

Measuring Concentration - Molarity and Dilution

Molarity (M) Equation:

$$M = \frac{\text{mols solute}}{\text{liter solution}}$$

Example Problems:

- 1) Calculate the **molarity** of a solution made by dissolving 0.0278 moles of glucose in enough water to form 0.15 L of solution.

$$M = \frac{0.0278 \text{ mols}}{0.15 \text{ L}} = 0.185 \text{ M glucose}$$

- 2) Calculate the **molarity** of a solution made by dissolving 23.4 grams of Na_2SO_4 in enough water to form 125 mL of solution.

$$\frac{23.4 \text{ g } \text{Na}_2\text{SO}_4}{142.0 \text{ g } \text{Na}_2\text{SO}_4} \times 1 \text{ mol } \text{Na}_2\text{SO}_4 = 0.165 \text{ mols } \text{Na}_2\text{SO}_4$$

$$M = \frac{0.165 \text{ mols}}{0.125 \text{ L}} = 1.32 \text{ M } \text{Na}_2\text{SO}_4$$

Dilutions Equation:

$$M_c V_c = M_d V_d$$

C = concentrated
D = diluted

- The higher the molarity, the more concentrated the solution
- Very concentrated solutions can be diluted down into less concentrated solutions by taking a small portion of the concentrated "stock" solution and adding water to it.
 - When a solution is diluted, the moles of solute are NOT changed, but because the volume of solvent is increased, there is a *decrease* in the molarity = diluted
 - moles of solute in concentrated solution = moles of solute in diluted solution

Example Problems:

- 1) We have a concentrated "stock" solution of 12.0 M HCl but we need a more dilute solution that is 250 mL and 1.5 M. What volume of the concentrated stock solution will be needed for this?

$$M_c = 12.0 \text{ M}$$

$$V_d = 250 \text{ mL}$$

$$M_d = 1.5 \text{ M}$$

$$M_c V_c = M_d V_d$$

$$(12.0 \text{ M})(V_c) = (1.5 \text{ M})(250 \text{ mL})$$

$$V_c = 31.25 \text{ mL}$$

$$M = \frac{\text{mols solute}}{\text{liter solution}}$$

Molarity (M) Practice Problems

- 1) Calculate the **molarity** when 0.50 moles of MgCl_2 are dissolved in 1.5 L of solution.

$$M = \frac{0.50 \text{ mols}}{1.5 \text{ L}} = 0.33 \text{ M MgCl}_2$$

- 2) Calculate the **molarity** when 1.24 moles of KCl are dissolved in 750 mL of solution.

$$M = \frac{1.24 \text{ mols}}{0.750 \text{ L}} = 1.65 \text{ M KCl}$$

- 3) Sea water contains roughly 28.0 g of NaCl for every 1 L of solution. What is the **molarity** of sea water?

$$\frac{28.0 \text{ g NaCl}}{58.5 \text{ g NaCl}} \times 1 \text{ mol NaCl} = 0.479 \text{ mols}$$

$$M = \frac{0.479 \text{ mols}}{1 \text{ L}} = 0.479 \text{ M NaCl}$$

- 4) Calculate the **moles of solute** in 1250 mL of a 0.64 M NaCl solution.

$$0.64 \text{ M NaCl} = \frac{x \text{ mols}}{1.250 \text{ L}}$$

$$x = 0.8 \text{ mols NaCl}$$

$$(0.64 \text{ M})(1.250 \text{ L}) = x \text{ mols}$$

- 5) What **volume** (in mL) of 12.0 M HCl is needed to contain 3.0 moles of HCl ?

$$12.0 \text{ M HCl} = \frac{3.0 \text{ mols}}{x \text{ L}}$$

$$x = \frac{3.0 \text{ mols}}{12.0 \text{ M}}$$

$$(x \text{ L})(12.0 \text{ M}) = 3.0 \text{ mols}$$

$$= 0.25 \text{ L} = 250 \text{ mL}$$

(11)

$$M_c V_c = M_D V_D$$

Dilutions Practice Problems

- 1) If I have 340 mL of a 3.5 M NaBr solution, what will the concentration be if I add 560 mL of water to it? (Hint: Think of the total volume of the dilute solution)

$$V_c = 340 \text{ mL}$$

$$M_c = 3.5 \text{ M}$$

$$V_D = 340 + 560 = 900 \text{ mL}$$

$$(340 \text{ mL})(3.5 \text{ M}) = (900 \text{ mL})(M_D)$$

$$M_D = 1.32 \text{ M NaBr}$$

- 2) If I dilute 250 mL of 2.75 M lithium acetate solution to a volume of 750 mL, what will the concentration of this solution be?

$$V_c = 250 \text{ mL}$$

$$M_c = 2.75 \text{ M}$$

$$V_D = 750 \text{ mL}$$

$$(250 \text{ mL})(2.75 \text{ M}) = (750 \text{ mL})(M_D)$$

$$M_D = 0.92 \text{ M LiC}_2\text{H}_3\text{O}_2$$

- 3) If 25 mL of 1.15 M KClO₃ solution is diluted to a new concentration of 0.30 M, what volume, in mL, of this dilute solution will be made?

$$V_c = 25 \text{ mL}$$

$$M_c = 1.15 \text{ M}$$

$$M_D = 0.30 \text{ M}$$

$$(25 \text{ mL})(1.15 \text{ M}) = (V_c)(0.30 \text{ M})$$

$$V_c = 95.83 \text{ mL}$$

- 4) A concentrated stock solution was made by dissolving 45 grams of Cu(NO₃)₂ in 200 mL of water.

- a. What is the concentration of this stock solution?

$$\frac{45 \text{ g Cu(NO}_3)_2}{187.5 \text{ g Cu(NO}_3)_2} \left| \frac{1 \text{ mol Cu(NO}_3)_2}{187.5 \text{ g Cu(NO}_3)_2} \right.$$

$$= 0.24 \text{ mols}$$

$$M = \frac{0.24 \text{ mols}}{0.200 \text{ L}}$$

$$= 1.2 \text{ M Cu(NO}_3)_2$$

- b. If 37.5 mL of this stock solution is then diluted to a new volume of 500 mL, what is the molarity of this dilute solution?

$$V_c = 37.5 \text{ mL}$$

$$M_c = 1.2 \text{ M}$$

$$V_D = 500 \text{ mL}$$

$$(37.5 \text{ mL})(1.2 \text{ M}) = (500 \text{ mL})(M_D)$$

$$M_D = 0.09 \text{ M Cu(NO}_3)_2$$