Basic Chemistry

Density **is the mass of an object divided by its volume. Density often has units of grams per cubic centimeter (g/cm^3)**.

$$\text{Density} = \frac{wt(g)}{v(cm^3)} \quad \text{or} = \frac{wt(g)}{v(ml)}$$

In the law above, It's also can replace the density by the Specific gravity which is the density of a material at a certain temperature divided by the density of water at certain temperature; the reference temperature is usually 20 degrees Celsius.

Dilution law

Dilution law: number of moles, equivalents or formal weights of the concentrated solution should be equal to those of diluted one.

number of moles = number of moles

(concentrated) = (diluted)

No. moles(con.) = MX V

M con. X Vcon. = Mdil. X Vdil.

Ex: **A bottle of concentrated HClO4 has the following information on its label : Gram formula weight (100.5g/fw), Specific gravity 1.60 and weight / weight % equal (70 %) calculate**:

A- Formal concentration

B- How many grams of HClO4 are contained in each milliliter of the reagent.

C- How would you prepare 250 ml of 3 F of HClO4 from the concentrated reagent؟

A– $F = \frac{\% \times Sp.g \times 10}{Gfw}$

F= $\frac{70 \times 1.6 \times 10}{100.5} = 11.144$ F

b– WtWt% = $\frac{\text{Wt of solute}}{\text{Wt of solution}} \times 100$

$$Sp.g = \frac{Wt\ g\ of\ solution}{Vml\ of\ solution}$$

∴ Wt g of solution = Sp.g× Vml of solution

$$Wt/Wt\% = \frac{Wt\ of\ solute}{Sp.g \times Vml\ of\ solution} * 100$$

$$70 = \frac{Wt(g)\ HClO_4}{1.6 \times 1} * 100$$

$Wt(g)\ HClO_4 = 1.12$ g

c- The formal concentration of concentrated solution equal 11.144 as calculated in (a)

F_1V_1(for concentrated solution)= F_2V_2 (for ditute solution)

$11.144 \times V_1 = 3 \times 250$

$V_1 = 67.3$ ml

67.3 ml of concentrated solution dilute to 250 ml by water

Molarity: **(M) is the number of molecular weights or moles of solute per liter of solution, or the number of mill moles per milliliter**.

Note: the formal and molar concentration of solution may in some cases be identical, in others, they will be quite different.

$$M = \frac{no.\ of\ moles}{V\ Liter} = \frac{no.\ of\ mmoles}{Vml}$$

$$M = \frac{Wt(g) \times 1000}{M.Wt \times Vml}\ mole/Liter$$

Ex: **describe the preparation of 2 liter of 0.108 M BaCl2 from BaCl2 .2H2O (Mw = 244.3 g /mol) (Aw of Ba =137.327, Cl = 35.5 , H=1 , O = 16).**

$$M = \frac{Wt(g) \times 1000}{MW \times Vml}$$

$$0.108 = \frac{Wt\ BaCl_2 \times 1000}{206.3 \times 2000}$$ ∴ $WBaCl_2 = 44.56$ gm

B/ **Molarity (M) for concentrated solutions** :

$$M = \frac{Wt(g) \times 1000}{MWt \times Vml}$$

density for solutioion (d) $= \frac{\text{Wt g of solution}}{\text{Vml of solution}}$

$\therefore \text{Vml} = \frac{\text{Wt g of sol.}}{d}$

$M = \frac{Wt(g) \times 1000 * d}{MWt \times W \text{ g of sol.}}$

$M = \frac{\% \times d \times 10}{MWt}$

or $M = \frac{\% \times Sp.g \times 10}{MWt}$

Ex: **A bottle of concentrated H2SO4 has the following information on its label : molecular weight 98.078 g/mole, density 1.84 g/ml and weight / weight % equal (98 %) calculate:**

a- Molar concentration

b- prepare 100 ml of 0.5M of H2SO4from the concentrated reagent ?

$a-$ $M = \frac{\% \times Sp.g \times 10}{MWt}$

M= 98×1.84×1098.078=18.38 mole Liter

$b- M_1V_1(for\ concentrated\ solution) = M_2V_2\ (for\ ditute\ solution)$

$18.38 \times V_1 = 0.5 \times 100\ V_1 = 2.72\ ml\ of concentrated\ solution\ dilute\ to\ 100\ ml\ by\ water$

Normality (N) : is the number of equivalents of solute which are contained in a liter of solution (or milliequivalents per milliliter)

$N = \frac{\text{no.of equivalents}}{\text{VLiter}}$

$= \frac{\text{no. of mequivalents}}{\text{Vml}}$

no.of equivalents (Eq)= $\frac{\text{Wight (Wt) in gram}}{\text{EW g/equivalent}}$

$N = \frac{Wt(g) \times 1000}{eq.Wt \times Vml}$ equivalent/Liter

$Eq.Wt = \frac{M.wt}{\eta}$

$\eta = no.\ of\ inoized\ H\ (acid)$

$= no.\ of\ inoized\ OH\ (base)$

$= oxdation\ no.\ of\ cation \times no.\ of\ their\ atmes\ (salt)$

$= no.of\ electrons\ gained\ or\ lost\ (oxidation\ and\ reduction)$

EX : **Describe the preparation of 2 liters of 0.1 N Na_2CO_3 (M.wt = 106 g/mole) from the pure solid.**

$$N = \frac{Wt(g)\times 1000}{eq.Wt * Vml} \quad = \frac{106}{2} = 53$$

$$0.1 = \frac{Wt\times 1000}{53\times 2000}, \quad Wt = 10.6\ g\ of\ Na_2CO_3$$

The relationship between Mand N

$$M = \frac{W * 1000}{Mw * Vml}$$

$$Eq.Wt = \frac{M.wt}{\eta}$$

$$M.wt = Eq.Wt * \eta$$

$$M = \frac{Wt * 1000}{Ew * \eta * Vml}$$

$$M = \frac{N}{\eta}$$

$$N = M * \eta$$

B/ Normality (N) for Liquids:

$$N = \frac{Wt(g)\times 1000}{Eq.Wt \times Vml}$$

$$\text{density for solutioion (d)} = \frac{\text{Wt g of solution}}{\text{Vml of solution}}$$

$$\therefore Vml = \frac{\text{Wt g of sol.}}{d}$$

$$N = \frac{Wt(g)\times 1000 \times d}{Eq.Wt\times \text{Wt g of sol.}}$$

$$N = \frac{\%\times d\times 10}{Eq.Wt}$$

$$\text{or } N = \frac{\%\times Sp.g\times 10}{Eq.Wt}$$

Ex: A bottle of concentrated H_2SO_4 has the following information on its label : molecular weight 98.078 g/mole, density 1.84 g/ml and weight / weight % equal (98 %) calculate:

A- normal concentration

B- prepare 100 ml of 0.5N of H2SO4from the concentrated reagent؟

$$A-\ N=\frac{\%\times Sp.g\times 10}{eq.\ Wt} \longrightarrow N=\frac{98\times 1.84\times 10}{\frac{98.078}{2}}$$

=36.76 equivalent /Liter

b− N_1V_1(for concentrated solution)= N_2V_2 (for ditute solution)

$36.76\times V_1=0.5\times 100\ V_1$

= 1.36 ml of concentrated solution dilute to 100 ml by water

Mole fraction or Molar fraction

$$Xi=\frac{moles\ of\ i}{Total\ moles\ of\ all\ substance}$$

$$X_A=\frac{moles\ of\ A}{moles\ A+moles\ B}$$

$$X_B=\frac{moles\ of\ B}{moles\ A+moles\ B}$$

A usually solute and B solvents and the summation of the mole fraction of both solute and solvent = 1 $X_A+X_B=1$

Ex: Solutions contain 5.8g of acetone (58 g/mole) and 90 g of water (18 g/mole) calculate mole fraction of each component.

No. of moles of water = 90/18=5

No. of moles of acetone =5.8/58 =0.1

Mole fraction of acetone=0.1/(0.1+5)=0.0196

Mole fraction of water =1-0.0196 =0.984.

Ex: prepare 250 ml of H_2SO_4 :H_2O in the ratio of 1:4.

$$each\ volume\ part=\frac{final\ volume\ in\ ml}{\Sigma of\ the\ ratios\ for\ substrate\ and\ solvent}$$

$$=\frac{250}{1+4}=50ml$$

H_2SO_4=1x50 =50ml

H_2O = 4x50 =200ml