AP CHEMISTRY • EXERCISE SHEET

4.6 Introduction to Titration

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

Objective

Build the skills to answer exam questions on **titration** —finding an unknown concentration.

You must be able to:

- use mol $= M \times V$ and the reaction's mole ratio
- find an unknown concentration from titration data
- identify the **equivalence point** 等当点

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

The titration idea

A solution of known concentration (the **titrant**) is added until it exactly reacts with the unknown —the **equivalence point**, often shown by an indicator's color change (**endpoint**).

The calculation route

1. moles of titrant $= M \times V$;
2. moles of unknown = (moles of titrant) $\times$ mole ratio;
3. concentration of unknown = moles $\div$ its volume.

A worked 1:1 titration

25.0 mL of HCl is neutralized by 20.0 mL of 0.100 M NaOH (1:1). Moles NaOH $= 0.100 \times 0.0200 = 0.00200$; so moles HCl $= 0.00200$; [HCl] $= \dfrac{0.00200}{0.0250} = 0.0800$ M.

Watch the mole ratio

For $H_2SO_4 + 2NaOH$, one acid needs **two** base —include the 1 : 2 ratio, or the answer is off by a factor of two.

2 Practice

Now apply the methods above.

2.1 Find the moles in 30.0 mL of 0.200 M NaOH. [2]

2.2 In a 1:1 titration, 0.0030 mol of base neutralizes how many moles of acid? [1]

2.3 What is the equivalence point? [1]

3 Exam-style questions

3.1 At the equivalence point of an acid-base titration, [1]

- **A** the acid is in excess
- **B** the moles of acid and base have exactly reacted (per the ratio)
- **C** the base is in excess
- **D** nothing has reacted

3.2 25.0 mL of an unknown HCl solution is neutralized by 18.0 mL of 0.150 M NaOH (1:1).

(a) Find the moles of NaOH used. [2]

(b) Find the concentration of the HCl. [3]

3.3 20.0 mL of H_2SO_4 is neutralized by 25.0 mL of 0.200 M NaOH. Using H_2SO_4 +

2NaOH → products, find the concentration of the acid. [4]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **4.6 Introduction to Titration** lesson on the **Learn** page;
- read the **Introduction to Titration** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 $0.200 \times 0.0300 = 0.00600$ mol.

2.2 0.0030 mol.

2.3 The point where the titrant has exactly reacted with the unknown (per the mole ratio).

3.1 B —the acid and base have exactly reacted in the stoichiometric ratio.

3.2 (a) $0.150 \times 0.0180 = 0.00270$ mol. (b) moles HCl = 0.00270; $[\text{HCl}] = \dfrac{0.00270}{0.0250} = 0.108$ M.

3.3 moles NaOH $= 0.200 \times 0.0250 = 0.00500$; moles $H_2SO_4 = 0.00500 \div 2 = 0.00250$; $[H_2SO_4] = \dfrac{0.00250}{0.0200} = 0.125$ M.