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CHEMISTRY WORKSHEET

WEAK ACIDS AND WEAK BASES

Course: SCH4U Grade 12 Chemistry

DOWNLOAD FULL WORKSHEET

50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ Identifying Brønsted-Lowry acids, bases, and conjugate acid-base pairs, ✓ writing conjugate acids and conjugate bases for neutral, positive, and negative species, ✓ calculating pH and pOH from $[H_3O^+]$ and $[OH^-]$, ✓ calculating pH of weak acid solutions from Ka and concentration, ✓calculating pH of weak base solutions from Kb and concentration, ✓ using Ka·Kb = Kw for conjugate acid-base pairs, ✓ calculating pH of weak-acid and weak-base salt solutions, ✓ solving for Ka, Kb, concentration, and percent ionization

All problems are designed to reflect style and difficulty commonly seen on quizzes, tests, and final exams. Detailed solutions are included to help students understand the reasoning behind every step.

PART A - FUNDAMENTAL PROBLEMS
Problems 1-15. Simple calculations and basic applications

PART B - INTERMEDIATE PROBLEMS
Problems 16-30. Typical unit test questions involving multiple steps

PART C - ADVANCED PROBLEMS
Problems 31-40. More challenging calculations requiring deeper understanding

PART D - CHALLENGE PROBLEMS
Problems 41-50. Difficult exam-style questions combining multiple concepts

SUITABLE FOR:
quizzes, unit tests and final exam preparation

Section 1: Essential Information

Salt hydrolysis happens when an ion from a salt reacts with water and changes $[H_3O^+]$ or $[OH^-]$. The main idea is to identify whether each ion comes from a strong acid, strong base, weak acid, or weak base.

Ion type	Hydrolysis behaviour	Main result
Cation from strong base	No important hydrolysis	Neutral effect
Anion from strong acid	No important hydrolysis	Neutral effect
Cation from weak base	$BH^+ + H_2O \rightleftharpoons B + H_3O^+$	Acidic solution
Anion from weak acid	$A^- + H_2O \rightleftharpoons HA + OH^-$	Basic solution
Weak acid + weak base salt	Both ions hydrolyse	Compare K_a (cation) and K_b (anion)

Key relationships

Weak acid model: HA reacts with water to form H_3O^+ and A^-.

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + A^-_{(aq)}$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

Weak base model: B reacts with water to form BH^+ and OH^-.

$$B_{(aq)} + H_2O_{(l)} \rightleftharpoons BH^+_{(aq)} + OH^-_{(aq)}$$

$$K_b = \frac{[BH^+][OH^-]}{[B]}$$

pH relationships at 25 °C	Conjugate pairs: $K_a K_b = K_w$
$pH = -\log[H_3O^+]$ $\quad [H_3O^+] = 10^{-pH}$ $pOH = -\log[OH^-]$ $\quad [OH^-] = 10^{-pOH}$ $pH + pOH = 14.00$ $[H_3O^+][OH^-] = K_w = 1.0 \times 10^{-14}$	use $K_b = K_w/K_a$ for a conjugate base and $K_a = K_w/K_b$ for a conjugate acid

For weak acid + weak base salts: $pH = 7.00 + \frac{1}{2}\log\left(\frac{\text{[Weak cation]}}{\text{[Weak anion]}}\right)$

For amphiprotic ions such as HCO_3^-: $pH = \frac{pK_{a1} + pK_{a2}}{2}$

Common constants used in this worksheet

Acid or base	Constant	Acid or base	Constant
CH_3COOH	$K_a = 1.8 \times 10^{-5}$	NH_3	$K_b = 1.8 \times 10^{-5}$
HF	$K_a = 6.8 \times 10^{-4}$	CH_3NH_2	$K_b = 4.4 \times 10^{-4}$
HNO_2	$K_a = 4.5 \times 10^{-4}$	C_5H_5N	$K_b = 1.7 \times 10^{-9}$
HCN	$K_a = 3.5 \times 10^{-10}$	$HCOOH$	$K_a = 1.8 \times 10^{-4}$
HClO	$K_a = 3.2 \times 10^{-8}$	HCO_3^-	$K_{a2} = 4.7 \times 10^{-11}$

Section 2: Practice Problems

Part A: Fundamental Skills

Problem 8

Calculate the pH of a solution with $[OH^-] = 7.5 \times 10^{-6}$ mol/L

Part B: Intermediate Practice

Problem 16

Calculate the pH of 0.010 mol/L HF if $K_a = 6.8 \times 10^{-4}$

Part C: Advanced Practice

Problem 32

Calculate the exact pH of 0.0010 mol/L NH_3 if $K_b = 1.8 \times 10^{-5}$

Part D: Challenge Problems

Problem 45

The conjugate acid BH^+ has $K_a = 5.6 \times 10^{-10}$.

Calculate K_b for B and the pH of 0.100 mol/L B

Section 3: Solutions

Problem 8 Solution

Given: $[OH^-] = 7.5 \times 10^{-6}$ mol/L

pOH = -log$[OH^-]$, pH = 14.00 - pOH

pOH = -log(7.5×10^{-6}) = 5.12; pH = 14.00 - 5.12 = 8.88

Final answer: pH = 8.88

Problem 16 Solution

Given: C = 0.01 mol/L, $K_a = 6.8 \times 10^{-4}$

Find: pH

Let x = $[H_3O^+]$ formed at equilibrium

$K_a = x^2/(C - x)$, so $x = (-K_a + (\sqrt{Ka^2 + 4KaC}))/2$

$x = 2.29 \times 10^{-3}$ mol/L, pH = -log(2.29×10^{-3}) = 2.64

Final answer: pH = 2.64

Problem 32 Solution

Given: C = 0.001 mol/L, $K_b = 1.8 \times 10^{-5}$

Find: pH

Let x = $[OH^-]$ formed at equilibrium

$K_b = x^2/(C - x)$, so $x = (-K_b + (\sqrt{Kb^2 + 4KbC}))/2$

$x = 1.25 \times 10^{-4}$ mol/L, pOH = -log(1.25×10^{-4}) = 3.90, pH = 14.00 - 3.90 = 10.10

Final answer: pH = 10.10

Problem 45 Solution

Given: $K_a(BH^+) = 5.6 \times 10^{-10}$; C(B) = 0.100 mol/L

$K_b(B) = K_w/K_a(BH^+)$; then $K_b = x^2/(C - x)$

$K_b = (1.0 \times 10^{-14})/(5.6 \times 10^{-10}) = 1.79 \times 10^{-5}$;

$[OH^-] = 1.33 \times 10^{-3}$ mol/L; pOH = 2.88; pH = 11.12

Final answer: $K_b = 1.8 \times 10^{-5}$; pH = 11.12

Section 4: Answer Key

Problem	Answer
8	pH = 8.88
16	pH = 2.64
32	pH = 10.10
45	$K_b = 1.8 \times 10^{-5}$; pH = 11.12