Solutions-Dilutions

Concentration - many ways to measure:

use a ratio to describe: $\frac{\text{stuff}}{\text{stuff}}$ (solute / solvent or solution)

$$\text{molarity} = \frac{\text{mol}}{\text{L}}$$

$$\%\text{ by mass} = \frac{\text{mass of solute}}{\text{total mass}} \times 100$$

$$\%\text{ by volume} = \frac{\text{volume of solute}}{\text{total volume}} \times 100$$

$$\text{mole fraction} = \frac{\text{x moles}}{\text{total moles}}$$

$$\text{mole \%} = \frac{\text{x moles}}{\text{total moles}} \times 100$$

$$\text{ppm} = \frac{\text{parts}}{1{,}000{,}000 \text{ total parts}}$$

others:
molality
normality

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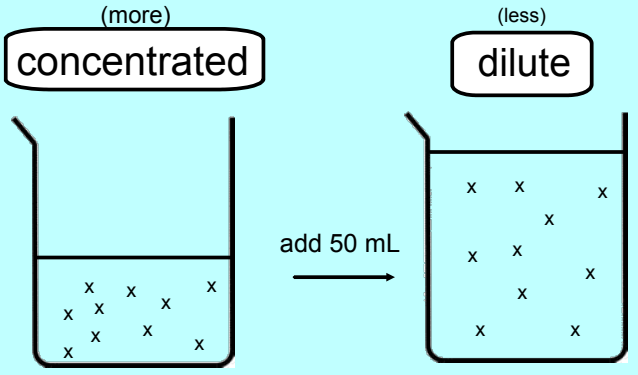
Dilutions



10 particles ← same → 10 particles

50 mL ← doubled → 100 mL

molarity= $\frac{\text{mol}}{\text{L}}$ solve for mole: mol = M x V

solution 1 — solution 2

M x V= mol ← same (10 particles) → mol = M x V

combine both equations:

$M_1V_1=M_2V_2$ → reciprocal relationship -- as one goes up the other goes down

linear relationships: $\frac{x_1}{y_1}=\frac{x_2}{y_2}$ (proportional)

-as one goes up, the other goes up

V_1 M_1 V_2

A 100 mL of a 5.0M solution of NaOH is diluted to 1.0 L. What is the molarity of the diluted solution?

M_2?

units must be the same

$(5.0\ M)(100mL) = M_2(1000mL)$

$M_2 = 0.5\ M$

Another example:

50.0 mL of 0.125M $CuSO_4$ was added to 0.500 L of pure water. What is the final concentration of the solution?

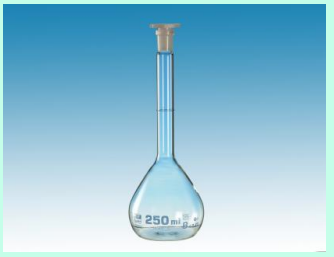
50 + 500

$$(50.0mL)(0.125M) = (550\ mL)M_2$$

$$M_2 = 0.0114\ M$$

2.1 g copper sulfate hydrate is dissolved in a 250mL volumetric flask. What is the molarity?

(mol. wt: 250g/mol)



5 mL of this solution is diluted to 500 mL. What is the molarity of this solution?

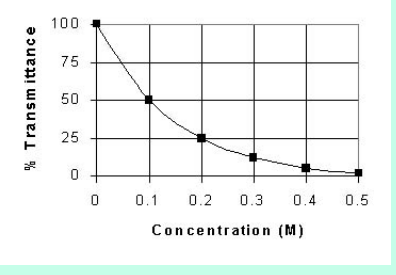
the sample goes in a cuvette

spectrophotometer
- measures light transmittance

Lab:

Use Knowns to Determine Unknowns

dilute sample to several concentrations
graph known concentrationd with measured % transmittance
use graph(determine line equation) to determine unknowns



If I have 20g KNO_3 dissolved in 500 mL of water:

1. What is the Molarity?

2. What is the % by mass of the solute?

3. What is the mole fraction of the solute?

4. What is the mole percent if the solute?

If I have 20g KNO_3 dissolved in 500 mL of water:

What is the Molarity?

$$20\text{g } KNO_3 \left| \frac{1 \text{ mol}}{101 \text{ g}} \right. = 0.20 \text{ mol}$$

$$\frac{0.20 \text{ mol}}{0.5 \text{ L}} = \boxed{0.4 \text{ M } KNO_3 \text{ solution}}$$

What is the % by mass of the solute?

1 g/mL

$$\frac{20 \text{ g}}{520 \text{ g}} \times 100 = \boxed{3.85\% \ KNO_3}$$

What is the mole fraction of the solute?

$$20\text{g } KNO_3 \left| \frac{1 \text{ mol}}{101 \text{ g}} \right. = 0.20 \text{ mol } KNO_3$$

$$500\text{g } H_2O \left| \frac{1 \text{ mol}}{18 \text{ g}} \right. = 27.8 \text{ mol } H_2O$$

$$\frac{0.20 \text{ mol}}{27.8 + 0.2 \text{ mol}} = \boxed{0.00714}$$

What is the mole percent of the solute?

$$\frac{0.20 \text{ mol}}{27.8 + 0.2 \text{ mol}} \times 100 = \boxed{0.714\% \ KNO_3}$$

Lab

Dilution

$(0.1M)(5mL) = (100mL)M_2$

$M_2 = 0.005\ M$

Stock Solution

0.008g CV

407 g/mol

$\frac{0.008g}{407g\ CV} \cdot \frac{1\ mol\ CV}{} = 0.0000197\ mol$

$\frac{0.00002}{1L} = \boxed{\frac{2\times10^{-5}M}{CV}}$

$12mL\left(\frac{2\times10^{-5}M}{}\right) = 100mL \cdot M_2$

mL's in 100	Conc in M	% trans.
2	4×10^{-7}	
4	8×10^{-7}	
6	1.2×10^{-6}	
8	1.6×10^{-6}	
10	2×10^{-6}	
12	2.4×10^{-6}	

$(M_1)(V_1) = (M_2)(V_2)$

$10mL\left(\frac{0.00002M}{100mL}\right) = \frac{M_2 \cdot 100mL}{100mL}$

$M_2 = \frac{10 \times 0.00002}{100}$

$M_2 = 0.000002$

$\left(\frac{10mL}{100mL}\right)(2M) = \frac{M_2\ 100mL}{100mL}$

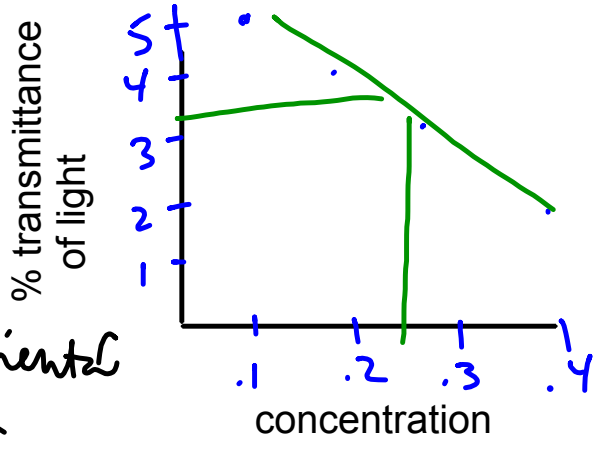
Graph the following:

concentration	% transmittance of light
0.1M	5
0.2M	4
0.3M	3
0.4M	2

create dilution (knowns)

experimental value

Beer Law Plot



Unknown @ 3.5 % trans.
what is the conc.?
0.25 M

figure out how knowns "react" to determine how unknowns "react"