BRUSH UP YOUR CONCEPTS

Class XI

This specially designed column will help you to brush up your concepts by practicing questions. You can mail us your queries and doubts related to this topic at editor@mtg.com. The queries will be entertained by the author.*

SOME BASIC CONCEPTS OF CHEMISTRY

In continuation with previous article :

- In 1961, ^{12}C was taken to decide masses of other atoms. $\left(\frac{1}{12}\right)^{th}$ the mass of ^{12}C-atom was taken as 1 unified mass (u), 1 atomic mass unit (amu), 1 carbon unit, 1 dalton, 1 aston and also 1 avogram. One amu corresponds to the production of 931.48 MeV energy.
- Average mass of all the naturally occurring isotopes of an element was taken its average atomic mass.
- The sum of atomic masses of all atoms of elements present in one molecule or formula unit was considered molecular mass.
- The mass of a compound per pre-decided atom is called its minimum molecular mass (Cannizzaro's view).
- The methodology for calculating number of particles, masses, moles and volumes of substance using chemical equations of reactions is called stoichiometry.
- In a chemical reaction, where two reactants are involved, the one which is completely consumed is called limiting reagent. Calculations of other substances are based on this limiting reagent.
- Most commonly used methods of expressing concentrations of solutions are :

  (I) Concentration terms which are not affected by temperature.

  (a) $\text{Mass fraction} = \frac{\text{Mass of component}}{\text{Total mass of solution}}$

  (b) $\text{Mass percent} = \frac{\text{Mass of component}}{\text{Total mass of solution}} \times 100$

  (c) $\text{ppm by mass} = \frac{\text{Mass of component}}{\text{Total mass of solution}} \times 10^6$

  (d) $\text{Mole fraction} = \frac{\text{Moles of component}}{\text{Total moles in solution}}$

  $$\Rightarrow x_B = \frac{n_B}{n_A + n_B}$$

  (e) $\text{Molality}(m) = \frac{\text{Moles of solute}}{\text{Wt. of solvent in kg}}$

  $$= \frac{W_B}{M_B} \times \frac{1000}{W_A(\text{g})}$$

  $$= \frac{1000 \times \text{molarity}}{1000 \times d_{\text{soln}}(\text{g mL}^{-1}) - \text{molarity} \times M_B}$$

  $$= \frac{1000\chi_B}{\chi_A M_A}$$

  (II) Concentration terms which are affected by temperature (volume based).

  (a) $\text{Strength in g L}^{-1} = \frac{W_B(\text{g})}{V_{\text{soln.}}(\text{L})}$

  (b) $\text{Molarity }(M) = \frac{n_B}{V_{\text{soln}}(\text{L})} = \frac{1000\, W_B}{M_B \cdot V_{\text{soln}}(\text{mL})}$

  $$= \frac{1000\, md}{1000 + mM_B} = \frac{10 \times x\%(w/w) \times d}{M_B}$$

- **Dilution of solution :** Molarity of final solution (M_f) if V_1 mL of solution of M_1 molarity is diluted by adding x mL of water, then

  $$M_f = \frac{M_1 V_1}{V_1 + x}$$

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- **Mixing of different solutions of the same solute**
  $M_f V_f = M_1 V_1 + M_2 V_2 + ...$
- **Reactions of two solutions**
  (a) $aA + bB \rightarrow$ Products
  $$\frac{(MV)_A}{(MV)_B} = \frac{a}{b}$$
  (b) W_B g of a substance of molar mass M_B, if completely reacts with V_A mL of another solution of molarity M_A (n_A and n_B are n factors of A and B respectively).
  $$\frac{n_B W_B}{M_B} \times 1000 = M_A V_A n_A$$
  (c) **Acid-base reaction:** A is for acid and B is for base, b is basicity of acid and a is acidity of base.
  (i) If $b(MV)_A = a(MV)_B$, the final solution is neutral with pH = 7
  (ii) If $b(MV)_A > a(MV)_B$, the final solution is acidic (pH < 7) and molarity of final solution
  $$M_f = \frac{b(MV)_A - a(MV)_B}{b(V_A + V_B)}$$
  (iii) If $b(MV)_A < a(MV)_B$, the final solution is basic (pH > 7) and molarity of final solution
  $$M_f = \frac{a(MV)_B - b(MV)_A}{a(V_A + V_B)}$$

MULTIPLE CHOICE QUESTIONS

1. One amu corresponds to ...... MeV energy.
(a) 831.49 (b) 931.48
(c) 6.6×10^{-34} (d) 6.022×10^{23}

2. How many molecules of HCl gas will be produced by reacting 112 L of H_2 (0 °C, 1 atm) with 213 g of Cl_2?
(a) 3.61×10^{24} (b) 6.13×10^{23}
(c) 6.13×10^{24} (d) 1.63×10^{24}

3. 20 mL of 0.4 M $AgNO_3$ (molar mass = 170 g) is reacted with 15 mL of 0.6 M $BaCl_2$ (molar mass = 208.4 g). The mass of AgCl (molar mass = 143.5 g) produced is
(a) 11.48 g (b) 18.14 g
(c) 14.18 g (d) 1.148 g

4. 85 g $CaCO_3$ (limestone sample), on heating produces exactly the same amount of CO_2 which converts 30 g of MgO to $MgCO_3$. The percentage purity of limestone sample is
(a) 80% (b) 82.4%
(c) 88.24% (d) 84.8%

5. Mole fraction of acetic acid in an aqueous sample is 0.1, the molality of the solution is
(a) 7.16 (b) 1.67 (c) 6.17 (d) 5.25

6. The density of 4 M NaOH solution is 1.6 g mL^{-1}. The molality of the solution is
(a) 2.77 (b) 14.28 (c) 7.14 (d) 57.14

7. Which of the following varies with temperature?
(a) Molality (b) Mole fraction
(c) Molarity (d) Mass per cent

8. 1.5 moles of each of XY_2 and XY_3 if weigh 96 g and 120 g respectively. The atomic masses of X and Y respectively are
(a) 4, 8 (b) 8, 16 (c) 32, 16 (d) 32, 64

9. Volume of 0.5 M HCl required for complete reaction of 10 g equimolar mixture of Na_2CO_3 (molar mass = 106 g) and $NaHCO_3$ (molar mass = 84 g) is
(a) 135.8 mL (b) 315.8 mL
(c) 831.5 mL (d) 513.8 mL

10. $KMnO_4$ reacts with oxalic acid solution :
$$2KMnO_4 + 3H_2SO_4 + 5H_2C_2O_4 \rightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$$
What mass of $KMnO_4$ in aqueous solution will suffice to completely react with 100 mL of $M/10$ oxalic acid solution?
(a) 10.53 g (b) 0.632 g
(c) 3.105 g (d) 3.501 g

11. Three samples of NaCl (molar mass = 58.5 g) solutions of molarities 3 M, 5 M and 7 M are mixed in equal volumes. The same volume of water is now added to the solution. The molarity of the final solution is
(a) 3.0 M (b) 5.0 M (c) 2.5 M (d) 7.5 M

12. What volume of H_2SO_4 of 98% mass/mass solution of density 1.8 g mL^{-1} will be used for preparing 5 L of 0.2 M H_2SO_4?
(a) 11.11 mL (b) 44.44 mL
(c) 33.33 mL (d) 55.55 mL

13. What mass of a tribasic acid of molar mass 98 g mol^{-1} will completely neutralise 100 mL of $M/2$ NaOH solution?
(a) 1.633 g (b) 16.33 g
(c) 13.63 g (d) 31.36 g

14. 200 mL of $M/5$ dibasic acid is mixed with 150 mL of $M/2$ monoacid base. The pH of the resulting solution is likely to be
(a) more than 7 (b) less than 7
(c) equal to 7 (d) uncertain.