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CHEMISTRY WORKSHEET

HYDROLYSIS OF SALTS

Course: SCH4U Grade 12 Chemistry

DOWNLOAD FULL WORKSHEET

50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ Classifying acidic, basic, and neutral salt solutions, ✓ writing hydrolysis equations for cations and anions, ✓ using Ka, Kb, and Kw relationships, ✓ calculating pH of salts from weak acids and weak bases, ✓ comparing weak acid/weak base salt behavior, ✓ percent hydrolysis and dilution problems, ✓ amphiprotic ions and challenge-level salt pH calculations

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

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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 hydrolyze	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: $K_a K_b = K_w$
$pH = -\log[H_3O^+]$ $[H_3O^+] = 10^{-pH}$ $pOH = -\log[OH^-]$ $[OH^-] = 10^{-pOH}$ $pH + pOH = 14.00$ $[H_3O^+][OH^-] = K_w = 1.0 \times 10^{-14}$	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: $pH = 7.00 + \frac{1}{2}\log\left(\frac{[\text{BH}^+\text{cation}]}{[\text{A}^-\text{anion}]}\right)$

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_4^+	$K_a = 1.8 \times 10^{-5}$
HF	$K_a = 6.8 \times 10^{-4}$	$C_6H_5NH_3^+$	$K_a = 4.4 \times 10^{-5}$
HNO_2	$K_a = 4.5 \times 10^{-4}$	C_5H_5N	$K_b = 1.7 \times 10^{-9}$
HCN	$K_a = 3.5 \times 10^{-10}$	$HCOOH$	$K_a = 1.8 \times 10^{-4}$
HCN	$K_a = 6.2 \times 10^{-10}$	HCO_3^-	$K_{a2} = 4.7 \times 10^{-11}$

Section 2 - Practice Problems

Part A - Fundamental Problems

8. Classify KCN as acidic, basic, or neutral in water

Part B - Intermediate Problems

16. Calculate the pH of 0.100 mol/L NH_4Cl at 25°C

Part C - Advanced Problems

32. Calculate the approximate pH of 0.100 mol/L NH_4F at 25°C

Part D - Challenge Problems

45. Compare the pH values of 0.100 mol/L NaClO and 0.100 mol/L KCN. Which salt solution is more basic

Section 3 - Solutions

Problem 8 Solution

K^+ is neutral; CN^- is the conjugate base of weak acid HCN

CN^- produces OH^- by hydrolysis

Final answer: Basic

Problem 16 Solution

Given: C = 0.1 mol/L NH_4Cl; $K_a(NH_4^+) = 5.6 \times 10^{-10}$

NH_4^+ is an acidic cation, so calculate $[H_3O^+]$ from hydrolysis

$$NH_4^+{}_{(aq)} + H_2O_{(l)} \rightleftharpoons NH_{3(aq)} + H_3O^+{}_{(aq)}$$

$K_a = x^2 / (C - x)$, so $x \approx \sqrt{(K_a \cdot C)}$ when x is small

$x = [H_3O^+] \approx \sqrt{((5.6 \times 10^{-10})(0.1))} = 7.45 \times 10^{-6}$ mol/L

$pH = -\log(7.45 \times 10^{-6}) = 5.13$

Final answer: pH = 5.13; the solution is acidic

Problem 32 Solution

Given: $K_a(NH_4^+) = 5.6 \times 10^{-10}$; $K_b(F^-) = 1.5 \times 10^{-11}$

Both ions hydrolyze, so compare acidic cation strength with basic anion strength

$pH \approx 7.00 + 1/2 \log(K_b(\text{anion}) / K_a(\text{cation}))$

$pH \approx 7.00 + 1/2 \log((1.5 \times 10^{-11}) / (5.6 \times 10^{-10})) = 6.21$

Final answer: pH ≈ 6.21; the solution is acidic

Problem 45 Solution

Compare the base strengths of ClO^- and CN^-

$K_b(ClO^-) = 2.9 \times 10^{-7}$; $K_b(CN^-) = 1.6 \times 10^{-5}$

0.100 mol/L NaClO gives pH ≈ 10.23; 0.100 mol/L KCN gives pH ≈ 11.10

Final answer: KCN is more basic because CN^- has the larger K_b and gives the higher pH

Section 4 - Answer Key

Problem	Answer
8	Basic
16	pH = 5.13
32	pH ≈ 6.21
45	KCN is more basic; KCN pH ≈ 11.10, NaClO pH ≈ 10.23