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CHEMISTRY WORKSHEET

AVERAGE AND INSTANTANEOUS RATES

Course: SCH4U Grade 12 Chemistry

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20 Practice Problems with Answers and Detailed Solutions

FULL worksheet contains 20 representative problems on:

✓ Average rate from concentration changes, ✓ reactant disappearance, ✓ product appearance, ✓ stoichiometric rate relationships, ✓ instantaneous rate from tangent lines, ✓ central secant rate estimates from data tables

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 Summary

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Section 2. Practice Problems

Part A. Average rate from concentration changes

Problem 3 The concentration of H_2O_2 changes as shown. Calculate the average rate of disappearance from 0 to 100 s and from 100 to 300 s, then state what happens to the rate

Time (s)	0	100	200	300
$[H_2O_2]$ (M)	0.800	0.640	0.520	0.430

Part C. Instantaneous rate from tangent lines and data

Problem 14 A tangent line to the concentration-time curve for product Y at 80 s passes through the points (60 s, 0.145 M) and (100 s, 0.205 M). Estimate the instantaneous rate of appearance of Y at 80 s

Problem 17 Use a central secant from 10 s to 30 s to estimate the instantaneous rate of appearance of product P at 20 s

Time (s)	0	10	20	30	40
[P] (M)	0.000	0.035	0.062	0.083	0.099

Part D. Mixed exam-style problems

Problem 19 For the reaction below, $[SO_3]$ increases from 0.120 M to 0.270 M in 75.0 s. Calculate the average rate of appearance of SO_3, the average reaction rate, the rate of disappearance of SO_2, and the rate of disappearance of O_2

$$2\ SO_{2(g)} + O_{2(g)} \rightarrow 2\ SO_{3(g)}$$

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Solutions

Problem 3 Solution

Given: [H_2O_2] decreases from 0.800 M to 0.640 M from 0 to 100 s, and from 0.640 M to 0.430 M from 100 to 300 s

Average rate of disappearance = ([reactant]$_{initial}$ - [reactant]$_{final}$) / Δt

From 0 to 100 s: (0.800 M - 0.640 M) / 100 s = 1.60 × 10^{-3} M/s

From 100 to 300 s: (0.640 M - 0.430 M) / 200 s = 1.05 × 10^{-3} M/s

Final answer: The rate decreases from 1.60 × 10^{-3} M/s to 1.05 × 10^{-3} M/s

Problem 14 Solution

Given: Tangent points are (60 s, 0.145 M) and (100 s, 0.205 M) for product Y

For a product, instantaneous rate of appearance = slope of the tangent

Slope = (0.205 M - 0.145 M) / (100 s - 60 s) = 0.060 M / 40 s = 1.50 × 10^{-3} M/s

Final answer: Instantaneous rate of appearance of Y = 1.50 × 10^{-3} M/s

Problem 17 Solution

Given: To estimate the instantaneous rate at 20 s, use the points around it: 10 s and 30 s

For a product, rate of appearance = central secant slope

Slope = (0.083 M - 0.035 M) / (30 s - 10 s) = 0.048 M / 20 s = 2.40 × 10^{-3} M/s

Final answer: Estimated instantaneous rate of appearance of P at 20 s = 2.40 × 10^{-3} M/s

Problem 19 Solution

Given: [SO_3]$_{initial}$ = 0.120 M, [SO_3]$_{final}$ = 0.270 M, Δt = 75.0 s

SO_3 appearance rate = Δ[SO_3] / Δt, and reaction rate = 1/2 × SO_3 appearance rate

SO_3 appearance rate = (0.270 M - 0.120 M) / 75.0 s = 2.00 × 10^{-3} M/s

Reaction rate = (1/2)(2.00 × 10^{-3}) = 1.00 × 10^{-3} M/s

SO_2 disappears at 2 × reaction rate = 2.00 × 10^{-3} M/s

O_2 disappears at 1 × reaction rate = 1.00 × 10^{-3} M/s

Final answer: SO_3 appearance = 2.00 × 10^{-3} M/s; reaction rate = 1.00 × 10^{-3} M/s; SO_2 disappearance = 2.00 × 10^{-3} M/s; O_2 disappearance = 1.00 × 10^{-3} M/s

Section 4. Answer Key

Problem	Answer
3	0-100 s: 1.60×10^{-3} M/s; 100-300 s: 1.05×10^{-3} M/s; rate decreases
14	1.50×10^{-3} M/s
17	2.40×10^{-3} M/s
19	SO_3 2.00×10^{-3} M/s; reaction rate 1.00×10^{-3} M/s; SO_2 2.00×10^{-3} M/s; O_2 1.00×10^{-3} M/s

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