Dilutions

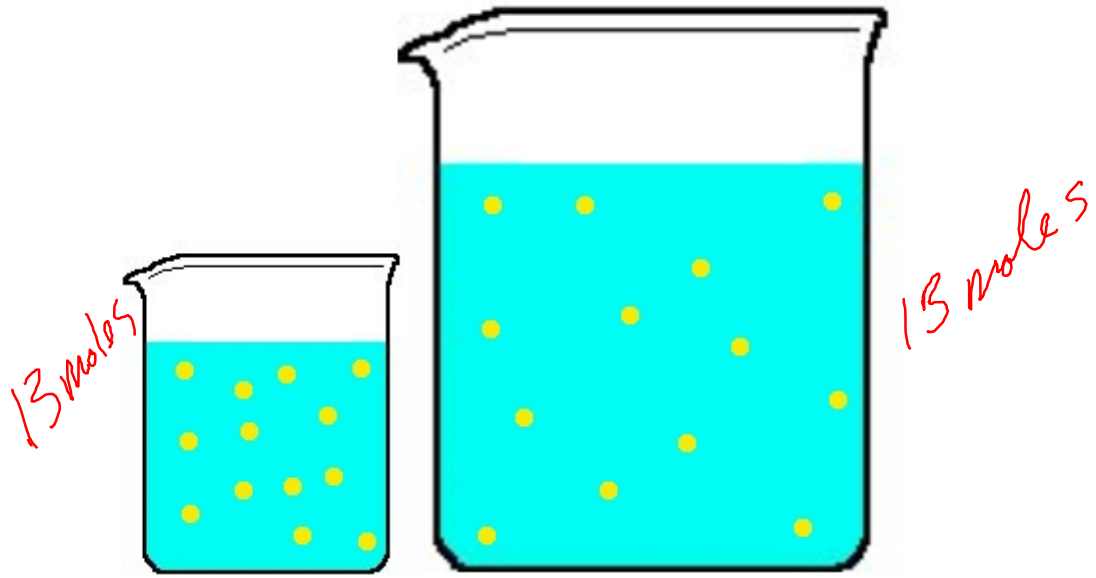
Outcomes:

- Solve problems involving the dilution of solutions.
- Perform a dilution from a solution of known concentration.

Diluting a Solution:

Most solutions are stored in **CONCENTRATED** form. We need to **DILUTE** them to yield solutions of a desired concentration.

- When a solution is **DILUTED**, we are **ONLY INCREASING** the number of **MOLES** of **SOLVENT**. The **MOLES** of **SOLUTE** will **NOT CHANGE** during a **DILUTION**, only the **CONCENTRATION** will **DECREASE**.



Moles Before (initial) = Moles After (final)

Diluting a Solution:

Recall that:

$$Moles = M \times V$$

Therefore:

$$M_i V_i = M_f V_f \qquad \text{OR} \qquad M_1 V_1 = M_2 V_2$$

Where:

M_i = ***initial concentration***

V_i = ***initial volume***

M_f = ***final concentration***

V_f = ***final volume*** (total)

Dilution Problems:

1. What is the final concentration of a NaF solution made by diluting 100mL of a 0.500M solution to 4.00L?

$M_1V_1 = M_2V_2$

$(0.5\ \frac{mol}{L})(0.1\ L) = M_2(4.00\ L)$

$M_2 = \frac{(0.5\ \frac{mol}{L})(0.1\ L)}{4.00\ L}$

$M_2 = 0.0125\ \frac{mol}{L}$

2. To what final volume must 10.0mL of 6.0M H_2SO_4 be diluted to give a 0.020M solution? How much solvent was added for this dilution?

$M_1V_1 = M_2V_2$

$(6.0\ \frac{mol}{L})(0.01\ L) = (0.02\ \frac{mol}{L})V_2$

$V_2 = \frac{(6.0\ \frac{mol}{L})(0.01\ L)}{(0.02\ \frac{mol}{L})} = 3.0\ L$

$3.0\ L - 0.01\ L = 2.99\ L$

or

2990mL added

Dilution Problems:

3. What volume of 0.500M $K_2Cr_2O_7$ is needed to yield 600mL of a 0.400M solution?

M_1 (make) V_2 M_2 mol/L

$$M_1V_1 = M_2V_2$$

$$\left(0.5\ \frac{mol}{L}\right)V_1 = \left(0.4\ \frac{mol}{L}\right)(0.6\ L)$$

$$V_1 = \frac{\left(0.4\ \frac{mol}{L}\right)(0.6\ L)}{0.5\ \frac{mol}{L}}$$

$$V_1 = 0.48\ L$$

M m

Mixing Solutions:

Mixing Two Similar Solutions:

- If we mix two solutions together, the **MOLES** of **SOLUTE** will be **ADDITIVE**!
- i.e. if you had **3 MOLES** of salt in **ONE BEAKER**, and **2** in **ANOTHER**, after **MIXING** you would have **5 MOLES** of salt.

So therefore:

$$\left(\frac{mol}{L}\right)(L) \qquad \left(\frac{mol}{L}\right)(L) = \left(\frac{mol}{L}\right)(L)$$

$$Moles_{\cancel{before}\ 1} + Moles_{\cancel{after}\ 2} = Moles_{final}$$

OR

$$M_1V_1 + M_2V_2 = M_fV_f$$

Mixing Solutions:

Example:

What is the final concentration when 200mL of 0.500M H_2SO_4 and 300mL of 6.00M H_2SO_4 are mixed?

M_f V_1 M_1 V_2 M_2

$$M_1V_1 + M_2V_2 = M_fV_f$$

$$\left(0.5\frac{mol}{L}\right)(0.2L) + \left(6.00\frac{mol}{L}\right)(0.3L) = M_f(0.5L)$$

$$M_f = \frac{\left[\left(0.5\frac{mol}{L}\right)(0.2L) + \left(6.00\frac{mol}{L}\right)(0.3L)\right]}{(0.5L)}$$

$$M_f = 3.8\frac{mol}{L}$$

Dilutions & Mixing Solutions:

Try these ones…

What is the final concentration when 3.5L of 2.6M HCl and 750mL of 2.5M HCl are mixed?

V_1 M_1 V_2 M_2

$$M_1V_1 + M_2V_2 = M_fV_f$$

$$\left(2.6\frac{mol}{L}\right)(3.5L) + \left(2.5\frac{mol}{L}\right)(0.75L) = M_f(4.25L)$$

$$M_f = \frac{\left(2.6\frac{mol}{L}\right)(3.5L) + \left(2.5\frac{mol}{L}\right)(0.75L)}{4.25L}$$

$$M_f = 2.58\frac{mol}{L}$$

Dilutions & Mixing Solutions:

Try these ones…

Calculate the amount of water that must be added to 175mL of a 0.0140mol/L solution of sodium chloride to yield a final concentration of 0.01mol/L.

V_1 M_1 M_2

$0.07\cancel{L} \times \frac{1000\,mL}{1\cancel{L}}$

$M_1V_1 = M_2V_2$

$(0.0140\,\frac{mol}{L})(0.175L) = (0.01\,\frac{mol}{L})V_2$

$V_2 = \frac{(0.014\,\frac{mol}{\cancel{L}})(0.175L)}{(0.01\,\frac{mol}{\cancel{L}})}$

$V_2 = 0.245L - 0.175L = 0.07L$

$(70mL)$