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Solution is mixture of two or more substance in a single phase. One constituent is usually regarded as the solvent and solutes.

- Solute a substance that is dissolved to make solution.

-solvent is a substance that dissolves solute.

Example

1. **Salt Water**

Salt =solute

Water= solvent

2. **Sugars water**

Sugars = solute

Water = solvent

3. **Air**

Oxygen = solute

Nitrogen = solvent

Water as solvent

Water as solvent for aqueous solutions, many biological fluids are solution or have solution components, ionic substances but poor solvent for non-polar covalent substances (CCl_4).

H-bonding binds water molecules tightly

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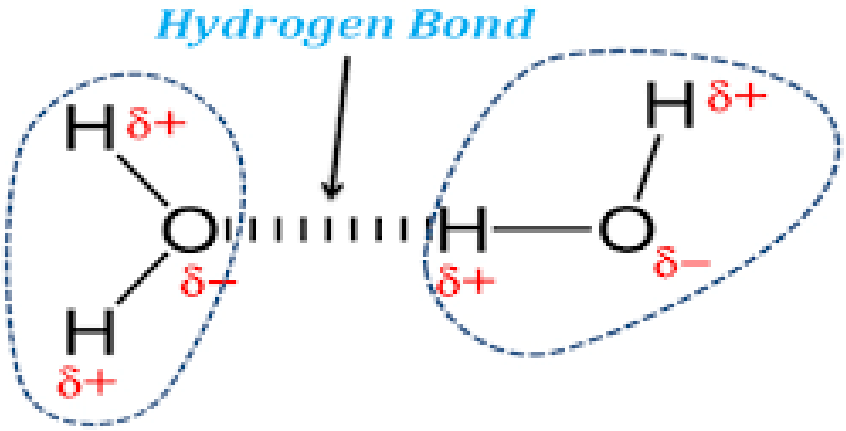
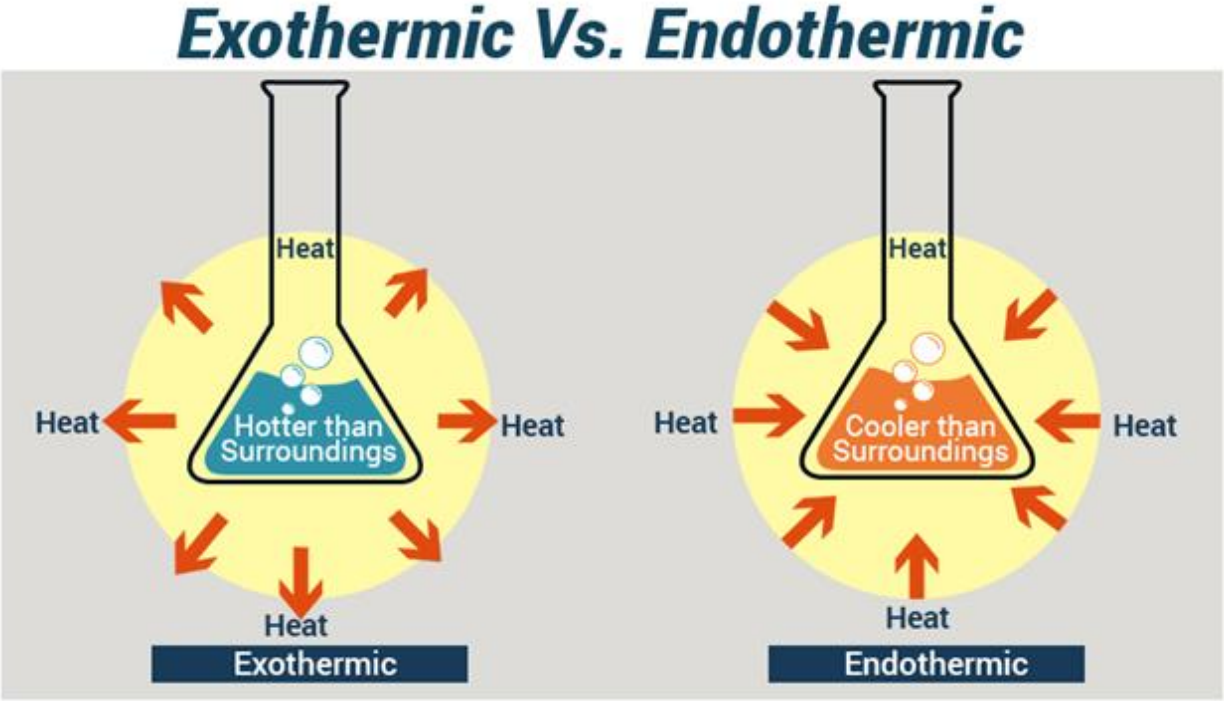


Hydrogen bond increase the boiling point for water.

- **Positive ion associate with negative end of water (O_2) and negative ions associate with positive ends of waters (H_2).**
- **Crystal's +/- attractions cause lattice energy, which must be overcome to break up crystal. On dissolving we must overcome lattice energy.**

Exothermic and endothermic



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Exothermic processes release energy. Hydration energy is grate than lattice energy. Example of exothermic was H_2SO_4 to water.

Endothermic processes absorb energy. Lattice energy greater than hydration energy.

Classified of Solution.

1. **Unsaturated solution contains less than the maximum amount of solute that can dissolve at room temperature.**
2. **Saturated is a Maximum amount of solute for given solvent**
3. **Dilute is a small amount of solute for given solvent**
4. **Concentrated is a large amount of solute for given solvent**

These terms are qualitative, not quantitative

1. **Weight/ weight percentage**

   Percent by volume of solute in a solution = %= $\frac{wt.of\ solute}{wt\ of\ solution}\ x100$

   $(weight\ of\ solute + weight\ of\ solvent$

2-Volume/Volume percentage.

$$\text{percent by volume of solute in a solution} = \frac{\text{Volume of solute(ml)}}{\text{Total volume of solution(ml)}}\ \text{x1oo}$$

3-Weight/Volume percentage.

$$\text{percent by weight/Volume of solute in a solution} = \frac{\text{Weight of solute(gm)}}{\text{Volume of solution(ml)}}\ \text{x100}$$

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4-Parts per million (p.p.m)

$$p.p.m = \frac{\text{Weight of solute(mg)}}{\text{weight of solution (kg)}}$$

- milligram/ litter (mg/L) called ppm

$$Conc. = \frac{wt\ (mg)}{V\ (L)}$$

Chemical concentration

1-Molarity (M):Is number of moles of solute per liter of solution

$$\text{Molarity} = \frac{\text{number of mole}}{\text{Volume of solution}}$$

$$\text{Mole} = \frac{\text{Weigh of solute (gm)}}{\text{Molecular weight(glmole)}}$$

2-Normality(N):

The number of equivalent weight per liter of solution

$$\text{Normality(Eq /L)} = \frac{\text{Number of equivalents (Eq)}}{\text{Volume in litter(L)}}$$

$$\text{Equivalent weight} = \frac{\text{Molecular weight}}{\text{Valence}}$$

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Valence (n) = number of acidic hydrogens in acid or number of hydroxide ion per molecular or number of electrons transport in reaction.

3- N= n x M

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Q/ calculate molarity of 4g from NaOH soluble in 500ml distilled water. (M.Wt= 40)

A/

$$\mathrm{M} = \frac{Wt}{M.Wt} \times \frac{1000}{V\ ml}$$

$$\mathrm{M} = \frac{4}{40} \times \frac{1000}{500}$$

= 0.2 mol/L Molar

➢ Normality

number of equivalent per litter solution

$$\mathrm{N} = \frac{\mathrm{wt.(g)}}{\mathrm{eq.wt}} \mathrm{x}\ \frac{1000}{\mathrm{V_{mL}}}$$

for liquids:

$$\mathbf{N} = \frac{\mathbf{\% \times density \times 1000}}{\mathbf{Eq.Wt}}$$

unit of normality : equivalent /L

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Q/ find normality of HCl solution contain 4.01g/L (M.Wt= 36.45)

A/ $$N = \frac{\mathbf{wt.(g)}}{\mathbf{eq.wt.}} \times \frac{\mathbf{1}}{\mathbf{V_L}}$$

$$= \frac{4.01}{36.45} \times \frac{1}{1}$$

$$= 0.11\ Eq/L$$

Dilution law

We can dilute concentrated liquids using dilution law which is :

(Concentration ×volume) = (concentration × volume)

Before dilution after dilution

$$M \times V_{\text{(before dilution)}} = M \times V_{\text{(after dilution)}}$$

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Q- prepare sulfuric acid (H2SO4) 0.1 Molar in 250 ml of distilled water in volumetric flask from concentrated ((98% density 1.84 g/cm3 M.Wt 98.08))

A-

For concentrated acid

$$\mathbf{M} = \frac{\% \times \mathbf{density} \times 1000}{\mathbf{M.Wt}}$$

$$\mathbf{M} = \frac{\frac{98}{100} X 1.84 X\ 1000}{98.08}$$

M= 18.3

M_1 x V_1 = M_2 xV_2

0.1 x 250 = 18.3x V_2

=1.3 ml

Example

1. **Calculate how many grams of NaOH are required to make a 30.0% solution by using De-ionized water as the solvent.**

Solution

Substitute the numbers that are known in the basic formula for per cent weight

X g of solute in 100g of solution = 30.0%

30.0 g of NaOH = X

2- Determine the % of a solution which has 25.0g of NaCl dissolved in100mL of De-ionized water.

Solution

Given,

Mass of solute (NaCl) = 25g

Mass of solvent (de-ionized water) = 100g (1 mL of de-ionized water roughly weighs 1g)

Therefore, mass of solution = mass of solute + mass of solvent = 100g + 25g = 125g

Mass % of NaCl in this solution = (25g/125g)*100% = 20%

Therefore, mass % of NaCl in the solution is 20%

3- 1 M NaCL solution in 1L H_2O what %(w/v)?

$$\mathbf{M= \frac{wt}{V\ x\ M.Wt}}$$

wt=MxM.wtx V (L)

=1x1X 58.5

=58.5

4- 10g NaCl in 100ml H_2O what %(w/v)?

$$\mathbf{(w/v) = \frac{wt\ of\ solute}{valume\ of\ sovent}\ x100}$$

$$\mathbf{= \frac{10}{100}\ x\ 100}$$

= 10%

5- 4.75 g of NaCl is dissolved in sufficient water to make 750 ml of solution what is the % (w/v) concentration of this solution?

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- **(w/v) =** $\frac{wt\ of\ solute}{valume\ of\ sovent}$ **x100**

$= \frac{4.75\ g}{750\ ml}$ **x 100**

= 0.633% (g/ml)

6- 12.5 g of H2SO4 is dissolved in sufficient water to make o.5 L of solution what is the % (w/v) concentration of this solution?

(w/v) = $\frac{wt\ of\ solute}{valume\ of\ sovent}$ **x100**

$= \frac{12.5\ g}{500\ ml}$ **x 100**

= 2.5%

7- What mass of NaCl is present in 2000ml of 0.85% NaCl solution?

Wt	Vol
0.85g	100 ml
X	2000 ml

$= \frac{0.85\ g}{100\ ml}$ **x 2000 ml**

= 17 g in 2000 ml

Another Solution

w/w%= $\frac{wt.of\ solute}{V\ of\ solution}\ x100$

0.85 %= $\frac{wt.of\ solute}{2000}\ x100$

= 17 g

8- What volume of 0.85% NaCl solution should contain 2.5 g of dissolved NaCl?

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Wt	Vol
0.85g	100 ml
2.5g	x

w/w%= $\frac{wt.of\ solute}{wt\ of\ solution}\ x100$

0.85 %= $\frac{2.5}{wt\ of\ solution}\ x100$

= 294.11 g

9-How would one prepare 6L of 5 percent glucose solution?

Sol.

Conversion factor $\frac{5}{100}$

Wt.	Vol.
5g	100 ml
x	6000 ml

= $\frac{5g}{100}$ **x 6000 ml**

= 300 g dissolved in 6L H_2O.

w/w%= $\frac{wt.of\ solute}{V\ of\ solution}\ x100$

5 %= $\frac{wt.of\ solute}{6000}\ x100$

= 300 g

10- Describe how the following solutions would be prepared

A-500ml of 5% boric acid

B-2L of 0.1%AgNO3

11- How many milli liters of 5% glucose solution should be used to have 10 g of glucose?

Wt.	Vol.
5g	100 ml
10g	x

$= \frac{100}{5}$ x 10 ml

= 200 ml

w/w%= $\frac{wt.of\ solute}{V\ of\ solution}\ x100$

5 %=$\frac{10}{V\ of\ solution}\ x100$

= 200 ml

12-Determine the amount (in milliliters) of solution that will contain the in dictated amount of solute.

A-12g of glucose from 2% glucose solution

B-3.6 g of Nacl from 0.9% NaCl?

13-Determine the number of grams of solute contained in the following solutions?

C-15ml (1table spoon) of 0.25% solute?

D-350ml of 0.9%NaCl?

14-How much 0.1M NaCl solution contains 0.03 mole of NaCl?

M= $\frac{mol}{v}$

= $\frac{0.03}{0.1}$

= 0.3 L

15--How many moles of glucose are in 3L of 0.5 M glucose?

Moles =molarity x vol. (L)

= 0.5 x 3

= 1.5

16-How to prepare 100ml of 1M glucose M.Wt(glucose)=180?

$$\textbf{Wt} = 1 \times 180 \times \frac{100}{1000}$$

= 18 g glucose to be dissolved in 100 ml H_2O.

17- calculate the grams of solute required to prepare each of the following solution

A-250ml of 0.5M Nacl M.wt=58

B-250 ml of 0.2 M NaHCO3 M.wt =84

C-0.5 L of 0.15 M sucrose (C12H22 O11)

18-How many grams of NaCl are in 1500 ml of 0.4 M NaCl? M.t =58

19.Fill the blanks

A-300ml of 0.2 M sucrose contains ……. Moles of sucrose

B-0.25 mole of NaHCO3 are contained in ……. ml of 0.1M NaHCO3

20- How much 5% glucose solution should be diluted to give 750 ml of 2% glucose solution

$$\textbf{V}_1 \textbf{C}_1 = \textbf{V}_2 \textbf{C}_2$$

$$\textbf{V1} \times \frac{5}{100} = 750 \times \frac{2}{100}$$

=300 ml to be diluted to 750 ml