Exercise walk-through

Introduction to Titration ▪ 4.6

eXercise

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

Method — 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**).

Method — 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.

Method — 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 $= 0.00200$; $[\text{HCl}] = \dfrac{0.00200}{0.0250} = 0.0800$ M.

Method — 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.

Practice 2.1 ▪ 2 marks

Find the moles in 30.0 mL of 0.200 M NaOH.

Solution 2.1

Method: A worked 1:1 titration

Worked steps

$0.200 \times 0.0300 = 0.00600$ mol M1 A1.

Practice 2.2 ▪ 1 mark

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

Solution 2.2

Worked steps

0.0030 mol B1.

Practice 2.3 ▪ 1 mark

What is the equivalence point?

Solution 2.3

Method: The titration idea

Worked steps

The point where the titrant has exactly reacted with the unknown (per the mole ratio) B1.

Exam-style 3.1 ▪ 1 mark

At the equivalence point of an acid-base titration,

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

Solution 3.1

Method: The titration idea

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

Worked steps

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

Exam-style 3.2 ▪ 2 marks

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.
(b) Find the concentration of the HCl.

Solution 3.2

Method: A worked 1:1 titration

Worked steps

(a) $0.150 \times 0.0180 = 0.00270$ mol M1 A1. (b) moles HCl $= 0.00270$; $[\text{HCl}] = \dfrac{0.00270}{0.0250} = 0.108$ M M1 M1 A1.

Exam-style 3.3 ▪ 4 marks

20.0 mL of H_2SO_4 is neutralized by 25.0 mL of 0.200 M NaOH. Using $H_2SO_4 + 2NaOH \rightarrow$ products, find the concentration of the acid.

Solution 3.3

Worked steps

moles NaOH $= 0.200 \times 0.0250 = 0.00500$ (M1); moles $H_2SO_4 = 0.00500 \div 2 = 0.00250$ (M1); $[H_2SO_4] = \dfrac{0.00250}{0.0200} = 0.125$ M (M1)(A1).