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CHEMISTRY WORKSHEET

REACTION MECHANISMS

Course: SCH4U Grade 12 Chemistry

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50 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 50 representative problems on: a

✓ Elementary steps, molecularity, catalysts, intermediates, ✓ Rate-determining steps and mechanism-based rate laws, ✓ Pre-equilibrium and advanced mechanism reasoning,

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

Essential Information

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Practice Problems

Part A - Fundamental Problems (1-15)

Problem 8. The following substitution is treated as one elementary step

$$CH_3Br + OH^- \rightarrow CH_3OH + Br^-$$

Identify the molecularity and write the elementary-step rate law

Part B - Intermediate Problems (16-30)

Problem 16. Nitric oxide can catalyze ozone decomposition by the following mechanism

$$NO + O_3 \rightarrow NO_2 + O_2$$

$$NO_2 + O \rightarrow NO + O_2$$

Find the overall reaction, catalyst, intermediate, and rate law if Step 1 is slow

Part C - Advanced Problems (31-40)

Problem 32. For the rate law from Problem 31

$$\text{rate} = k[O_3]^2/[O_2]$$

Determine the units of k when rate is in mol/(L·s)

Part D - Challenge Problems (41-50)

Problem 45. For the rate law from Problem 44

$$\text{rate} = k[H^+][H_2O_2][Br^-]$$

Predict the rate change if $[H^+]$ is doubled, $[Br^-]$ is doubled, and $[H_2O_2]$ is halved

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Solutions

Problem 8 Solution

Given: The elementary step has CH_3Br and OH^- as reactants

Find: Molecularity and rate law

Count the reacting particles in the elementary step and use their concentrations in the rate law

rate = $k[CH_3Br][OH^-]$

Two reactant particles collide, so the step is bimolecular

Final answer: Bimolecular; rate = $k[CH_3Br][OH^-]$

Problem 16 Solution

Given: NO is regenerated, NO_2 is temporary, and Step 1 is slow

Find: Overall reaction, catalyst, intermediate, and rate law

Cancel species that appear on both sides and use the slow elementary step for rate

Slow Step 1 gives rate = $k[NO][O_3]$

NO and NO_2 cancel in the sum, leaving $O_3 + O \rightarrow 2O_2$

Final answer: Overall: $O_3 + O \rightarrow 2O_2$; catalyst: NO; intermediate: NO_2; rate = $k[NO][O_3]$

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Problem 32 Solution

Given: rate = $k[O_3]^2/[O_2]$

Find: Units of k

Determine the net concentration power in the rate law

$[O_3]^2/[O_2]$ has units $(mol/L)^2/(mol/L) = mol/L$

Since rate units are mol/(L·s), k must have units 1/s

Final answer: k units = 1/s

Problem 45 Solution

Given: $[H^+] \times 2$, $[Br^-] \times 2$, and $[H_2O_2] \times 1/2$

Find: Overall rate factor

Multiply the concentration factors because each species is first order

rate factor = 2 × 2 × 1/2

2 × 2 × 1/2 = 2

Final answer: The rate increases by a factor of 2

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Answer Key

Problem	Answer
8	Bimolecular; rate = k[CH_3Br][OH^-]
16	Overall: O_3 + O → 2O_2; catalyst: NO; intermediate: NO_2; rate = k[NO][O_3]
32	k units = 1/s
45	The rate increases by a factor of 2

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