

Exercise walk-through

pH and pKa ■ 8.7

eXercise

You must be able to

- use $\text{p}K_a = -\log K_a$
- rank acids by K_a or $\text{p}K_a$ (smaller $\text{p}K_a = \text{stronger}$)
- relate $\text{p}K_a$ to the pH where an acid is half-ionized

Method — $\text{p}K_a$

$$\text{p}K_a = -\log K_a.$$

A **larger** K_a (stronger acid) gives a **smaller** $\text{p}K_a$.

Method — Ranking acids

A stronger acid has a bigger K_a and a **smaller** pK_a . So acid X ($pK_a = 3$) is stronger than acid Y ($pK_a = 5$).

Method — pK_a and half-ionization

At $pH = pK_a$, the acid is **half-ionized** ($[HA] = [A^-]$). Below that pH the acid form dominates; above it, the conjugate base dominates.

Method — A worked conversion

$K_a = 1.8 \times 10^{-5}$ gives $\text{p}K_a = -\log(1.8 \times 10^{-5}) = 4.74$. Reverse: $\text{p}K_a = 3$ gives $K_a = 10^{-3}$.

Practice 2.1 ■ 1 mark

Find $\text{p}K_a$ for $K_a = 1 \times 10^{-4}$.

Solution 2.1

Method: A worked conversion

Worked steps

$$\text{p}K_a = 4 \text{ (B1)}.$$

Practice 2.2 ■ 1 mark

Acid A has $\text{p}K_a = 2$, acid B has $\text{p}K_a = 6$. Which is stronger?

Solution 2.2

Worked steps

Acid A ($\text{p}K_a = 2$) **B1**.

Practice 2.3 ■ 1 mark

At what pH is a weak acid half-ionized?

Solution 2.3

Method: pK_a and half-ionization

Worked steps

$$\text{pH} = pK_a \text{ (B1)}.$$

Exam-style 3.1 ■ 1 mark

A stronger acid has a

- A** larger pK_a
- B** smaller pK_a
- C** pK_a of exactly 7
- D** negative K_a

Solution 3.1

A larger pK_a

B smaller pK_a



C pK_a of exactly 7

D negative K_a

Worked steps

B — a smaller pK_a .

Exam-style 3.2 ■ 2 marks

Three acids have K_a values 1×10^{-3} , 1×10^{-5} , and 1×10^{-9} .

- (a) Find each $\text{p}K_a$.
- (b) Rank the acids from strongest to weakest.

Solution 3.2

Worked steps

(a) 3, 5, 9 **M1** **A1**. (b) strongest to weakest: $K_a = 10^{-3}$, then 10^{-5} , then 10^{-9} (smallest pK_a first) **M1** **A1**.

Exam-style 3.3 ■ 2 marks

An acid has $pK_a = 4.2$. Below pH 4.2, which form (acid or conjugate base) dominates? Explain.

Solution 3.3

Method: pK_a and half-ionization

Worked steps

The acid form (HA) dominates — below $pH = pK_a$ there is more H^+ , which keeps the acid protonated **M1** **A1**.