EXAM 1

PRACTICE PROBLEMS

CHEMISTRY 165B // SPRING 2020

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PRACTICE PROBLEM 1.1

Consider the decomposition of nitrous oxide:

$$2\ N_2O\ (g) \rightarrow 2\ N_2\ (g) + O_2\ (g)$$

Given the following initial rates data collected at 321 K, determine the rate law for the reaction.

Experiment	$[N_2O]_0$ (M)	Initial Rate (M/min)
1	0.387	0.00190
2	1.161	0.0171
3	1.935	0.0476

— answer —

PRACTICE PROBLEM 1.2

Consider the decomposition of nitrous oxide:

$$2\ N_2O\ (g) \rightarrow 2\ N_2\ (g) + O_2\ (g)$$

Determine the value and units for the rate constant *k*.

— answer —

Experiment	$[N_2O]_0$ (M)	Initial Rate (M/min)
1	0.387	0.00190
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PRACTICE PROBLEM 1.3

Consider the decomposition of nitrous oxide:

$$2\ N_2O\ (g) \rightarrow 2\ N_2\ (g) + O_2\ (g)$$

If we start with $[N_2O]$ = 1.00 M, how long would it take for this reaction to go to 15% completion?

– answer –

PRACTICE PROBLEM 1.4

Consider the decomposition of nitrous oxide:

$$2\ N_2O\ (g) \rightarrow 2\ N_2\ (g) + O_2\ (g)$$

Which of the following proposed mechanisms is not valid?

Justify your choice briefly.

— answer —

I
$N_2O \rightleftharpoons N_2 + O$ (fast)
$N_2O + O \rightarrow N_2 + O_2$ (slow)

II
$2\ N_2O \rightleftharpoons N_4O_2$ (fast)
$N_4O_2 \rightarrow 2\ N_2 + O_2$ (slow)

III
$N_2O + N_2O \rightarrow 2\ N_2 + O + O$ (slow)
$O + O \rightarrow O_2$ (fast)

PRACTICE PROBLEM 2.1

Hypochlorous acid (HClO) is a weak acid with a $K_a = 2.98 \times 10^{-8}$ at 298 K.

What is the pH of a 100. mL solution of 2.01 M HClO?

— answer —

PRACTICE PROBLEM 2.2

Hypochlorous acid (HClO) is a weak acid with a $K_a = 2.98 \times 10^{-8}$ at 298 K.

To 100. mL of 2.01 M HClO we add 0.080 moles of NaOH. What is the pH of the resulting solution?

You may assume no change in volume or temperature.

— answer —

PRACTICE PROBLEM 2.3

Hypochlorous acid (HClO) is a weak acid with a $K_a = 2.98 \times 10^{-8}$ at 298 K.

How many grams of solid NaClO would need to be added to 100. mL of 2.01 M HClO to produce a solution with a pH = 7.60?

You may assume no change in volume or temperature.

— answer —

PRACTICE PROBLEM 3.1

Consider the equilibrium reaction: $Ag^+ (aq) + 2\ NH_3 (aq) \rightleftharpoons [Ag(NH_3)_2]^+ (aq)$ $K_c = 1.7 \times 10^7$ (at 298 K)

If the initial solution contains only 0.10 M $[Ag(NH_3)_2]^+$, what is the equilibrium concentration of NH_3 in solution?

— answer —

PRACTICE PROBLEM 3.2

To a 0.10 M KCl solution, $AgNO_3$ is added gradually until a precipitate beings to form. If the concentration of $[Ag^+]$ at the time of precipitate formation is 1.6×10^{-9} M, what is the value of K_{sp} for AgCl?

— answer —

PRACTICE PROBLEM 3.3

Do you expect AgCl to be more or less soluble in a solution of pure NH_3 than in a solution of pure water? Justify your answer.

Refer to Practice Problem 3.1.

— answer —

PRACTICE PROBLEM 4

Consider the gaseous equilibrium: $N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$

At 298 K, the value of K_c for this reaction is 0.060. Write an expression for K_p using K_c at 298K.

— answer —

PRACTICE PROBLEM 5

Which of the following aqueous salt solutions are acidic? Assume all are 1.0 M.

(a) $NaNO_2$

(b) KCH_3COO

(c) NH_4Br

(d) $BaCl_2$

— answer —

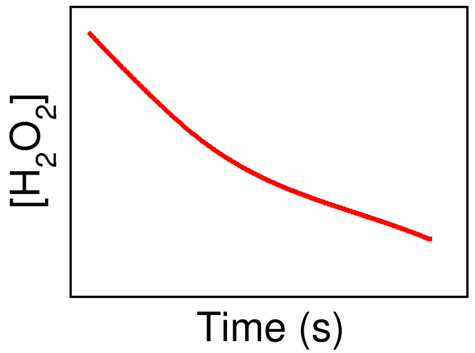
PRACTICE PROBLEM 6

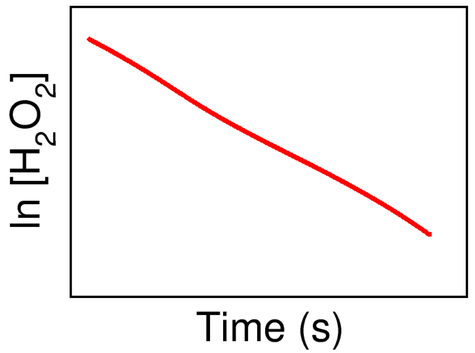
The following concentration-time data are plotted below for the decomposition of hydrogen peroxide (H_2O_2) at 298 K.

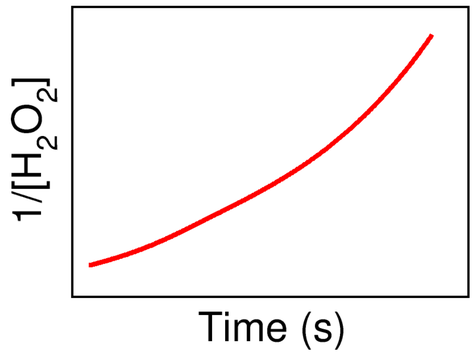
$$2\ H_2O_2\ (aq) \rightarrow 2\ H_2O\ (l) + O_2\ (g)$$

What is the order of the reaction with respect to $[H_2O_2]$?

Time (s)	$[C_4H_6]$ (M)
0	1.00
120.	0.91
300.	0.78
600.	0.59
1200.	0.37
1800.	0.22







— answer —

PRACTICE PROBLEM 7

Which of the following changes would increase the concentration of $[Br_2]$ for the following chemical reaction?

$$2\ Br\ (g) \rightleftharpoons Br_2\ (g) \qquad ;\ \Delta H = -244\ kJ$$

(a) Increasing the temperature.

(b) Increasing the total pressure of the system.

(c) Increasing the volume of the container.

— answer —

PRACTICE PROBLEM 8

Consider the reaction: $A \rightarrow B$

The initial concentration of A is $[A]_0 = 0.561$ M. You determine the first three *successive* half-life times to be 483, 483, and 483 seconds. How long will it take for the concentration to decrease to 0.241 M?

– answer –

PRACTICE PROBLEM 9

Consider the reaction: $2\ NOCl\ (g) \rightleftharpoons 2\ NO\ (g) + Cl_2\ (g)$

Into a 2.0 L container at 35 °C, you place 1.0 mol NO (g) and 1.0 mol Cl_2 (g) and allow the system to reach equilibrium. If the concentration of Cl_2 (g) at equilibrium is 0.252 M, what is the value of K_c for this reaction?

– answer –

PRACTICE PROBLEM 10

Consider a solution that is 0.45 M HCN and 0.69 M NaCN, where K_a (HCN) = 6.2×10^{-10} at 298 K.

If 0.25 mol of NaOH is added to 1.0 L of the above solution, what is the pH of the final solution?

Assume the volume does not change.

— answer —

PRACTICE PROBLEM 11

A 145 mL solution of 1.35 M methylamine (CH_3NH_2, $K_b = 4.4 \times 10^{-4}$) is titrated with 0.250 M HCl.

What is the pH at the equivalence point?

— answer —