

8.7 pH and pK_a

Name: _____ Class: _____ Date: _____

Total: 10 marks**KEY WORDS** acid • pH • base • weak acid • conjugate base

Objective

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

You must be able to:

- use $\text{p}K_a = -\log K_a$
- rank acids by K_a or $\text{p}K_a$ (smaller $\text{p}K_a$ = stronger)
- relate $\text{p}K_a$ 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.

■ pK_a

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

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

■ Ranking acids

A stronger acid has a bigger K_a and a **smaller** $\text{p}K_a$. So acid X ($\text{p}K_a = 3$) is stronger than acid Y ($\text{p}K_a = 5$).

■ pK_a and half-ionization

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

■ A worked conversion

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

2 Practice

Now apply the methods above.

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

2.2 Acid A has $\text{p}K_a = 2$, acid B has $\text{p}K_a = 6$. 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 $\text{p}K_a$
B smaller $\text{p}K_a$
C $\text{p}K_a$ of exactly 7
D negative K_a

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

(a) Find each $\text{p}K_a$. [2]

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

3.3 An acid has $\text{p}K_a = 4.2$. Below pH 4.2, which form (acid or conjugate base) dominates? Explain. [2]

Solutions

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

2.1

- $\text{p}K_a = 4$

2.2

- Acid A ($\text{p}K_a = 2$)

2.3

- $\text{pH} = \text{p}K_a$

3.1 B

- a smaller $\text{p}K_a$

3.2

(a)

- 3, 5, 9

(b)

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

3.3

- The acid form (HA) dominates – below $\text{pH} = \text{p}K_a$ there is more H^+ , which keeps the acid protonated