# 8.7 pH and pKa

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

**KEY WORDS** acid • ph pH • base • weak acid • conjugate base

## Objective

Build the skills to answer exam questions on **pH and pKa** – comparing acid strengths.

**You must be able to:**

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

## 1 Key knowledge and 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.

### pKa

$$pK_a = -\log K_a.$$

A **larger** $K_a$ (stronger acid) gives a **smaller** $pK_a$.

### 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 ($pK_a = 5$).

### pKa 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.

### A worked conversion

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

## 2 Practice

Now apply the methods above.

**2.1** Find $pK_a$ for $K_a = 1 \times 10^{-4}$. [1]

**2.2** Acid A has $pK_a = 2$, acid B has $pK_a = 6$. Which is stronger? [1]

**2.3** At what pH is a weak acid half-ionized? [1]

## 3 Exam-style questions

**3.1** A stronger acid has a [1]

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

**3.2** Three acids have $K_a$ values $1 \times 10^{-3}$, $1 \times 10^{-5}$, and $1 \times 10^{-9}$.

(a) Find each $pK_a$. [2]

(b) Rank the acids from strongest to weakest. [2]

**3.3** An acid has $pK_a = 4.2$. Below pH 4.2, which form (acid or conjugate base) dominates? Explain. [2]

## Solutions

Each answer shows the steps, then the **result**.

**2.1**

- $pK_a = 4$

**2.2**

- Acid A ($pK_a = 2$)

**2.3**

- $pH = pK_a$

**3.1 B**

- a smaller $pK_a$

**3.2**

(a)

- 3, 5, 9

(b)

- strongest to weakest: $K_a = 10^{-3}$, then $10^{-5}$, then $10^{-9}$ (smallest $pK_a$ first)

**3.3**

- The acid form (HA) dominates – below $pH = pK_a$ there is more $H^+$, which keeps the acid protonated