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CHEMISTRY WORKSHEET

ACID-BASE TITRATION

Course: SCH4U Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on:

✓ pH at equivalence point, ✓ strong acid-strong base, ✓ weak acid-strong base, ✓ weak base-strong acid, ✓ polyprotic acids, ✓ back titration, ✓ purity analysis.

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

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Section 2 - Practice Problems

Part A - Fundamental Problems

Problem 8

Calculate the initial pH of a 0.0250 mol/L HCl solution before any titrant is added

Part B - Intermediate Problems

Problem 16

A 10.00 mL sample of H_2SO_4 is titrated with 0.1500 mol/L NaOH. Concordant titres are 22.42 mL, 22.38 mL, and 22.40 mL. Calculate the concentration of H_2SO_4

$$H_2SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$$

Part C - Advanced Problems

Problem 32

A 5.00 mL sample of H_2SO_4 is diluted to 250.0 mL. A 25.00 mL aliquot of the diluted solution requires 18.75 mL of 0.1000 mol/L NaOH. Calculate the concentration of the original H_2SO_4 sample

$$H_2SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$$

Part D - Challenge Problems

Problem 45

A 20.00 mL sample of H_3PO_4 is titrated to the second equivalence point with 32.40 mL of 0.2000 mol/L NaOH. Calculate the concentration of H_3PO_4

$$H_3PO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2HPO_{4(aq)} + 2H_2O_{(l)}$$

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Section 3 - Solutions

Problem 8 Solution

Given: HCl is a strong acid and c_{HCl} = 0.0250 mol/L

Find: initial pH

For a strong monoprotic acid, $[H^+]$ equals the acid concentration

Formula: pH = $-\log[H^+]$

$[H^+]$ = 0.0250 mol/L

pH = -log(0.0250) = 1.602

Final answer: pH = 1.60

Significant figures note: pH is rounded to 2 decimal places after keeping guard digits in intermediate concentration or equilibrium calculations

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Problem 16 Solution

Given: V_{H2SO4} = 10.00 mL = 0.01000 L, c_{NaOH} = 0.1500 mol/L, titres = 22.42 mL, 22.38 mL, 22.40 mL

Find: c_{H2SO4}

Average the titres, then use the 2:1 NaOH:H_2SO_4 mole ratio

$$H_2SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$$

average V_{NaOH} = 22.40 mL = 0.02240 L

n_{NaOH} = 0.1500 mol/L · 0.02240 L = 0.003360 mol

n_{H2SO4} = 0.003360 mol / 2 = 0.001680 mol

c_{H2SO4} = 0.001680 mol / 0.01000 L = 0.1680 mol/L

Final answer: 0.1680 mol/L H_2SO_4

Significant figures note: Final result is reported to 4 significant figures because the titration volumes and standard concentration are given to 4 significant figures

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Problem 32 Solution

Given: 5.00 mL original sample diluted to 250.0 mL; 25.00 mL aliquot uses 18.75 mL of 0.1000 mol/L NaOH

Find: original c_{H2SO4}

Use diprotic stoichiometry for the aliquot, scale to the full diluted flask, then divide by the original sample volume

$$H_2SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$$

n_{NaOH} in aliquot = 0.1000 mol/L · 0.01875 L = 0.001875 mol

n_{H2SO4} in aliquot = 0.001875 mol / 2 = 0.0009375 mol

scale factor = 250.0 mL / 25.00 mL = 10.00

n_{H2SO4} in original 5.00 mL sample = 0.0009375 mol · 10.00 = 0.009375 mol

$c_{original}$ = 0.009375 mol / 0.00500 L = 1.875 mol/L

Final answer: 1.88 mol/L H_2SO_4

Significant figures note: The original 5.00 mL volume has 3 significant figures, so the final concentration is reported to 3 significant figures

Problem 45 Solution

Given: V_{acid} = 20.00 mL = 0.02000 L, V_{NaOH} = 32.40 mL = 0.03240 L, c_{NaOH} = 0.2000 mol/L

Find: c_{H3PO4}

At the second equivalence point, 2 mol OH^- have reacted with each mole of H_3PO_4

$$H_3PO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2HPO_{4(aq)} + 2H_2O_{(l)}$$

n_{NaOH} = 0.2000 mol/L · 0.03240 L = 0.006480 mol

n_{H3PO4} = 0.006480 mol / 2 = 0.003240 mol

c_{H3PO4} = 0.003240 mol / 0.02000 L = 0.1620 mol/L

Final answer: 0.1620 mol/L H_3PO_4

Significant figures note: Final result is reported to 4 significant figures because the titration volumes and standard concentration are given to 4 significant figures

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Section 4 - Answer Key

Problem	Answer
8	pH = 1.60
16	0.1680 mol/L H_2SO_4
32	1.88 mol/L H_2SO_4
45	0.1620 mol/L H_3PO_4

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