sns academy

an International CBSE Finger Print School

Coimbatore

SUBJECT – CHEMISTRY

GRADE-XII

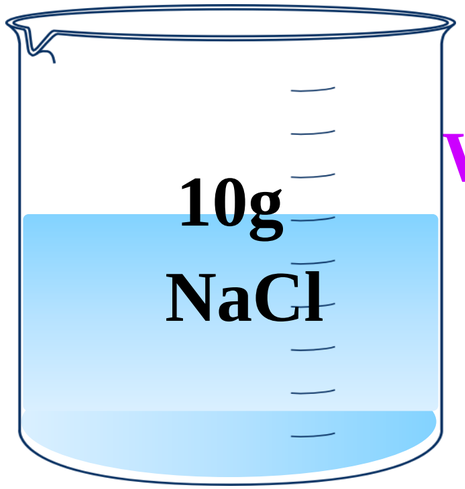
SOLUTIONS

TOPIC – CONCENTRATION

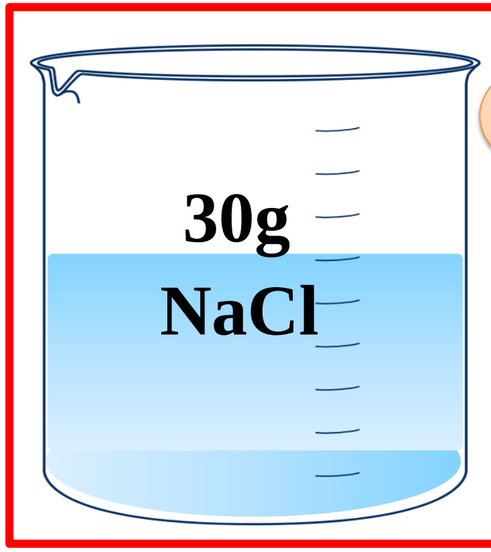
SOLUTIONS

CONCENTRATION

Concentration



Which solution will be more salty ?



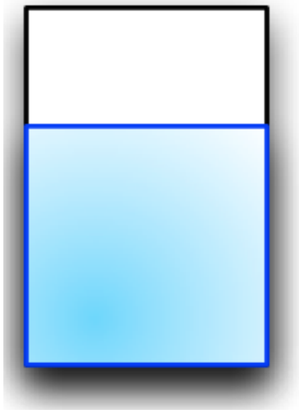
Consider two beakers which contain solvent like water. Add solute like salt in both containers, but in different quantities. more quantity of NaCl. Concentration of NaCl is more

Why is it more salty ?

Concentration is the amount of solute in a known amount of solvent or solution

Question

What is the meaning of dilute solution?



Answer:

- **A solution in which solute is present in very small quantity.**

Question

What is the meaning of concentrated solution?

Answer:

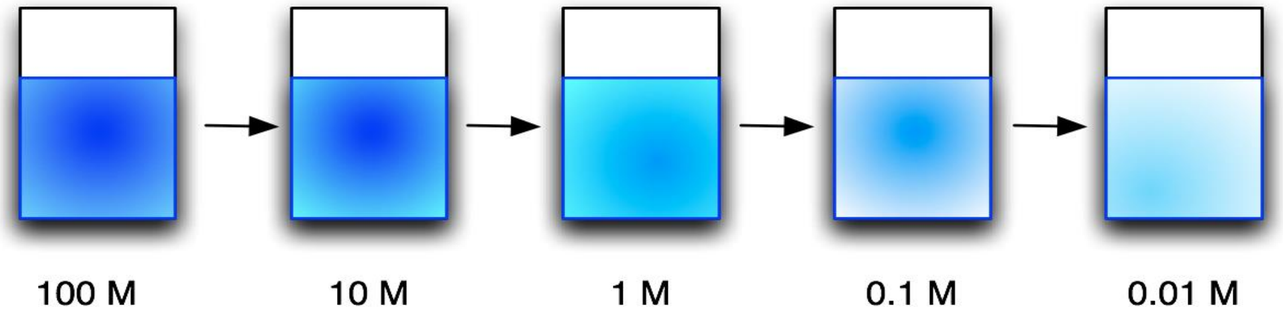
- **A solution in which solute is present in large quantity.**

Question

What is the meaning of standard solution?

Answer:

- **A solution whose concentration is known is called as *standard solution*.**
- **From this any other known concentration can be prepared.**



Question

Which way is better to describe solution if the options are given

1 . Qualitatively

2. Quantitatively

Answer:

- **Quantitatively.**

  i.e., based on amount of solute

The most commonly expressed concentration terms are..

1 MASS PERCENTAGE

2 VOLUME PERCENTAGE

3 MASS BY VOLUME PERCENTAGE

4 ppm (parts per million)

5 MOLE FRACTION

6 MOLARITY

7 MOLALITY

8 NORMALITY

9 FORMALITY

Concentration can be expressed in one ways, two ways or many ways?

MASS & VOLUME PERCENTAGE

A) MASS PERCENTAGE

It is denoted with (w/w)%

Definition:

The amount of solute in grams present in 100 grams of the solution is called *"Mass percentage".*

Formula:

$$\text{Mass \% of component} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

A) MASS PERCENTAGE

What do you mean by 35%(w/w) glucose solution ?

Ans:

35 gms of glucose in 100 g solution

Wt. of glucose = 35 g

Wt. of solution = 100 g

Wt. of solvent = wt. of solution – wt. of solute

= 100 - 35

= 65 g

Question

Calculate the mass percentage of benzene (C_6H_6) and carbon tetrachloride (CCl_4). If 22 g of benzene dissolved in 122 g of carbon tetrachloride (CCl_4).

Answer:

Mass. of solute (Benzene) = 22 g

Mass. of solvent (CCl_4) = 122 g

Mass. of solution = 22+122

= 144 g

Question

Calculate the mass percentage of benzene (C_6H_6) and carbon tetrachloride (CCl_4). If 22 g of benzene dissolved in 122 g of carbon tetrachloride (CCl_4).

Answer:

$$\text{Mass \% of solute} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

$$= \frac{22}{144} \times 100$$

$$= 15.28\ \%$$

$$\text{Mass \% of solvent} = 100 - 15.28 = 84.72\%$$

B) VOLUME PERCENTAGE

It is denoted with (V/V)%

Definition:

The volume of solute in ml present in 100 ml of the solution. It is called *"Volume percentage".*

Formula:

Volume percentage of a component

$$= \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

Question

Can you tell what 10% ethanol means?

Answer:

- **10 ml of ethanol present in 100 ml of aqueous solution.**

Question

Calculate the volume percentage of 10% of ethyl alcohol in a solution of water.

Answer:

Vol. of solute = 10 ml

Vol. of solvent = Vol. of solution – Vol. of solute

= 100 - 10

= 90 ml

Question

Calculate the volume percentage of 10% of ethyl alcohol in a solution of water.

Answer:

$$\text{Vol \% of solute} = \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

$$= \frac{10}{100} \times 100$$

$$= 10$$

MASS BY VOLUME PERCENTAGE & PARTS PER MILLION

C) MASS BY VOLUME PERCENTAGE

It is denoted with (w/V)%

Definition:

The mass of solute in grams present in 100 ml solution or it is the mass of solute dissolved in 100 ml of solution.

Formula:

mass by volume %

$$= \frac{\text{mass of solute}}{\text{Volume of solution}} \times 100$$

Question

What is meant by 10% (w/V)?

Answer:

10 grams of solute present in 100 ml of solution.

Question

Calculate the mass by volume percentage of "NaOH" when 10 grams of NaOH is present in 100 ml of a solution?.

Answer:

Mass. of solute = 10 gms

$$= 10\% \left(\frac{w}{V}\right)$$

Vol. of solution = 100 ml

Question

Calculate the mass by volume of “NaOH” when 10 grams of NaOH is present in 100 ml of a solution.

Answer:

Mass by volume % of NaOH

$$= \frac{\text{mass of solute}}{\text{Volume of solution}} \times 100$$

$$= \frac{10}{100} \times 100 \quad = 10$$

D) Parts per million

- **When a solute is present in very small (trace) quantities, then it is convenient to express the concentration in ppm.**

Formula:

$$\text{ppm} = \frac{\text{Number of parts of the component}}{\text{Total number of parts of all the components in a solution}} \times 10^6$$

D) Parts per million

For example

- **Concentration of dissolved oxygen in a sea water can be expressed in ppm.**

- **Concentration of pollutants in water or atmosphere can be expressed in ppm.**

Question

Explain the importance of fluoride ion in water and any other use?

Answer:

- **1 ppm of fluoride ions concentration in water prevents tooth decay.**
- **1.5 ppm of fluoride ions in water leads to mottled teeth.**
- **Higher concentration of fluoride ions in water becomes poisonous.**
- **Sodium fluoride is used in rat poison.**

MCQs

1. Water pollution can be measured in……..

a) (w/w)%

b)(w/v)%

c) (v/v)%

d) ppm ✓

MOLE FRACTION

E) MOLE FRACTION

It is denoted with X

Definition:

The ratio of number of moles of one component to the total number of moles of all the components present in a solution.

E) MOLE FRACTION

For example

In a binary mixture, if the number of moles of A and B are n_A and n_B respectively, the mole fraction of A will be

$$X_A = \frac{n_A}{n_A + n_B}$$

E) MOLE FRACTION

For a solution containing i number of components, we have

Formula:

$$X_1 = \frac{n_1}{n_1 + n_2 + \ldots\ldots\ldots + n_i} = \frac{n_1}{\sum n_i}$$

- **The sum of mole fractions of all the components is unity.**

i.e $X_1 + X_2 + \ldots\ldots\ldots X_n = 1$

E) MOLE FRACTION

- It is useful in relating some physical properties of solutions like vapour pressure etc.
- It has no units (because it is a ratio of no.of moles).
- It is independent of temperature.

Make a note :

$$\text{Number of moles (n)} = \frac{\text{Weight (Wt)}}{\text{Gram molecular weight (GMW)}}$$

$$\text{Mole percent} = \text{mole fraction} \times 100$$

Question

Calculate the mole fraction of H_2SO_4 in a solution containing 98% H_2SO_4 by mass.

Answer:

98% H_2SO_4 by weight means 100 g of solution contains 98 g of H_2SO_4 by mass

$$\text{Wt. of water} = 100 - 98 = 2\ \text{g}$$

$$\text{No. of moles of } H_2SO_4\ (n_1) = \frac{\text{Wt}}{\text{GMW}} = \frac{98}{98} = 1$$

Question

Calculate the mole fraction of H_2SO_4 in a solution containing 98% H_2SO_4 by mass.

Answer:

$$\text{No. of moles of } H_2O\ (n_2) = \frac{\text{Wt}}{\text{GMW}} = \frac{2}{18} = \frac{1}{9}$$

$$\text{Mole fraction of } H_2SO_4\ (X_1) = \frac{n_1}{n_1 + n_2}$$

$$= \frac{1}{1 + \frac{1}{9}}$$

$$= 0.9$$

Question

A solution of sucrose in water is labelled as 20% (w/w). What would be the mole fraction of each component in the solution ?

Answer:

Mass of sucrose = 20 g

Molar mass of sucrose ($C_{12}H_{22}O_{11}$) = 342 g mol^{-1}

Mass of water (solvent) = 100 - 20

= 80 g

Molar Mass of water = 18 g mol^{-1}

Question

A solution of sucrose in water is labelled as 20% (w/w). What would be the mole fraction of each component in the solution ?

Answer:

$$n_{sucrose} = \frac{20}{342} = 0.0585 \text{ mol}$$

$$n_{water} = \frac{80}{18} = 4.45 \text{ mol}$$

$$n = n_{sucrose} + n_{water}$$

$$= 0.0585 + 4.45 = 4.5$$

Question

A solution of sucrose in water is labelled as 20% (w/w). What would be the mole fraction of each component in the solution ?

Answer:

$$X_{sucrose} = \frac{n_{sucrose}}{n_{total}} = \frac{0.0585}{4.5} = 0.013$$

$$X_{water} = \frac{n_{water}}{n_{total}} = \frac{4.45}{4.5} = 0.987$$

Question

Calculate the mole fraction of benzene in a solution containing 30% by mass in carbon tetrachloride.

Answer:

Mass of solution = 100 g

Mass of CCl_4 = 70 g

Mass of C_6H_6 = 100 - 70

= 30 g

Molecular weight of CCl_4 = 154

Molecular weight of benzene = 78

Question

Calculate the mole fraction of benzene in solution containing 30% by mass in carbon tetrachloride.

Answer:

$$\text{No. of moles of } C_6H_6 = \frac{\text{Mass}}{\text{Molar mass}}$$

$$= \frac{30}{78} = 0.385 \text{ mol}$$

$$\text{No. of moles of } CCl_4 = \frac{70}{154} = 0.454 \text{ mol}$$

Question

Calculate the mole fraction of benzene in solution containing 30% by mass in carbon tetrachloride.

Answer:

$$\text{Mole fraction of } C_6H_6 = \frac{n_{C_6H_6}}{n_{C_6H_6} + n_{CCl_4}}$$

$$= \frac{0.385}{0.385 + 0.454}$$

$$= 0.4583$$

$$\text{Mole fraction of } C_6H_6 = 0.4583$$


Thank you...