Unit 09 Outcomes

LPT

Identify characteristic properties of a solution

Uniform distribution of components (homogeneous)

Components cannot be seen

Variable compositions

May exist in any of three states:

solid, liquid, or gas

Particles do not settle upon standing

Identify and/or define terms relating to solutions

Solution = homogeneous mixture

= uniform composition

Solubility

quantity of a solute that will dissolve at a fixed temperature

typically expressed a grams solute/per 100 mL

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Distinguish among terms in the following groups:

Solute and solute

Solvent

single substance that does the dissolving

substance present in the largest amount

Solute

1 or more substance that is dissolved

substance present in the lower amount

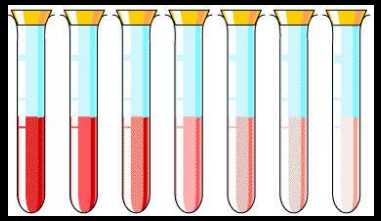
Concentrated and dilute

Concentrated

Contains a relatively large amount of solute

Dilute

Contains a relatively small amount of solute



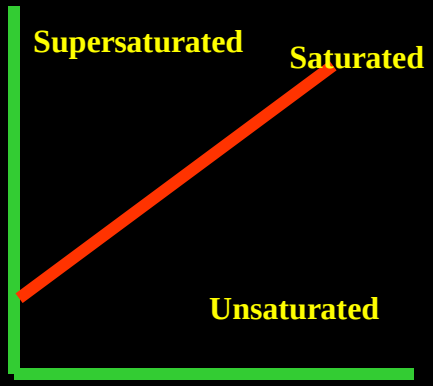
Solubility, saturated, unsaturated

Solubility

quantity of a solute that will dissolve at a fixed temperature

typically expressed a grams solute/per 100 mL

LPT



Saturated

solution contains the maximum amount of solute

a dynamic equilibrium exists (the line on solubility curve)

Unsaturated

solution contains less than the maximum amount of solute

Supersaturated

solution contains more than the maximum amount of solute

carefully prepared (usually from slow cooling)

unstable

Miscible and immiscible

Miscible

Liquids that dissolve in each other in all proportions

Alcohol & water

Vinegar & water

Immiscible

Liquids that do not dissolve in each other

Separate into separate layers

Hydrocarbons & water

LPT

Describe the formation of a solution or the dissolving process in terms of separation of ions, hydration, homogeneity and reversibility.

Ions in solid matrix move into solvent
Ions are surrounded by water molecules (hydration)
- **negative charges near water hydrogen atoms**
- **positive charges near oxygen atoms**

Hydrated ions move in solution until they reach uniform concentration
Equilibrium process between ions in solution and in solid state (reversibility)

Define solution concentration using a "per expression."
- **% by mass = grams solute per 100 mL solution**
- **Moles per Liter = moles / Liter**

Identify the following concentration ratios:

Percentage concentration by mass

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

Molarity

$$M = \frac{\text{moles solute}}{\text{liters solution}} = \text{mol/L}$$

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Given grams of solute and grams of solvent, (or grams of solution), calculate %, (by mass), concentration.

$$\text{Mass \%} = \frac{\text{grams solute}}{(\text{g solute} + \text{g solvent})} \times 100$$

Given desired %, (by mass), concentration calculate the grams of solvent and/or grams of solvent needed to prepare a given volume of solution.

$$\frac{(\text{Mass \%})(\text{grams solution})}{100} = \text{grams solute}$$

Given two of the following, calculate the third:
Moles of solute (or data from which it may be found)
Volume of solution
Molarity

$$M = \frac{\text{moles solute}}{\text{liters solution}} = \text{mol / L}$$

LPT

What is the percent by mass of a solution which is made by dissolving 30.85 g of KBr in 132.4 g of water?

$$\frac{30.85 \text{ g}}{30.85\text{g} + 132.4 \text{ g}} \times 100$$

$$\frac{30.85 \text{ g}}{163.25 \text{ g}} \times 100 = 18.89\ \%$$

How many grams of KNO_3 would be needed to prepare 125.0 g of a 11.5 % by mass solution of KNO_3?

$$11.5\ \% = \frac{\text{g } KNO_3}{125.0 \text{ g}} \times 100$$

$$\text{g } KNO_3 = 14.38 \rightarrow 14.4 \text{ g}$$

How many moles of Na_2SO_4 are in 225.0 mL of a 0.725 M Na_2SO_4 solution?

$$\frac{0.725 \text{ moles}}{1 \text{ L}} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times 225.0 \text{ mL} = 0.163 \text{ moles}$$

4.25 moles of sulfuric acid are dissolved to make 5.00 L. The Molarity of this solution is:

$$\frac{4.25 \text{ moles}}{5.00 \text{ L}} = 0.850 \text{ moles / L} = 0.850 \text{ M}$$

Calculate the molarity of a solution prepared from 78.3 g KBr dissolved in 600. mL of water.

$$\frac{78.3 \text{ g KBr}}{600. \text{ mL}} \times \frac{1 \text{ mole}}{119.01 \text{ g}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 1.0967 \text{ moles / L} \rightarrow 1.10 \text{ M}$$

LPT

Given the quantity of any species participating in a chemical reaction for which the equation can be written, find the quantity of any other species, either quantity being measured in:

a) grams

grams → moles → per expression for reaction → moles → grams

b) volume of gas at STP

1 mole of anything has volume of 22.4 L
Mass of 22.4 L is the molar mass

c) volume of solution of specified molarity

Determine moles present in given solution
Use reaction coefficients ("per expression") to get moles wanted
Convert moles wanted to solution concentration

LPT

How many grams of barium fluoride can be produced from 45.0 mL of 0.645 M sodium fluoride added to an excess of barium nitrate solution?

$$2\ NaF_{(aq)} + Ba(NO_3)_{2\ (aq)} \rightarrow BaF_{2\ (s)} + 2\ NaNO_{3\ (aq)}$$

$$\frac{0.645\ \text{moles NaF}}{1000\ \text{mL}} \times 45.0\ \text{mL} \times \frac{1\ \text{mole } BaF_2}{2\ \text{moles NaF}} \times \frac{175.34\ \text{g}}{1\ \text{mole } BaF_2} = 2.54\ \text{g}$$

How much CO_2 (mL) is formed from 2.00 grams Na_2CO_3?

$$Na_2CO_{3\ (aq)} + 2\ HCl_{\ (aq)} \rightarrow 2\ NaCl_{\ (aq)} + H_2O_{\ (l)} + CO_{2\ (g)}$$

(One mole of a substance occupies 22.4 L at STP)

$$0.83\ \text{g } CO_2 \times \frac{1\ \text{mole } CO_2}{44.01\ \text{g}} \times \frac{22.4\ \text{L}}{1\ \text{mole}} = 422\ \text{mL}$$

LPT

How many milliliters of 0.175 M $NiCl_2$ solution are needed to completely react with 75.0 mL of 0.425 M NaOH solution?

$$NiCl_{2\,(aq)} + 2\,NaOH_{\,(aq)} \rightarrow Ni(OH)_{2\,(s)} + 2\,NaCl_{(aq)}$$

$$\frac{0.425 \text{ moles NaOH}}{1000 \text{ mL}} \times 75.0 \text{ mL} \times \frac{1 \text{ mole } NiCl_2}{2 \text{ mole NaOH}} \times \frac{1000 \text{ mL}}{0.175 \text{ moles } NiCl_2} = 91.1 \text{ mL}$$

LPT

Define the terms relating to titration:

Titration
Controlled addition of a liquid into a vessel to measure the volume that reacts with a substance already in the vessel

Indicator
substance that changes color to signal when to stop a titration

Endpoint
point in a titration when the indicator changes color

Standard Solution
solution of known concentration used in a titration

Neutralization
double replacement reaction: an acid and a base react to form water and a salt

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + \text{Water}$$

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