 62.1 grams mol^{-1}. Determine its empirical formula.

ELEMENT	%	NO. OF GRAM ATOMS	ATOMIC RATIO	EMPIRICAL FORMULA
CARBON	38.7	$\frac{38.7}{12} = 3.22$	$\frac{3.22}{3.22} = 1$	CH_3O
HYDROGEN	9.7	$\frac{9.7}{1} = 9.7$	$\frac{9.7}{3.22} = 3$	
OXYGEN	51.6	$\frac{51.6}{16} = 3.22$	$\frac{3.22}{3.22} = 1$	

EMPIRICAL FORMULA WT = CH_3O

$= 12 + 3 + 16 = 31$

MOLECULER WT = 62.1

$n = \frac{\text{MWT}}{\text{Empirical formula WT}} = \frac{62.1}{31} = 2$

MOLECULER FORMULA = (EMPIRICAL FORMULA) × n

$(CH_3O) \times 2 = C_2H_6O_2$

Q.17 Serotenin (Molecular mass = 176 g mol^{-1}) is a compound that conducts nerve impulses in brain and muscles. It contains 68.2 % C, 6.86 % H, 15.09 % N, and 9.08 % O. What is its molecular formula.

SOLUTION

ELEMENT	%	MOLE % / ATWT	ATOMIC RATIO	EMPIRICAL FORMULA
C	68.2	$\frac{68.2}{12} = 5.68$	$\frac{5.68}{0.56} = 10.14 = 10$	$C_{10}H_{12}N_2O_1$
H	6.86	$\frac{6.86}{1} = 6.86$	$\frac{6.86}{0.56} = 12.25 = 12$	
O	9.09	$\frac{9.08}{16} = 0.56$	$\frac{0.56}{0.56} = 1 = 1$	
N	15.09	$\frac{15.09}{14} = 1.07$	$\frac{1.07}{0.56} = 1.9 = 2$	

EMPIRICAL FORMULA WT = $C_{10}H_{12}N_2O_1$

$23 \quad (12) + (1) + (14)_2 + (16)_1 = 176$

GIVEN MOLECULAR WT = 176

$$n = \frac{\text{MWT}}{\text{Emp. FWT}} = \frac{176}{176} = 1$$

Molecular formula = (Empirical formula) × n

$$= (C_{10}H_{12}N_2O_1) \times 1 = C_{10}H_{12}N_2O_1$$

Q.18 ✓ An unknown metal M reacts with S to form a compound with a formula M_2S_3. If 3.12 g of M reacts with exactly 2.88 g of sulphur, what are the names of metal M and the compound M_2S_3.

SOLUTION: EQUATION OF REACTION.

$$2M + 3S \longrightarrow M_2S_3$$

MOLES OF S = $\frac{\text{MASS IN GRAM}}{\text{ATOMIC WT}} = \frac{2.88}{32} = 0.09$ MOLE

3 MOLE S requires M = 2 MOLE

1 " " " " = $\frac{2}{3}$

0.09 " " m = $\frac{2}{3} \times 0.09 = 0.06$ MOLE

GIVEN MASS OF m = 3.12 g

∴ THIS IS MASS OF 0.06 MOLE OF "m" WHICH REACTS WITH 0.09 MOLE OF "S".

$$\text{MOLE} = \frac{\text{MASS IN GRAMS}}{\text{ATOMIC WT}}$$

$$\text{ATOMIC WT} = \frac{\text{MASS IN GRAM}}{\text{MOLE}} = \frac{3.12}{0.06} = 52$$

THIS IS ATOMIC WT OF "Cr" = Cr

∴ THUS M_2S_3 = Cr_2S_3

Q.19 The octane present in gasoline burns according to the following equation.

$$2C_8H_{18}(l) + 25O_2(g) \longrightarrow 16CO_2(g) + 18H_2O(l)$$

a) How many moles of O_2 are needed to react fully with 4 moles of octane?

b) How many moles of CO_2 can be produced from one mole of octane?

c) How many moles of water are produced by the combustion of 8 moles of octane?

d) If this reaction is to be used to synthesize 8 moles of CO_2, how many grams of oxygen are needed? How many grams of octane will be used?

SOLUTION:-

(a) 2 MOLE OCTANE REQUIRE OXYGEN = 25 MOLE

1 " " " = $\frac{25}{2} \times 4 = 50$ MOLE

4 " " "

(b) 2 MOLE OCTANE PRODUCES CO_2 = 16 MOLE
1 MOLE OCTANE PRODUCES $CO_2 = \frac{16}{2}$ = 8.0 MOLE

(c) 2 MOLE OCTANE PRODUCES H_2O = 18 MOLE
1 " " " $H_2O = \frac{18}{2}$
6 " " " $= \frac{18}{2} \times 6$ = 54 MOLE.

(d) 16 MOLE CO_2 REQUIRES OXYGEN = 25 MOLE
1 " " " = $\frac{25}{16}$
8 " " " = $\frac{25}{16} \times 8$ = 12.5 MOLE

MASS OF OXYGEN = 12.5 × 32 = 400 g.

Q No. 20 Calculate the number of grams of Al_2S_3 which can be prepared by the reaction of 20 g of Al and 30 g of sulphur. How much the non-limiting reactant is in excess?

SOLUTION. $2Al + 3S \longrightarrow Al_2S_3$

GIVEN Al = 20 g
S = 30 g

MOLE OF Al = $\frac{20}{27}$ = 0.741 MOLE
MOLE OF S = $\frac{30}{32}$ = 0.938 MOLE

2 MOLE Al produces Al_2S_3 = 1 MOLE
1 MOLE Al produces $Al_2S_3 = \frac{1}{2}$
0.741 MOLE Al produces $Al_2S_3 = \frac{1}{2} \times 0.741 =$ 0.370 MOLE

3 MOLE S produces Al_2S_3 = 1 MOLE
1 " " " = $\frac{1}{3}$
0.938 MOLE will produce $Al_2S_3 = \frac{1}{3} \times 0.938$
Al_2S_3 = 0.313 MOLE

Since S produces least amount of products.
Therefore S is LIMITING REACTAN.
HENCE Al_2S_3 = 0.313 MOLE
MASS OF Al_2S_3 = 0.313 × 150
= 46.95 g.

NON LIMITING REACTANT

3 MOLE S REQUIRE Al = 2 MOLE
1 " " " = $\frac{2}{3}$
" " 25 = 2×0.938 = 0.625 MOLE

GIVEN Al = 0.741

REQUIRED Al = 0.625

UNREACTED = 0.116 MOLE MOLE × AT WT

MASS OF UNREACTED Al = 0.116 × 27 = 3.123 g.

✓ Q.21 A mixture of two liquids, hydrazine N_2H_4 and N_2O_4 are used as a fuel in rockets. They produce N_2 and water vapours. How many grams of N_2 gas will be formed by reacting 100 g of N_2H_4 and 200 g of N_2O_4.

$2N_2H_4 + N_2O_4 \longrightarrow 3N_2 + 4H_2O$

SOLUTION:

MOLES OF $N_2H_4 = \frac{100}{32}$ g = 3.125 MOLE

MOLES OF $N_2O_4 = \frac{200}{92}$ g = 2.174 MOLE

2 MOLE HYDRAZINE (N_2H_4) PRODUCES N_2 = 3 MOLE

1 " " " " = $\frac{3}{2}$

3.125 MOLE " " " = $\frac{3}{2} \times 3.125$

N_2 = 4.688 MOLE

SIMILARLY

1 MOLE N_2O_4 PRODUCES N_2 = 3 MOLE

2.174 " " " $N_2 = 3 \times 2.174 = 6.522$ MOLE

SINCE N_2H_4 PRODUCES LEAST AMOUNT OF N_2.

THEREFORE N_2H_4 IS LIMITING REACTANT

AMOUNT OF N_2 = 4.688 MOLE

MASS OF N_2 = 4.688 × 28 = **131.26 g**.

Q NO 22 $SiO_2 + 3C \longrightarrow SiC + 2CO$

When 100 kg sand is reacted with excess of carbon, 51.4 kg of SiC is produced. What is the percentage yield of SiC.

MASS OF SiO_2 = 100 kg = 100000 g, ACTUAL YIELD

MOLES OF $SiO_2 = \frac{100000}{60}$ = 1666.67 MOLE

1 MOLE SiO_2 PRODUCES SiC = 1 MOLE

1666.67 MOLE " SiC = 1666.67

MASS OF SiC = 1666.67 × 40

= 66666.67 g

THUS THEORATICAL YIELD = 66.66667 kg

% YIELD = $\frac{\text{ACTUAL YIELD}}{\text{THEORATICAL YIELD}} \times 100$

= $\frac{51.4}{66.67} \times 100 = 77\%$

P-1

CHAPTER NO. 1 (SHORT QUESTIONS).

Q No: 1: LAW OF CONSERVATION OF MASS HAS TO BE DURING STOICHIOMETRIC CALCULATIONS?

ANS:- STOICHIOMETERY IS THE BRANCH OF CHEM. WH DEALS WITH CALCULATION OF RELATIVE QUAN OF REACTANTS AND PRODUCTS ON THE BASIS BALANCED CHEMICAL EQ. THE EQUATION BE BALANCED ONLY IF LAW OF CONS MASS IS OBEYED I.E TOTAL MASS OF R MUST BE EQUAL TO TOTAL MASS OF P

Q No:2:- MANY CHEMICAL REACTIONS IN OUR SURRO INVOLVE RX LIMITING REACTANTS? HOW?

ANS:- IF REACTANTS ARE NOT MIXED IN STOICHIOMETR AMOUNTS ONE OF THE REACTANTS IS CONSUME EARLIER. IT IS CALLED LIMITING REACTA IN MIST OF REACTIONS TAKING PLACE AR US REACTANTS ARE NOT PRESENT IN STOI METERIC AMOUNTS. FOR EXAMPLE WHEN IS BURNT IN AIR, OXYGEN IS EXCESSIVE AND CH_4 IS CONSUMED EARLIER. IT IS.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

LIMITING EXCESSIVE

BURNING OF COAL IN AIR. COAL IS LIMITI

$$C + O_2 \longrightarrow CO_2$$

REACTION CONTINOUS UNTILL COAL IS PRESE AND STOPS DUE TO ITS CONSUMPTION.

Q No: 3:- WT INDIVIDUAL NEON ATOM IN A SAMPLE OF NEON HAS A MASS OF 20.18 AMU.

ANS:- IT IS AVERAGE ATOMIC MASS OF NEON WHICH DEPEND UPON WT OF ISOTOPES AND THEIR % ABUN. NEON HAS THREE ISOTOPES WITH ATOMIC MASSES 20, 21, 22 WITH % ABUNDANCE 90.92, 0.26 AND 8.82 % RESPECTIVELY. THUS ITS AV. AT. MASS IS $= \frac{20\times90.92 + 21\times0.26 + 22\times8.82}{100}$

AV. ATOMIC MASS = 20.18 AMU.

THUS NO INDIVIDUAL ATOM OF NEON HAS 20.18 amu.

Q No: 4:- ONE ~~MOLE~~ MOLE OF H_2SO_4 SHOULD COMPLETELY REACT WITH ~~ONE~~ TWO MOLE OF NaOH? WHY?

ANS. ACID BASE REACTION IS SIMPLY COMBINATION OF H^{1+} FROM ACID AND OH^{1-} IONS FROM BASE.

$$H^{1+} + OH^{1-} \longrightarrow H_2O$$

1 MOLE H^{1+} ION REQUIRE 1 MOLE OH^{1-} ION EACH MOLE OF H_2SO_4 PRODUCES TWO MOLE OF H^{1+} IONS. EACH MOLE OF NaOH PRODUCES ONE MOLE OF OH^{1-} IONS. SO FOR TWO MOLE OF H^{1+} ION FROM 1 MOLE H_2SO_4 WE WILL REQUIRE TWO MOLE OF OH^{1-} IONS WHICH ARE PRODUCED BY TWO MOLE NaOH

$$H_2SO_4 \longrightarrow 2H^{1+} + SO_4^{2-}$$

$$2\,NaOH \longrightarrow 2Na^{1+} + 2OH^{1-}$$

$2H^{1+} + 2OH^{1-} \longrightarrow 2H_2O$

Q No: 5 ONE MOLE OF H_2O HAS TWO MOLES OF BONDS

ANSWER:- SINCE 1 MOLECULE OF H_2O HAS TWO COVALENT BONDS, THREE ATOMS (2H, 1 Oxy) AND 10 ELECTRONS. EACH MOLECULE HAS

PROTONS 2+8
ELECTRON 2+8
NEUTRON 0+8
} 28 PARTICLES (Electrons, protons, neutrons)

THUS IN ONE MOLE OF H_2O THERE WILL BE 3 MOLE BONDS, THREE MOLE ATOMS, 10 MOLE ELEC AND 28 MOLE FUNDAMENTAL PARTICLES.

Q NO: 6:- N_2 AND CO HAVE SAME NO. OF ELECTRONS PROTONS AND NEUTRONS.

ANS:- NITROGEN HAS ATOMIC NO: 7 AND ATOMIC MASS 1
THUS NITROGEN MOLECULE HAS (7+7) PROTON (7+7) ELECTRONS, (7+7) NEUTRONS.

IN CO CARBON HAS 6P, 6e^- AND 6 NEUTRON.
OXYGEN HAS 8P 8e AND 8 NEUTR.

THUS TOTAL NO. OF PROTON = 14, ELECTRON 14
NEUTRON = 14

THUS BOTH N_2 AND CO HAVE SAME NO. OF ALL FUNDAMENTAL PARTICLES.