Exercise walk-through

Acid-Base Titrations ▪ 8.5

eXercise

You must be able to

- identify the **equivalence point** 等当点 on a titration curve
- locate the **half-equivalence point** where $\mathrm{pH} = \mathrm{p}K_a$
- describe the curve shape for strong and weak acids

Method — The equivalence point

The **equivalence point** is where the moles of added base exactly equal the moles of acid. On the curve it is the **steep vertical jump** in pH.

Method — Equivalence pH depends on the acids

- **Strong acid + strong base** $\rightarrow$ equivalence pH $= 7$.
- **Weak acid + strong base** $\rightarrow$ equivalence pH > 7 (the conjugate base is basic).

Method — The half-equivalence point

At the **half-equivalence point** (half the base added), $[\mathrm{HA}] = [\mathrm{A}^-]$, so

$$\mathrm{pH} = \mathrm{p}K_a.$$

This is the flattest part (the buffer region) and a quick way to read $\mathrm{p}K_a$ off a curve.

Method — Reading Ka from a curve

Find the half-equivalence volume (half the equivalence volume), read its pH — that is pK_a, and $K_a = 10^{-pK_a}$.

Practice 2.1 ▪ 1 mark

What is true of the moles of acid and base at the equivalence point?

Solution 2.1

Method: The equivalence point

Worked steps

They are equal (in the stoichiometric ratio) B1.

Practice 2.2 ▪ 1 mark

At the half-equivalence point, pH equals what?

Solution 2.2

Method: The half-equivalence point

Worked steps

pK_a B1.

Practice 2.3 ▪ 1 mark

For a strong acid-strong base titration, what is the equivalence pH?

Solution 2.3

Method: Equivalence pH depends on the acids

Worked steps

7 B1.

Exam-style 3.1 ▪ 1 mark

The equivalence point of a weak acid titrated with a strong base has a pH that is

A exactly 7

B greater than 7

C less than 7

D zero

Solution 3.1

Method: Equivalence pH depends on the acids

A exactly 7

B greater than 7 ✓

C less than 7

D zero

Worked steps

B — greater than 7.

Exam-style 3.2 ▪ 1 mark

A weak acid is titrated with NaOH. The equivalence point is at 20.0 mL of base.
(a) At what volume is the half-equivalence point?
(b) If the pH there is 4.7, find pK_a and K_a.

Solution 3.2

Method: The half-equivalence point

Worked steps

(a) 10.0 mL (half of 20.0) B1. (b) $\mathrm{p}K_a = \mathrm{pH} = 4.7$; $K_a = 10^{-4.7} = 2.0 \times 10^{-5}$ M1 M1 A1.

Exam-style 3.3 ▪ 2 marks

Explain why the equivalence pH of a weak acid-strong base titration is above 7.

Solution 3.3

Method: Equivalence pH depends on the acids

Worked steps

At equivalence all the acid has become its conjugate base A^-, which is a weak base and reacts with water to give OH^-, raising the pH above 7 **M1** **A1**.