**Standard Solutions**

“A solution whose concentration is accurately known”

Made by

- Dissolving a known mass of a substance in a volumetric flask. E.g. 1.00 L of a 2.00 mol L\(^{-1}\) standard solution of sodium hydroxide (NaOH), requires 2.00 mol of NaOH (80.0g), dissolve it in some distilled water and make it up to a volume of 1 L in a volumetric flask.
- Making up a rough solution and standardizing it in a titration reaction with a solution of a known concentration

**Example: Finding the concentration of a standard solution**

Calculate the concentration of a solution of sodium carbonate made by dissolving 23.9 g of Na\(_2\)CO\(_3\) in water and made up to 250 mL. M(Na\(_2\)CO\(_3\)) = 106.0 g mol\(^{-1}\)

\[
\begin{align*}
m & = 23.9 \text{ g} & c & = 0.902 \text{ mol L}^{-1} \\
M & = 106.0 \text{ g mol}^{-1} & V & = 0.250 \text{ L} \\
n & = 0.225 \text{ mol} & n & = 0.225 \text{ mol}
\end{align*}
\]

**Making up Solutions**

**Example 1**

How many moles of NaOH are contained in 25.0 mL of 0.100 mol L\(^{-1}\) sodium hydroxide solution?

\[
\begin{align*}
c(\text{NaOH}) & = 0.100 \text{ mol L}^{-1} \\
V(\text{NaOH}) & = 0.025 \text{ L} \\
n(\text{NaOH}) & = cV \\
& = 0.100 \text{ mol L}^{-1} \times 0.025 \text{ L} \\
& = 0.00250 \text{ mol}
\end{align*}
\]

**Example 2**

What mass of potassium permanganate (KMnO\(_4\)) is required to make up 100 mL of a 0.0200 mol L\(^{-1}\) solution? M(KMnO\(_4\)) = 158.0 g mol\(^{-1}\)

\[
\begin{align*}
c(\text{KMnO}_4) & = 0.0200 \text{ mol L}^{-1} & m(\text{KMnO}_4) & = 0.316 \text{ g} \\
V(\text{KMnO}_4) & = 0.100 \text{ L} & M(\text{KMnO}_4) & = 158.0 \text{ g mol}^{-1} \\
n(\text{KMnO}_4) & = 0.00200 \text{ mol} & n(\text{KMnO}_4) & = 0.00200 \text{ mol}
\end{align*}
\]
**Solution Calculations**

We have already used the relationship \( m = nM \) combined with a balanced equation to calculate the mass of substances.

We can use \( n = cV \) in the same way.

**Steps**
1. Write a balanced equation
2. Find the number of moles of the known substance
3. Use the balanced equation to find the number of moles of the unknown substance
4. Find the mass / volume / concentration of the unknown substance

**Example**
What volume of 2.00 mol L\(^{-1}\) HCl solution will react with 0.430 g of magnesium ribbon

\[
\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2
\]

\[
m(\text{Mg}) = 0.430 \text{ g} \\
M(\text{Mg}) = 24.3 \text{ g mol}^{-1} \\
\frac{m(\text{Mg})}{M(\text{Mg})} = \frac{0.430 \text{ g}}{24.3 \text{ g mol}^{-1}} = 0.0177 \text{ mol (3sf)}
\]

\[
c(\text{HCl}) = 2.00 \text{ mol L}^{-1} \\
V(\text{HCl}) = \frac{0.0354 \text{ mol}}{2.00 \text{ mol L}^{-1}} = 0.0177 \text{ L (3sf)}
\]

\[
x2 \text{ due to stoichiometry}
\]