Concentration Calculations

Two equations are of use:

solution equation ➜ $n = CV$

dilution equation ➜ $C_S V_S = C_D V_D$

Solution Equation:

$$n = CV$$

n = amount (mol)

C = concentration (M = mol/L)*

V = volume (L)

eg Determine the concentration of a solution that has a volume of 350 mL in which 0.22 g of HCl has been dissolved

$$n = 0.22 \text{ g HCl} \times \frac{1 \text{ mol HCl}}{36.46 \text{ g HCl}} = 0.00603 \text{ mol HCl}$$

Being given a mass and a formula is as good as being given an amount. One conversion factor is all that is required.

C = ?

V = 350 mL ➜ 0.350 L

$$C = \frac{n}{V}$$

$$C = \frac{0.00603 \text{ mol HCl}}{0.350 \text{ L}}$$

$$C = 0.01723 \ \text{mol/L}^{*}$$

$$C = 0.01723 \text{ M}^{*}$$

* The unit of mol/L can be written as M. It is at times necessary to expand the M to mol/L so that unit cancellations can be made.

Find mass really means find amount first and then convert

eg Determine the mass of potassium sulphate required to make 250 mL of 0.2 M solution

n = ? ➜ mass

C = 0.2 mol/L (better than M)

V = 250 mL ➜ 0.250 L

$$n = CV$$

$$n = \frac{0.2\ \text{mol}}{\text{L}} \times 0.250\ \text{L}$$

$$n = 0.05\ \text{mol}$$

$$0.05\ \text{mol}\ K_2SO_4 \times \frac{174.27\ \text{g}\ K_2SO_4}{1\ \text{mol}\ K_2SO_4} = 8.7135\ \text{g}\ K_2SO_4$$

Dilution Equation:

$$C_1V_1 = C_2V_2$$

This is known as the dilution equation. Concentration and volume of one solution is converted to a concentration and volume of a second solution. The 1 and 2 subscripts are used to keep the solutions in order. Sometimes, the 1s are replaced by S which stands for stock solution and the 2s are replaced by D which stands for dilute solution. When making a solution through dilution, you can only go one way, from stock to dilute.

$C_S V_S = C_D V_D$

The stock solution is high concentration and low volume. The dilute solution is lower concentration and higher volume.

eg determine the concentration of 2.0 L of solution made from 165 mL of 12.1 M stock HCl solution?

C_S = 12.1 M

V_S = 165 mL*

C_D = ?

V_D = 2.0 L ⇨ 2000 mL*

Helpful hint: When comparing these two numbers, $C_D < C_S$. The stock solution is diluted to a lower concentration in the dilute solution

Helpful hint: When comparing these two numbers, $V_D > V_S$. The dilute solution will always have a larger volume than the stock solution.

$$C_D = \frac{C_S V_S}{V_D}$$

$$C_D = \frac{12.1\ M \times 165\ mL}{2000\ mL}$$

C_D = 0.998 M

* In this equation the volume units must agree. The same answer would have been achieved by converting 165 mL to 0.165 L instead of converting the 2.0 L. When using C = n/V, volume units must be in L