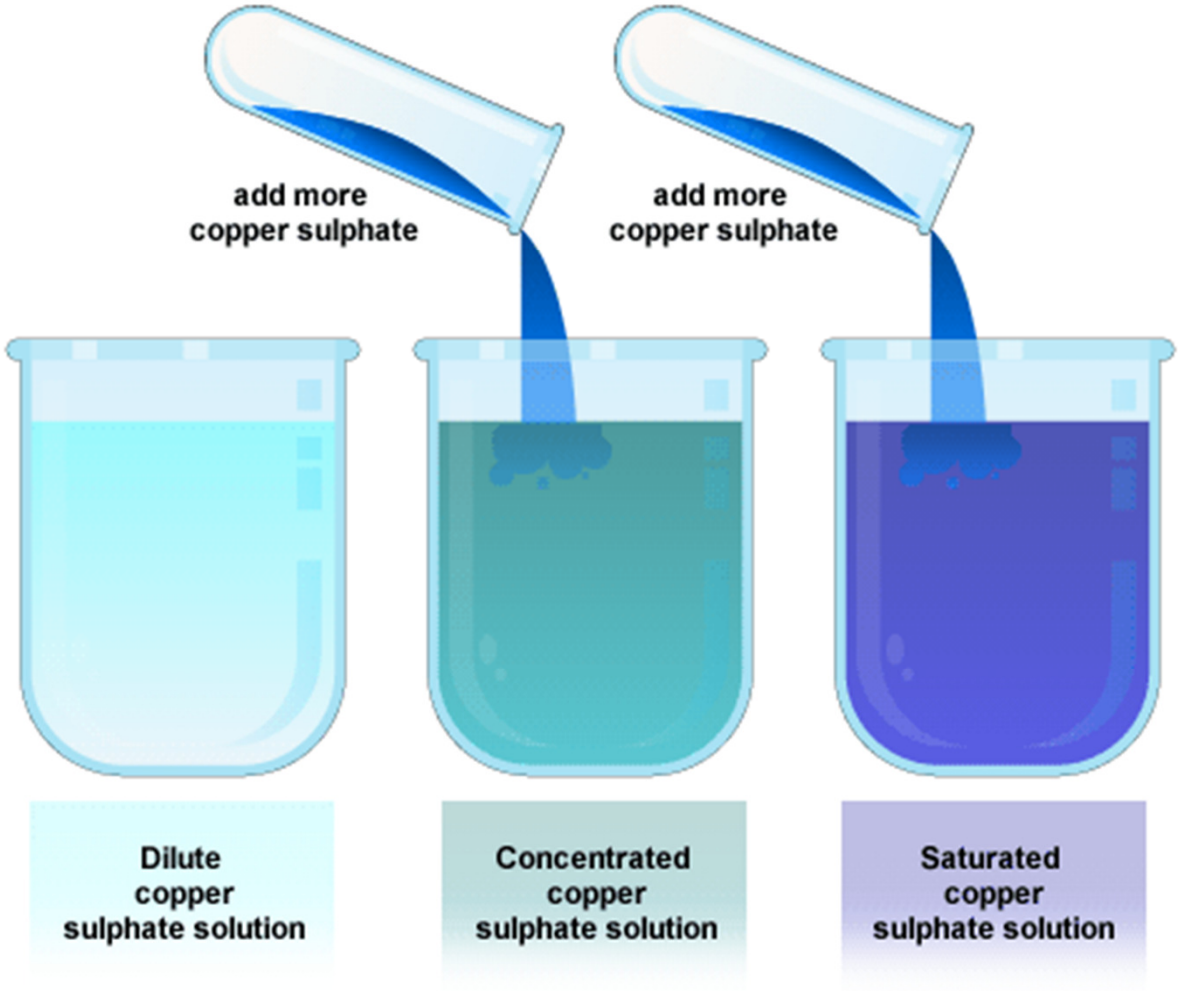
Concentration units

Definition of concentration:

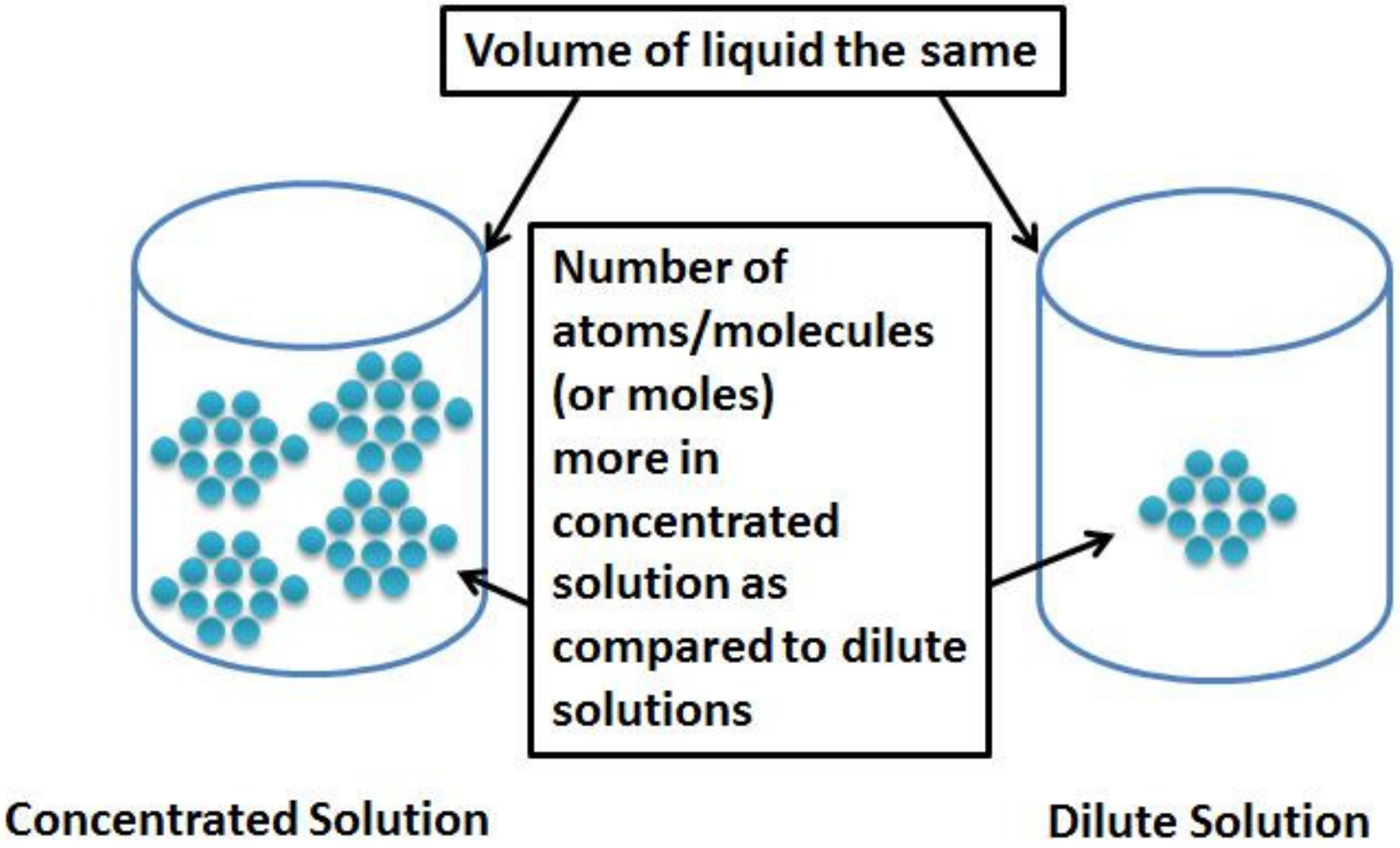
- The amount of substance that present in an unit volume of the solution.
- $$\text{concentration} = \frac{\text{Amount of solute}}{\text{Volume of solution}}$$
- Solution = Solute + Solvent

Concentration

Concentration



Concentration



Concentration units

1- Gram per liter (g/l)

2- Milligram per liter (mg/l)

3- Molarity (mole/l)

4- Normality ($g_{equiv.}$/l)

1- Gram per liter (g/l):

- **Definition**: number of grams of solute dissolved in 1 liter of solution.

- $$\text{Conc.(g/l)} = \frac{\text{No. of grams of solute}}{\text{Volume of solution in liter}}$$

Gram per liter (g/l)

- **Example (1):** calculate the concentration(g/l) of 0.001 Kg of NaCl dissolved in 2 liter of water?
- **Solution :**
  - Conc.(g/l) = $\frac{\text{No. of grams of solute (NaCl)}}{\text{Volume of solution in liter}}$
  - wt. of NaCl = 0.001 Kg * 1000 = 1 gram
  - Vol.= 2 liter
  - Conc.(g/l) = (1/2) = 0.5 g/l

2- Milligram per liter (mg/l)

- **Definition:** number of milligrams of solute dissolved in 1 liter of solution.

- $$\text{Conc.(mg/l)} = \frac{\text{No. of milligrams of solute}}{\text{Volume of solution in liter}}$$

Milligram per liter (mg/l)

- **Example (2):** calculate the concentration (mg/l) of 0.001 Kg of NaCl dissolved in 2 liter of water?
- **Solution :**
- Conc.(g/l) = $\dfrac{\text{No. of milligrams of solute}}{\text{Volume of solution in liter}}$
  - wt. of NaCl = 0.001 Kg * 10^6 = 1000 mg
  - Vol.= 2 liter
  - Conc.(g/l) = (1000/2) = 500 mg/l

3- Molarity (mole/l)

- **Definition:** number of moles of solute dissolved in 1 liter of solution.

- Conc. = $\dfrac{\text{No. of moles of solute}}{\text{Volume of solution in liter}}$

- No. of moles = $\dfrac{\text{weight of solute in gram}}{\text{Molecular weight of solute}}$

Molarity (mole/l)

- Example(3) : Calculate the molarity (M) of 2 gram weight of H_2SO_4 dissolved in 40 ml H_2O.
- **Given that :**
  - At.wt of (H)= 1 amu
  - At.wt of (S)= 32 amu
  - At.wt of (O)= 16 amu

Molarity (mole/l)

- Solution:
- M.wt of H_2SO_4 = (2*H)+(1*S)+(4*O)
- M.wt of H_2SO_4 = (2*1)+(1*32)+(4*16)= 98 amu
- No. of moles = $\frac{\text{weight of solute in gram}}{\text{Molecular weight of solute}}$
- No. of moles = (2/98) = 0.2 mole

Molarity (mole/l)

- Conc. (M) = $\dfrac{\text{No. of moles of solute}}{\text{Volume of solution in liter}}$
- Vol. = 40 ml $*10^{-3}$ = 0.04 liter
- Conc. (M) = (0.2/0.04) = 5 moles/liter

4- Normality ($g_{equiv.}/l$)

- **Definition:** number of gram equivalent of solute dissolved in 1 liter of solution.

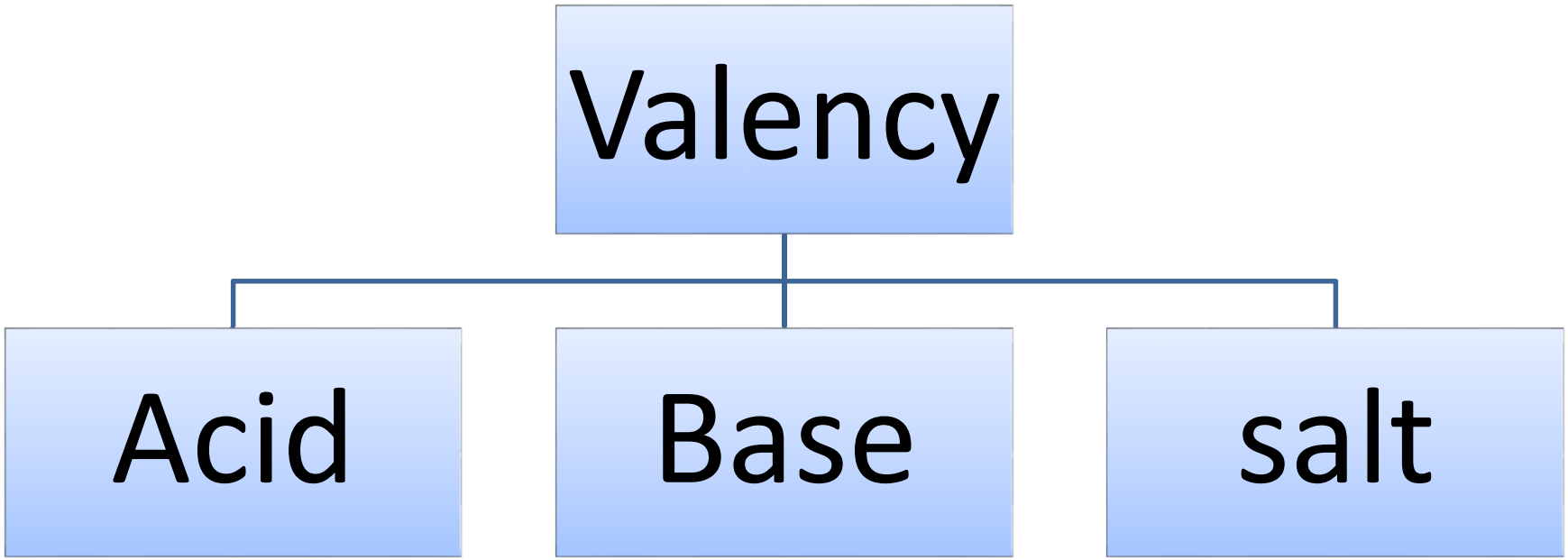
- Conc. = $\dfrac{\text{No. of grams equivalent of solute}}{\text{Volume of solution in liter}}$

- No. of grams equivalent = $\dfrac{\text{weight of solute in gram}}{\text{Equivalent weight of solute}}$

4- Normality ($g_{equiv.}/l$)

- Equivalent weight = $\frac{\text{M.wt of the solute}}{\text{Valency}}$

- Valency??????!!!!!!!!!!!!!


Valency
Acid
Base
salt

Valency

1. Valency of Acid: (maximum number of hydrogen ion (H^+) present in the acid).

- Examples:
  1. Hydrochloric acid : HCl = H_1Cl , valency = 1
  2. Sulfuric acid : H_2SO_4, Valency = 2
  3. Phosphoric acid : H_3PO_4, Valency = 3
  4. Acetic acid : CH_3COOH, CH_3COOH_1 ,Valency = 1

Valency

2. Valency of Base: (maximum number of hydroxide ions (OH^-) present in the base).

- Examples:
  1. Sodium hydroxide : NaOH = $Na(OH)_1$, valency = 1
  2. Calcium hydroxide : $Ca(OH)_2$, Valency = 2
  3. Magnesium hydroxide : $Mg(OH)_2$, Valency = 2
  4. Aluminium hydroxide : $Al(OH)_3$, Valency = 3

Valency

3. Valency of salt : the maximum number of electrons lost or gained to form a salt (ionic bond).

- Examples :
  1. Sodium chloride : NaCl, $Na^{+1}\ Cl^{-1}$, Valency = 1
  2. Calcium chloride : $CaCl_2$, $Ca^{+2}\ Cl_2^{(-2)}$, Valency = 2
  3. Calcium sulfate : $CaSO_4$, $Ca^{+2}\ SO_4^{-2}$, Valency = 2
  4. Aluminum chloride : $AlCl_3$, $Al^{+3}\ Cl_3^{-3}$, Valency = 3
  5. Tri sodium phosphate : Na_3PO_4, $Na_3^{(+3)}\ PO_4^{-3}$, Valency= 3

What is the relation between the Molarity (M) & Normality (N)?

- N = (no. of gram equivalent / Volume)
- N = $\frac{\text{Wt. of solute}}{\text{M.wt of solute}} * \frac{\text{Valency}}{\text{Volume in liter}}$
- N = M * Valency
- Normality = Molarity * valency

Normality (N)

- **Example(4) :** Calculate the normality of 2g of $CaCl_2$ dissolved in 200 ml H_2O
- **Given that :**
  - At.wt of (Ca)= 40 amu
  - At.wt of (Cl)= 35.5 amu

Normality (N)

- **Solution :**
- N = M * valency
- $$M = \frac{\text{No. of moles of solute}}{\text{Volume of solution in liter}}$$
- No. of moles of solute = (wt. of solute/ M.wt)
- $$M = \frac{\text{Wt. of solute}}{\text{M.wt of solute}} * \frac{1}{\text{Volume in liter}}$$

Normality (N)

- $N = \frac{\text{Wt. of solute}}{\text{M.wt of solute}} * \frac{\text{Valency}}{\text{Volume in liter}}$
- $N = \frac{2}{111} * \frac{2}{200 * 10^{-3}}$
- Normality = 0.18 $g_{equiv.}$/liter

Homework

- If a 0.2 g of $Ca(OH)_2$ is dissolved in 100 ml of H2O find the concentration in units:
  1. g/l
  2. Mg/l
  3. Molarity
  4. Normality
- **Given that :** At.wt of (Ca)=40, At.wt of (O)=16, At.wt of (H)=1 amu

Thank you