VMC Vidyamandir Classes SINCE 1986

IIT JEE | MEDICAL | FOUNDATION

Stoichiometry-1

SAP-4

Q. If Urea is dissolved in water to make a sol^n of density 1.2 gm/ml such that $\left(\%\frac{w}{w}\right)_{Urea} = 10\%$. Find

(i) $\left(\%\frac{w}{V}\right)_{Urea}$ (ii) M

iii) m (iv) x_{Urea}

Sol^n → $\left(\%\frac{w}{w}\right)_{Urea} = 10\%$

If $w_{sol^n} = 100$ gm, $d_{sol^n} = 1.2$ g/ml

$w_{Urea} = 10$ gm (NH_2CONH_2)

$w_{H_2O} = 90$ gm

$$V_{sol^n} = \frac{100}{1.2} = \frac{1000}{12} = \frac{250}{3} \text{ ml}$$

$$\left(\%\frac{w}{V}\right)_{Urea} = \frac{10}{250} \times 3 \times 100 = 12\%$$

Shortcut $\rightarrow$ $\left(\%\frac{w}{v}\right)_{solute} = \left(\%\frac{w}{w}\right)_{solute} \times \underset{gm/ml}{d_{sol^n}}$

$$M = \frac{(10/60)}{(250/3)} \times 1000 = 2\ Mol/lit.$$

$$* \quad M = \left(\%\frac{w}{v}\right)_{solute} \times \frac{10}{(M_o)_{solute}}$$

$$= \left(\%\frac{w}{w}\right)_{solute} \times d_{sol^n} \times \frac{10}{(M_o)_{solute}}$$

$$m = \frac{(10/60)}{(90/1000)} = 1.85\ mol/Kg$$

$$* \quad m = \frac{1000 \times M}{(1000 \times d_{sol^n}) - M \cdot (M_o)_{solute}}$$

$$x_{Urea} = \frac{(10/60)}{\left(\frac{10}{60} + \frac{90}{18}\right)} = \frac{1}{31}$$

Q. If glucose is dissolved in water to make a sol^n of 2M, having density equal to 1.1 gm/ml then find

(i) $\left(\%\frac{w}{w}\right)_{glucose}$ (ii) $\left(\%\frac{w}{v}\right)_{glucose}$

(iii) m (iv) $x_{glucose}$

<u>Sol^n →</u> 2 M sol^n

2 mol glucose ⇒ 360 gm glucose

1 lit. sol^n, $d_{sol^n} = 1.1$ gm/ml

$$w_{sol^n} = 1.1 \times (1000) = 1100 \text{ gm}$$

$$w_{H_2O} = 1100 - 360 = 740 \text{ gm}$$

$$\left(\%\frac{w}{w}\right)_{glucose} = \frac{360}{1100} \times 100 = 32.73\%$$

$$\left(\%\frac{w}{v}\right)_{glucose} = \frac{360}{1000} \times 100 = 36\%$$

$$m = \frac{2}{(740/1000)} = 2.7 \text{ mol/kg}$$

$$x_{glucose} = \frac{2}{2 + \frac{740}{18}} = \frac{36}{776}$$

110. If 100 mL of H_2SO_4 and 100 mL H_2O are mixed, the mass percent of H_2SO_4 in the resulting solution in

$(d_{H_2SO_4} = 0.9\ g\,mL^{-1}, d_{H_2O} = 1.0\ g\,mL^{-1})$

(A) 90 (B) 47.36 (C) 50 (D) 60

$$\left(\% \frac{w}{w}\right)_{H_2SO_4} = \frac{(100 \times 0.9)}{(100 \times 0.9) + (100 \times 1)} \times 100$$

$$= \frac{90}{190} \times 100 = 47.36\,\%$$

21. The amount of sugar ($C_{12}H_{22}O_{11}$) required to prepare 2 L of its 0.1 M aqueous solution is: **(2019)**

(A) 34.2 g (B) 17.1 g (C) 136.8 g (D) 68.4 g

Sol^n →

$$0.1 = \frac{(x/342)}{2}$$

$$x = 68.4\ gm$$

Equivalent mass → It is mass of atom that combines with 1 gm H, 8 gm O, 35.5 gm Cl in its hydride, oxide and chloride respectively.

Ex. MgO (oxide of Mg)

24 gm 16 gm

12 gm 8 gm

12 gm → Equivalent mass of Mg

Ex. CaH_2 (Hydrolith, Hydride of Ca)

Ca → 40 gm, H_2 → 2 gm

20 gm — 1 gm

20 gm → Equivalent mass of Ca

Ex. $AlCl_3$ (chloride of Al)

Al → 27 gm, Cl_3 → 106.5 gm

9 gm — 35.5 gm

9 gm → Equivalent mass of Al

*
$$\boxed{\text{Equivalent mass} = \frac{\text{Molar mass}}{\text{n-factor or valency factor}}}$$

Calculation of n-factor →

(1) **For atom** → n f. = valency of atom

Na → 1
Mg → 2
Ca → 2

O → 2
F → 1
Cl → 1

H → 1

(2) **For ion** → n f. = charge on ion

Ex. $SO_4^{2-} \longrightarrow 2$

$Cl^- \longrightarrow 1$

$PO_4^{3-} \longrightarrow 3$

$NH_4^+ \longrightarrow 1$

$CO_3^{2-} \longrightarrow 2$

$C_2O_4^{2-} \longrightarrow 2$

(3) For Salt $\longrightarrow$ n-factor = Total +ve charge
or
Total −ve charge

Ex.

$NaCl \longrightarrow 1$

$Na^+ \ Cl^-$

$MgCl_2 \longrightarrow 2$

$Mg^{2+} \ 2Cl^-$

$Al_2(CO_3)_3 \longrightarrow 6$

$2Al^{3+} \ 3CO_3^{2-}$

$Al_2(SO_4)_3 \longrightarrow 6$

$2Al^{3+} \ 3SO_4^{2-}$

$Ca_3(PO_4)_2 \longrightarrow 6$

$3Ca^{2+} \ 2PO_4^{3-}$

(4) For acids →

n-factor = basicity
or
No. of furnishable H^+ ions
Per molecule of acid

Ex.

$HCl \longrightarrow 1$

$H_2SO_4 \longrightarrow 2$

$H_2CO_3 \longrightarrow 2$

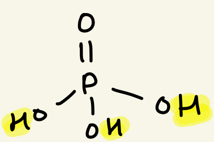
$H_2C_2O_4 \longrightarrow 2$

$H_2S \longrightarrow 2$

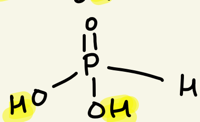
$HNO_3 \longrightarrow 1$

$HNO_2 \longrightarrow 1$

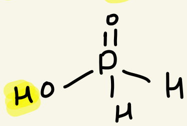
$H_2SO_3 \longrightarrow 2$



H_3PO_4 (Phosphoric acid) $\longrightarrow 3$



H_3PO_3 (Phosphorous acid or Phosphonic acid) $\longrightarrow 2$



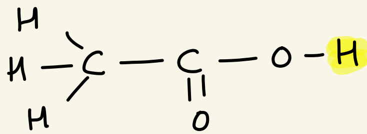
H_3PO_2 (Hypo Phosphorous acid or Phosphinic acid) $\longrightarrow 1$

$KHC_2O_4 \longrightarrow 1$

$KHC_2O_4 \cdot H_2C_2O_4 \longrightarrow 3$

$KHC_2O_4 \cdot 2H_2C_2O_4 \longrightarrow 5$

$CH_3COOH \longrightarrow 1$



* oxides of non metals are acidic.

CO_2 $\qquad CO_2 + H_2O \longrightarrow 2H^+ + CO_3^{2-}$

$nf. = 2$

SO_2 $\qquad SO_2 + H_2O \longrightarrow 2H^+ + SO_3^{2-}$

$nf. = 2$

SO_3 $\qquad SO_3 + H_2O \longrightarrow 2H^+ + SO_4^{2-}$

$nf. = 2$

P_4O_{10} $\qquad P_4O_{10} + 6H_2O \longrightarrow \underbrace{4H_3PO_4}_{\downarrow}$

$nf. = 12$

$$12H^+ + 4PO_4^{3-}$$

* H_3BO_3 $\qquad H_3BO_3 + H_2O \longrightarrow H^+ + [B(OH)_4]^-$

$nf. = 1$

* sol^n of salt of strong acid and weak base is acidic.

Ex. $\qquad FeCl_3 \qquad nf. = 3$

$AlCl_3$ $\quad$ n.f. = 3

$$AlCl_3 + 3H_2O \longrightarrow Al(OH)_3 + 3H^+ + 3Cl^-$$

(5) For Bases →

n-factor = no. of furnishable OH^- ions per molecule of base

or

no. of gained H^+ ions per molecule of base

Ex.

		n.f.
$NaOH$	→	1
KOH	→	1
$Ca(OH)_2$	→	2
$Mg(OH)_2$	→	2
NH_4OH	→	1
$Fe(OH)_3$	→	3
Na_2O	→	2
MgO	→	2
CaO	→	2
NH_3	→	1
$NaHCO_3$	→	1

$$Na_2O + H_2O \longrightarrow 2Na^+ + 2OH^-$$

$$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$$

$KHCO_3 \longrightarrow 1$

$Ca(HCO_3)_2 \longrightarrow 2$

$CaCO_3 \longrightarrow 2$

$MgCO_3 \longrightarrow 2$

$Al_2(CO_3)_3 \longrightarrow 6$

Calculation of no. of equivalents or no. of gram equivalents $\longrightarrow$

$$\boxed{\begin{aligned} \text{No. of eq.} &= \frac{\text{Mass in grams}}{\text{Equivalent mass}} \\ &= \text{no. of moles} \times \text{n-factor} \end{aligned}}$$

Normality (N) $= \dfrac{\text{No. of eq. of solute}}{\text{vol. of sol}^n \text{ in litre}}$

$$\boxed{N = M \times (\text{n-factor})_{\text{solute}}}$$

Q If 200 gm NaOH is dissolved in 900 gm H_2O to make a sol^n of density 1.2 g/ml then find

(i) No. of mmoles of NaOH

(ii) No. of equivalents of NaOH

(iii) Molarity

(iv) Normality (v) molality

Sol^n →

200 gm NaOH

$$\text{No. of moles of NaOH} = \frac{200}{40} = 5 \text{ mole}$$

$$\text{No. of mmoles of NaOH} = 5000 \text{ mmole}$$

$$\text{No. of eq. of NaOH} = 5 \times 1 = 5$$

$$\text{molality} = \frac{5}{0.9} = 5.56 \text{ mol/kg}$$

$$d_{sol^n} = 1.2 \text{ gm/ml}$$

$$w_{sol^n} = 200 + 900 = 1100 \text{ gm}$$

$$V_{sol^n} = \frac{1100}{1.2} \text{ ml}$$

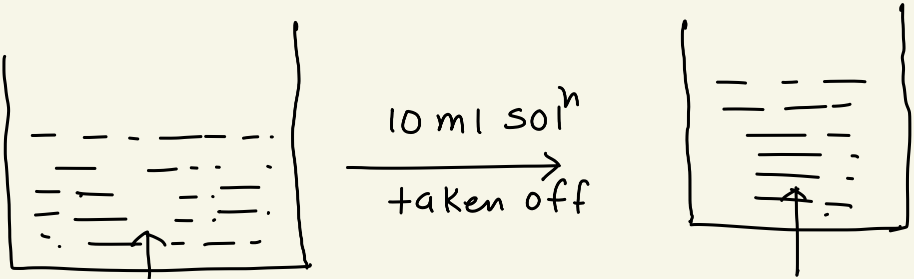
$$M = \frac{5 \times 1.2 \times 1000}{1100} = 5.45 \frac{\text{mol}}{\text{lit.}}$$

$$N = M \times n\text{-factor}$$

$$= 5.45 \times 1 = 5.45 \text{ eq./lit.}$$

Sampling and dilution of sol^n →

(1) Sampling →



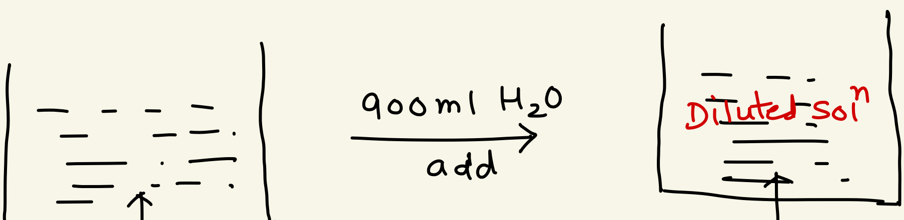
1 M
1000 ml
"stock sol^n"
1 mol solute

10 ml
"Sample sol^n"
0.01 mol solute

$$M = \frac{0.01}{10} \times 1000$$
$$= 1$$

During sampling no. of moles of solute, no. of eq. of solute will change but molarity, Normality will not change.

(2) Dilution → addition of H_2O



1 M
100 ml

1000 ml

0.1 mol solute

0.1 mol solute

$M = \frac{0.1}{1} = 0.1$

$$\boxed{\begin{gathered} M_1V_1 = M_2V_2 \\ \text{or} \\ N_1V_1 = N_2V_2 \end{gathered}}$$

$V_2 = V_1 + V_{H_2O}$

on dilution no. of moles of solute, no. of eq. of solute will not change but molarity, Normality will change.

Illustration - 1 *(a) Concentrated acid H_2SO_4 has a density of 1.8 g/ml and contains 49% acid by weight. Compute molarity of the solution. Also calculate the number of gmeq of H_2SO_4 contained in 1 L solution.*

(b) What is the normality of a solution which is prepared by dissolving 100 ml of conc. H_2SO_4 in part (a) in sufficient water to make 500 ml of solution?

(c) If we take 50 ml sample of above solution [in part (b)], find number of milli moles and milli equivalents in the sample.

$\underline{\text{sol}^n \rightarrow}$

$d_{sol^n} = 1.8 \text{ gm/ml}$

$\left(\% \frac{w}{w}\right)_{H_2SO_4} = 49\%$

$M = 49 \times 1.8 \times \frac{10}{98} = 9 \text{ mol/lit.}$

$1 \text{ lit. sol}^n \longrightarrow 9 \text{ mol } H_2SO_4$

No. of eq. of H_2SO_4 in 1 lit. $\text{sol}^n = 9 \times 2 = 18$ eq.

(b) $M_1V_1 = M_2V_2$

$9 \times 100 = M_2 \times 500$

$M_2 = 1.8\ M$

$N_2 = 1.8 \times 2 = 3.6\ N$

(c) 50 ml $sol^n \longrightarrow 1.8\ M$

No. of moles of solute $= \frac{1.8 \times 50}{1000}$

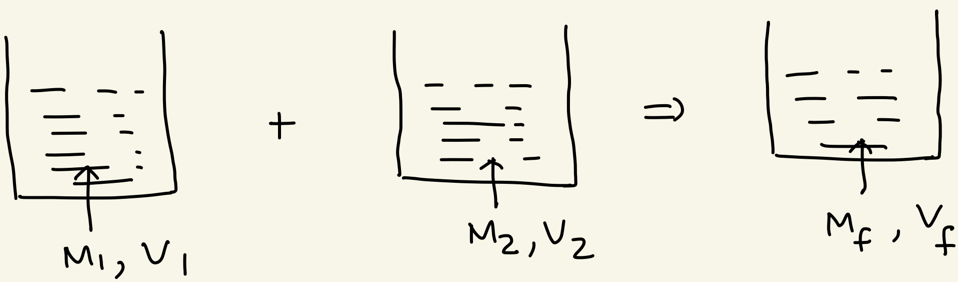
No. of mmoles of solute $= 1.8 \times 50$

$= 90$ mmole

No. of meq. of solute $= 90 \times 2$

$= 180$ meq

Mixing of $sol^n \longrightarrow$



$V_f = V_1 + V_2$

$$\boxed{M_1V_1 + M_2V_2 = M_3V_3}$$

Q. If 2M, 300ml $CaCl_{2(aq)}$ solⁿ is mixed with 3M, 500ml $CaCl_{2(aq)}$ solⁿ. Then find

(i) molarity of new solⁿ

(ii) Molarity of Ca^{2+} in new solⁿ

(iii) molarity of Cl^- ions in new solⁿ.

Solⁿ →

$$(2 \times 300) + (3 \times 500) = M_f \times 800$$

$$M_f = 2.625 \text{ mol/lit.}$$

$$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^-$$

$CaCl_2$	Ca^{2+}	$2Cl^-$
1 M	1 M	2 M
2.625 M	2.625 M	5.25 M

Homework

Workbook-
DTS-1 to 11 :
Q.16,22,23,48,63,65,75,80,89,94,109,115,117,127,134,138,139,140

JEE MAIN archive:
Q.1,2,3,6,7,13,15,21,22,26,30,32,35,36,38,40,41,43,44