

Working with Solutions

Solutions are uniform mixtures on the molecular level of 2 or more substances. The substance present in largest amount is called the *solvent* (usually water) and any substance dissolved in the solvent is called a *solute*.

Molarity, M

The *molar concentration* or *molarity*, M , of a solution is used to indicate the number of moles of solute per liter of solution:

$$\text{Molarity} = M = \frac{\text{mol}}{\text{L}} = \frac{(\text{no. of moles solute})}{(\text{no. of liters of solution})}$$

The molarity of a solution is often used as a *conversion factor* between *moles of solute* and *volume of solution*: it is a “molar density”.

Dilution

One common type of “lab assistant” problem is the *preparation of a dilute solution from a more concentrated solution*. For example, we might want to prepare 250 mL of a 0.500 M NaOH solution from a 6.00 M NaOH solution as in exercise 5 below. There is a shortcut way to work dilution problems which is based on the knowledge that the # of moles of solute you need for the dilute solution all come from the concentrated solution. Thus $(\# \text{ moles})_{\text{concentrated}} = (\# \text{ moles})_{\text{dilute}}$ and since $M(\text{mol L}^{-1}) \times V(\text{L}) = n(\text{mol})$, it follows that

$$M_{\text{concentrated}} \times V_{\text{concentrated}} = M_{\text{dilute}} \times V_{\text{dilute}}$$

or, in the notation of Chang,

$$M_{\text{initial}} \times V_{\text{initial}} = M_{\text{final}} \times V_{\text{final}}$$

In the laboratory this equation is often used to determine the $V_{\text{concentrated}}$ that needs to be diluted to give the desired volume of a more dilute solution.

Stoichiometry of Reactions in Solution

Problems involving solutions are very similar to the chemical stoichiometry problems we have discussed earlier. The only difference is that the *moles* of reactant or product may need to be calculated *from a solution volume* using the *molarity* ($M = \text{mol/L}$) as a conversion factor between volume and moles.

Lab Assistant Problems

The problems below will introduce you to calculations involving molarity. I call these “lab assistant problems” since we do this kind of calculation all the time when setting up labs! When working these problems, it is useful to recall that 1 L = 1000 mL.

Exercises:

1. What is the *molarity* of a solution containing 21.0 g NaCl in 200 mL of solution?