8.2 pH and pOH of Strong Acids and Bases

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

KEY WORDS strong base • ph pH • acid • strong acid • base

Objective

Build the skills to answer exam questions on **pH and pOH** of strong acids and bases.

You must be able to:

- use $\mathrm{pH} = -\log[\mathrm{H}^+]$ and $\mathrm{pOH} = -\log[\mathrm{OH}^-]$
- use $\mathrm{pH} + \mathrm{pOH} = 14$ and $[\mathrm{H}^+][\mathrm{OH}^-] = 1 \times 10^{-14}$
- find pH for a strong acid or base of known concentration

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.

The definitions

$$\mathrm{pH} = -\log[\mathrm{H}^+], \qquad \mathrm{pOH} = -\log[\mathrm{OH}^-].$$

At 25°C, $\mathrm{pH} + \mathrm{pOH} = 14$ and $[\mathrm{H}^+][\mathrm{OH}^-] = 1 \times 10^{-14}$.

Strong acid pH

A strong acid ionizes completely, so $[\mathrm{H}^+]$ equals its concentration. For 0.010 M HCl: $\mathrm{pH} = -\log(0.010) = 2$.

Strong base pH

A strong base gives $[\mathrm{OH}^-]$ equal to its concentration. For 0.010 M NaOH: $\mathrm{pOH} = 2$, so $\mathrm{pH} = 14 - 2 = 12$.

Finding [H+] back from pH

Reverse with $[\mathrm{H}^+] = 10^{-\mathrm{pH}}$. A pH of 3 means $[\mathrm{H}^+] = 1 \times 10^{-3}$ M.

2 Practice

Now apply the methods above.

2.1 Find the pH of 0.001 M HCl. [2]

2.2 Find the pOH of 0.010 M NaOH, then the pH. [2]

2.3 Find $[\mathrm{H}^+]$ for a solution of $\mathrm{pH} = 4$. [1]

3 Exam-style questions

3.1 At 25°C, $\mathrm{pH} + \mathrm{pOH} =$ [1]

☐ **A** 7
B 10
C 14
D 1

3.2 A 0.0050 M solution of HNO_3 (a strong acid).

(a) State $[\mathrm{H}^+]$. [1]

(b) Find the pH. [2]

3.3 A 0.020 M solution of NaOH.

(a) Find the pOH. [2]

(b) Find the pH. [1]

Solutions

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

2.1

- $\text{pH} = -\log(0.001) = 3$

2.2

- $\text{pOH} = -\log(0.010) = 2$; $\text{pH} = 14 - 2 = 12$

2.3

- $[\text{H}^+] = 10^{-4} = 1 \times 10^{-4}$ M

3.1 C

- 14

3.2

(a)

- $[\text{H}^+] = 0.0050$ M

(b)

- $\text{pH} = -\log(0.0050) = 2.30$

3.3

(a)

- $\text{pOH} = -\log(0.020) = 1.70$

(b)

- $\text{pH} = 14 - 1.70 = 12.30$