

# 8.7 pH and pKa

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 10 marks

## Objective

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Build the skills to answer exam questions on **pH and pKa** —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 Worked examples

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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

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

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 ( $\text{p}K_a = 5$ ).

### ■ pKa 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

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

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

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### 3 Exam-style questions

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3.1 A stronger acid has a [1]

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

### 4 Go further

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You are now ready for the real exam questions on this subtopic:

- work through the **8.7 pH and pKa** lesson on the **Learn** page;
- read the **pH and pKa** section of the AP Chemistry handout on the **Know** page.

## Solutions

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**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.