

Lesson 1 –Volume-volume stoichiometry

In order to solve a volume to volume stoichiometric problem we need.

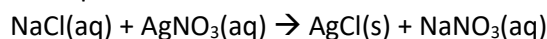
- **A balanced chemical equation**

- **The volume and concentration of one of the reacting solutions .**

$$\text{Mol} = C \times V$$

Let's try some exercises.

1. A 20.0 mL solution of NaCl reacts exactly 20.0 mL of a 0.100 M AgNO₃ solution according to the equation below.



Find the concentration, in mol/L, of the NaCl solution.

Step 1 derive the balanced chemical equation

Since the balanced equation is already given skip to step 2

Step 2 Find the mol of AgNO₃ that reacted

$$\Rightarrow n = C \times V = 0.100 \times 0.0200 = 0.00200 = 2.00 \times 10^{-3} \text{ mol}$$

Step 3 Using the ratio provided in the balanced equation calculate the mol of NaCl.

$$\Rightarrow \text{mol of AgNO}_3 = \text{mol of NaCl} = 2.00 \times 10^{-3} \text{ mol}$$

Step 4 Calculate the concentration of NaCl

$$\Rightarrow C = n/V = 2.00 \times 10^{-3} \text{ mol} / 0.0200 \text{ L} = 0.100 \text{ M}$$

2. 40.00 mL of a Na₂CO₃ solution completely reacts with a 30.00 mL 0.251 M HCl solution. Find the concentration, in mol/L, of the H₂CO₃ solution.

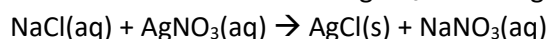
Step 1 derive the balanced chemical equation

Step 2 Find the mol of one of the reactants

Step 3 Using the ratio provided in the balanced equation to calculate the mol of the other reactant

Step 4 Calculate the concentration of the second reactant

3. Find the concentration, in %m/v, of an 80.00 mL sample of NaCl solution that reacts exactly with 48.00 mL of a 0.145 M AgNO₃ according to the equation below.



Step 1 derive the balanced chemical equation

This already given so skip to step 2

Step 2 Find the mol of one of the reactants

Step 3 Using the ratio provided in the balanced equation to calculate the mol of the other reactant

Step 4 Calculate the concentration of the second reactant

4. What volume, in litres, of a 0.100 M Na_2CO_3 solution reacts exactly with 40.00 mL of a 0.521 M H_3PO_4 solution?

Step 1 derive the balanced chemical equation

Step 2 Find the mol of one of the reactants

Step 3 Using the ratio provided in the balanced equation to calculate the mol of the other reactant

Step 4 Calculate the volume needed of the second reactant

5. What is the minimum amount, in mL, of a 0.621 M HCl solution that will react exactly with 50.00 mL of a 0.255 M Na_2CO_3 solution.

Step 1 derive the balanced chemical equation

Step 2 Find the mol of one of the reactants

Step 3 Using the ratio provided in the balanced equation to calculate the mol of the other reactant

Step 4 Calculate the volume needed of the second reactant.

6. 60.00 mL of HCl acid solution reacts with exactly 60.00 mL of a 0.452 M K_2CO_3 solution. Calculate the concentration of the HCl solution in %m/v.

Step 1 derive the balanced chemical equation

Step 2 Find the mol of one of the reactants

Step 3 Using the ratio provided in the balanced equation to calculate the mol of the other reactant

Step 4 Calculate the concentration of the second reactant

7. A common brand of cleaner contains NaOH. 40.00 mL of this cleaner reacted exactly with 23.13 mL of 0.155 M HCl. Calculate the concentration of the NaOH in the original cleaner in mol/L

Step 1 derive the balanced chemical equation

Step 2 Find the mol of one of the reactants

Step 3 Using the ratio provided in the balanced equation to calculate the mol of the other reactant

Step 4 Calculate the concentration of the second reactant

Notice how all the problems stated above have two things in common.

1. They give an accurate volume and concentration of one of the solutions.
2. They state that one solution reacts with exactly a given volume of another.

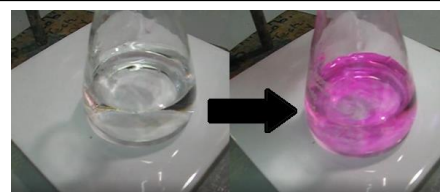
These two characteristics are experimentally determined using a titration procedure during which the following pieces of equipment are essential.

- A **burette**. This is glassware that accurately measures a variable volume of solution with a high degree of precision. Readings are taken to two decimal places. The volume dispensed is known as a **titre**.



- **Standard solution**. This solution has a concentration that is very accurately known. This precise concentration together with the accurate volume dispensed by the burette will allow us to calculate the mol of one of the reactants.

- **Indicator** – Is a substance that changes colour when the reactants have been mixed exactly in the correct stoichiometric ratio, as shown by a balanced chemical equation. A change of colour signals the end of the titration procedure. An indicator does not take part in the reaction between the two reactants given in the balanced chemical equation.



The colour change of each indicator differs. An indicator is carefully selected to match the chemical reaction being performed.