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CHEMISTRY WORKSHEET

STRONG ACIDS AND STRONG BASES

Course: SCH4U Grade 12 Chemistry

DOWNLOAD FULL WORKSHEET

50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ pH from strong monoprotic acids, ✓ pH from strong bases, ✓ Group 2 hydroxide pH calculations, ✓ converting pH to concentration, ✓ converting pOH to concentration, ✓ dilution problems, ✓strong acid-strong base neutralization, ✓ excess H^+ or OH^- after mixing, ✓ titration pH before/at/after equivalence, ✓ finding unknown acid/base concentration, ✓ preparing solutions from stock acids or solid bases, ✓ multi-step dilution and neutralization challenge problems

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

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	$K_a = 6.8 \times 10^{-4}$	$CH_3NH_3^+$	$K_a = 4.4 \times 10^{-4}$
HNO_2	$K_a = 4.5 \times 10^{-4}$	C_6H_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^-	$K_{a2} = 4.7 \times 10^{-11}$

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Section 2 Practice Problems

Part A Fundamental Skills

Problem 8

Calculate the pH of 1.50×10^{-3} mol/L KOH

Part B Intermediate Applications

Problem 16

35.0 mL of 0.200 mol/L HNO_3 is mixed with 20.0 mL of 0.300 mol/L NaOH.

Find the final pH

Part C Advanced Applications

Problem 32

50.00 mL of 0.0500 mol/L $Ba(OH)_2$ is titrated with 0.1000 mol/L HCl. Find the pH after 0.00 mL, 25.00 mL, 50.00 mL, and 60.00 mL of HCl are added

Part D Challenge Problems

Problem 45

A student calculates the pH of 0.0250 mol/L $Sr(OH)_2$ as 12.40 by using $[OH^-]$ = 0.0250 mol/L. Identify the error and find the correct pH

Section 3 Solutions

Problem 8 Solution

Given: KOH is a strong base; C = 0.0015 mol/L

Find: pH

Each formula unit gives 1 mol OH^- per mol base

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

[OH^-] = 1(0.0015) = 0.0015 mol/L

pOH = -log(0.0015) = 2.8239

pH = 14.00 - 2.8239 = 11.1761

Final answer: pH = 11.18

Problem 16 Solution

Given: 35 mL of 0.2 mol/L HNO_3; 20 mL of 0.3 mol/L NaOH

Find: final pH after neutralization

Compare total mol H^+ with total mol OH^-; then divide the excess by total volume

Equation:

$HNO_{3(aq)} + NaOH_{(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$

n = C·V, excess concentration = n_{excess}/V_{total}

n(H^+) = (0.2)(0.035)(1) = 0.007 mol

n(OH^-) = (0.3)(0.02)(1) = 0.006 mol

V_{total} = 0.055 L

excess n(H^+) = 0.001 mol

[H^+] = (0.001)/(0.055) = 0.0181818 mol/L

pH = -log(0.0181818) = 1.7404

Final answer: pH = 1.74

Problem 32 Solution

Given: 50.00 mL of 0.0500 mol/L $Ba(OH)_2$; titrant = 0.1000 mol/L HCl

Find: pH at four titration points

Convert $Ba(OH)_2$ to mol OH^-; compare with mol H^+ added

$n = C \cdot V$, $[\text{excess}] = n_{excess}/V_{total}$

Initial $n(OH^-) = 2(0.0500)(0.05000) = 0.005$ mol

0.00 mL HCl: pH = 13.0000

25.00 mL HCl: pH = 12.5229

50.00 mL HCl: pH = 7.0000

60.00 mL HCl: pH = 2.0414

Final answer: 0.00 mL: pH 13.00; 25.00 mL: pH 12.52; 50.00 mL: pH 7.00; 60.00 mL: pH 2.04

Problem 45 Solution

Given: 0.0250 mol/L $Sr(OH)_2$

Find: student error and correct pH

$Sr(OH)_2$ is a strong base with two hydroxide ions per formula unit

$[OH^-] = 2C_{base}$

$[OH^-] = 2(0.0250) = 0.05$ mol/L

pOH = -log(0.05) = 1.3010

pH = 14.00 - 1.3010 = 12.6990

2 mol OH^- per mol $Sr(OH)_2$; correct pH = 12.70

Final answer: Error: forgot the 2 mol OH^- per mol $Sr(OH)_2$; correct pH = 12.70

Section 4 Answer Key

Problem	Answer
8	pH = 11.18
16	pH = 1.74
32	0.00 mL: pH 13.00; 25.00 mL: pH 12.52; 50.00 mL: pH 7.00; 60.00 mL: pH 2.04
45	Error: forgot 2 OH^-; correct pH = 12.70