NORMALITY :-

$$N = \frac{Gram\ eq.of\ Solute}{Volume\ of\ sol.in\ litre} = \frac{Weight}{Equivalent\ weight} \times \frac{1000}{V\ ml}$$

$$\text{Equivalent Weight} = \frac{Molar\ Mass}{n}$$

Equivalent Weight Definition and Gram Equivalent Weight Equivalent Weight is defined the as ratio of Molar Mass of substance to the valence of the substance. Valence is also denoted as equivalence factor. The valence is the number of H^+ in Acid , OH^- in base and for salt,charge present in ionic forms. For reduction/oxidation (redox) reactions it is number of electrons that an oxidizing or reducing agent can accept or donate are counted as valence or equivalence factor. When the Equivalent Weight is expressed in gram using molar mass in gram, it is called Gram equivalent weight.

Relation between Normality and Molarity

Here is Normality formula in terms of molarity

Normality=n×Molarity

where n = number of H^+ in Acid , OH^- in base and for salt,charge present in ionic forms

EXAMPLE :- Calculate the equivalent weight of following:-

1. NaOH
2. Na2CO3

Molar Mass of NaOH=40
n = 1 as it has 1 OH- ion
Equivalent Weight=Molar Mass÷n=40÷1=40

Molar Mass of Na2CO3

Na2CO3=106
The salt Na2CO3Na2CO3 ionizes to form 2Na+2Na+ and CO−23CO3−2.

So, the charge present on both is 2
n = 2
Equivalent Weight=Molar Mass÷n=106÷2=53

- Molarity = Moles of solute / Liters of Solution (abbreviation = M)
- Molality = Moles of solute / Kg of Solvent (abbreviation = m)
- Normality = number of equivalent of solute x Molarity of Solution (abbreviation = N)
- Mass Percent = mass of solute / mass of solution

Normality equation

To calculate the volume of a definite solution required to prepare solution of other Normality, the following equation is used:
$N_1 V_1 = N_2 V_2$
where N_1= initial Normality
N_2= Normality of the new solution
V_1= initial volume
V_2= volume of the new solution

Suppose we have mix three solution of same solute of Normality N_1 ,N_2 ,N_3 and Volume V_1,V_2 ,V_3
Normality of the resulting solution is given by

NR=N1V1+N2V2+N3V3/V1+V2+V3
Suppose we have mix three solution of different solute(acid) of Molarity M_1 ,M_2 ,M_3 , Volume V_1,V_2 ,V_3
and no of H^+ as n_1 ,n_2 ,n_3

Normaility of the resulting solution is given by
NR=n1M1V1+n2M2V2+n3M3V3÷V1+V2+V3

Acid-Base Titration equation using Normality

In titration, acid and base react with each other and neutralize the solution.The below equation can be used to find the Normality of the acid and base in titration
$N_a V_a = N_b V_b$
Where
N_a =Normality of Acid solution
V_a= Volume of Acid solution
N_b=Normality of base solution
V_b= Volume of base solution

FORMALITY (F)

Formality is used for ionic compounds solution like NaCl It is the number of moles of solute (ionic compound) present in 1 litre solution
Molar mass of ionic compound is known as formula Mass i. e. (FM)
So it is the number of Formula mass in gram of solute in 1 litre solution

unit = 'F' or 'Moles L^{-1}'

$$F = \frac{W\ solute}{F\ M} \times \frac{1000}{V\ ml}$$

Normality Problems

Question 1. 1 M of fe(OH)3fe(OH)3 Solution is

- (a) 2 N
- (b) 3 N
- (c) 1 N
- (d) .333 N

Question 2. .5 gram equivalent of H2SH2S is equal to ?

- (a) .25 Moles of H2SH2S
- (b) 1 moles of H2SH2S
- (c) .05 moles of H2SH2S
- (d) None of the above

Question 3. 300 ml 0.2 M HCl and 200 ml of 0.03M H2SO4H2SO4 are mixed. The normality of the resulting mixture will be

- (a) .044 N
- (b) .72 N
- (c) .84 N
- (d) .144 N

Question 4. Find the Normality of the solution containing .5 gm of NaOH in 1L solution

- (a) .0125 N
- (b) .125 N
- (c) .5 N
- (d) .0250 N

Question 5. how much water is to be added to prepare a .25N HCL solution from .5 N HCL 1 L solution

- (a) 500 ml
- (b) 100 ml
- (c) 1000 ml
- (d) 250 ml

Question 6. 20 ml of a 0.125 N HCl solution were neutralised by 25 ml of a KOH solution. What is the normaility of KOH solution

- (a) .01N
- (b) .1 N
- (d) .2 N
- (d) None of the above

SECTION B SOLVE THE FOLLOWING

SOLUTIONS :-

$\text{Normality}=n\times\text{Molarity}$Normality=n×Molarity
Here n=1 (as 3 OH ions) , Molarity = 1
Hence Normality = $3\times1=3\text{N}$3×1=3N

2. Gram equivalent = n × Moles
Or Moles = Gram equivalent / = .5 /2 = .25 moles

3. Normaility of the resulting solution is given by
$N_R=n_1M_1V_1+n_2M_2V_2V_1+V_2$NR=n1M1V1+n2M2V2V1+V2
$N_R=1\times.2\times300+2\times.03\times200300+200=.144\text{N}$NR=1×.2×300+2×.03×200300+200=.144N

4. Normality(N) = (no.Gram Equivalent of solute)/(Volume of Solution in litre)
No. of Gram Eq. of Solute = weight/Equivalent weight
Now, Equivalent weight=$\text{MolarMassn}=23+16+11=40$MolarMassn=23+16+11=40
So, N = (No.gram eq.mass)/(Vol (l)
=Weight/(Equivalent weight) × 1000/(V ml)
=(.5/40) X (1000/1000)
= .0125 N

5. Let x amount be water be added
$N_1V_1=N_2V_2$N1V1=N2V2
$.5\times1=.25(1+x)$.5×1=.25(1+x)
x= 1 litre

6. using titration formula
$N_aV_a=N_bV_b$NaVa=NbVb
$.125\times20=x\times25$.125×20=x×25
or x = .1 N

Practice Problems: Solutions (Answer Key)

1. What mass of solute is needed to prepare each of the following solutions?

   a. 1.00 L of 0.125 M K_2SO_4 **21.8 g K_2SO_4**

   b. 375 mL of 0.015 M NaF **0.24 g NaF**

   c. 500 mL of 0.350 M $C_6H_{12}O_6$ **31.5 g $C_6H_{12}O_6$**

2. Calculate the molarity of each of the following solutions:

   a. 12.4 g KCl in 289.2 mL solution **0.576 M KCl**

   b. 16.4 g $CaCl_2$ in 0.614 L solution **0.241 M $CaCl_2$**

   c. 48.0 mL of 6.00 M H_2SO_4 diluted to 0.250 L **1.15 M H_2SO_4**

3. Calculate the molality of each of the following solutions:

   a. 2.89 g of NaCl dissolved in 0.159 L of water (density of water is 1.00 g/mL) **0.311 molal NaCl**

   b. 1.80 mol KCl in 16.0 mol of H_2O **6.25 molal KCl**

   c. 13.0 g benzene, C_6H_6 in 17.0 g CCl_4 **9.80 molal C_6H_6**

4. The normality of 0.3 M phosphorus acid (H3PO3) is

   (a) 0.1 (b) 0.9

   (c) 0.3 (d) 0.6

5. The molarity of a solution obtained by mixing 750 mL of 0.5 M HCl with 250 mL of 2 M HCl will be (2013 Main)
(a) 0.875 M (b) 1.00 M (c) 1.75 M (d) 0.0975M

6. In which mode of expression, the concentration of a solution remains independent of temperature? (1988, 1M)
(a) Molarity (b) Normality (c) Formality (d) Molality