

3.12: Diluting and Mixing Solutions



How to Dilute a Solution by CarolinaBiological

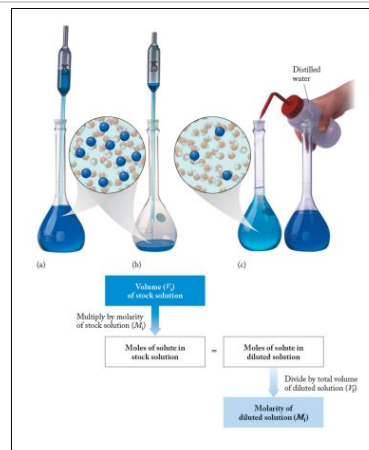


Illustration shows a twenty five milliliter pipette obtaining twenty five milliliters of stock solution from a volumetric flask. The contents of the pipette are emptied into an empty volumetric flask. The solution is then diluted with water up to the neck of the volumetric flask. Below the diagram is the steps needed to calculate molarity of diluted solution. Volume of stock solution is multiplied with molarity of stock solution to obtain moles of solute in stock solution. This is equals to moles of solute in diluted solution. This value is then divided by total volume of diluted solution to get the molarity of diluted solution.

Often it is convenient to prepare a series of solutions of known **concentrations** by first preparing a single **stock solution** as described in **Example 1 from Solution Concentrations**. **Aliquots** (carefully measured volumes) of the stock solution can then be diluted to any desired volume. In other cases it may be inconvenient to weigh accurately a small enough mass of sample to prepare a small volume of a dilute solution. Each of these situations requires that a solution be diluted to obtain the desired concentration.

✓ Example 3.12.1: Concentration of Diluted Solution

A pipet is used to measure 50.0 ml of 0.1027 M HCl into a 250.00-ml volumetric flask. Distilled water is carefully added up to the mark on the flask. What is the concentration of the diluted solution?

Solution

To calculate concentration, we first obtain the amount of HCl in the 50.0 ml (50.0 cm³) of solution added to the volumetric flask:

$$n_{\text{HCl}} = 50.0 \text{ cm}^3 \times \frac{0.1027 \text{ mmol}}{1 \text{ cm}^3} = 5.14 \text{ mmol}$$

Dividing by the new volume gives the concentration

$$c_{\text{HCl}} = \frac{n_{\text{HCl}}}{V} = \frac{5.14 \text{ mmol}}{250.00 \text{ cm}^3} = 0.0205 \text{ mmol cm}^{-3}$$

Thus the new solution is 0.0205 M.

Alternatively,

$$\begin{aligned} n_{\text{HCl}} &= 50.0 \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{0.1027 \text{ mol}}{1 \text{ L}} \\ &= 5.14 \times 10^{-3} \text{ mol} \end{aligned}$$

$$c_{\text{HCl}} = \frac{n_{\text{HCl}}}{V} = \frac{5.14 \times 10^{-3} \text{ mol}}{250.00 \text{ ml} \times \frac{1 \text{ ml}}{10^{-3} \text{ L}}} = 0.0205 \text{ mol/L}$$

✓ Example 3.12.2 : Concentration of a Solution

What volume of the solution of 0.316 46 M KI prepared in [Example 1 from Solution Concentrations](#) would be required to make 50.00 ml of 0.0500 M KI?

Solution

Using the volume and concentration of the desired solution, we can calculate the amount of KI required. Then the concentration of the original solution (0.316 46 M) can be used to convert that amount of KI to the necessary volume. Schematically

$$V_{\text{new}} \xrightarrow{c_{\text{new}}} n_{\text{KI}} \xrightarrow{c_{\text{old}}} V_{\text{old}} \quad (3.12.1)$$

$$(3.12.2)$$

$$V_{\text{old}} = 50.00 \text{ cm}^3 \times \frac{0.0500 \text{ mmol}}{1 \text{ cm}^3} \times \frac{1 \text{ cm}^3}{0.316 46 \text{ mmol}} = 7.90 \text{ cm}^3 \quad (3.12.3)$$

Thus we should dilute a 7.90-ml aliquot of the stock solution to 50.00 ml. This could be done by measuring 7.90 ml from a buret into a 50.00-ml volumetric flask and adding water up to the mark.

Note that the calculation above can be simplified, since the concentration and volume of a concentrated solution (C_{conc} and V_{conc}) were used to calculate the amount of solute, and this amount was entirely transferred to the dilute solution:

$$C_{\text{conc}} \times V_{\text{conc}} = n_{\text{conc}} = n_{\text{dil}} = C_{\text{dil}} \times V_{\text{dil}}$$

So

$$C_{\text{conc}} \times V_{\text{conc}} = C_{\text{dil}} \times V_{\text{dil}}$$

So for Example 3.12.2

$$(0.31646 M) \times (V_{\text{conc}}) = (50.00 \text{ ml}) \times (0.0500 M)$$

$$V_{\text{conc}} = 7.90 \text{ mL}$$

, which will be diluted to 50.00 mL as before.

Note that the calculated volume will have the same dimensions as the input volume, and dimensional analysis tells us that in this case we don't need to convert to liters, since L cancels when we divide M (mol/L) by M (mol/L).

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