# EXAM 1

## PRACTICE PROBLEMS

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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 |
| 2 | 1.161 | 0.0171 |
| 3 | 1.935 | 0.0476 |

# 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 2.2

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 $1.6 \times 10^{-9}$ 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 4.1

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 4.2

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 —*

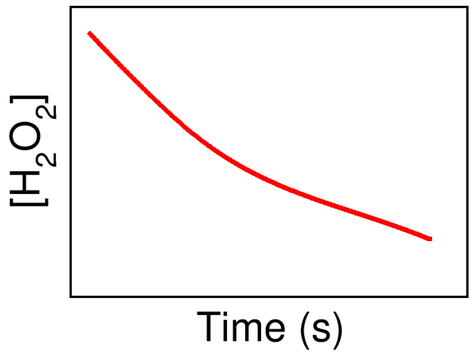
# PRACTICE PROBLEM 4.3

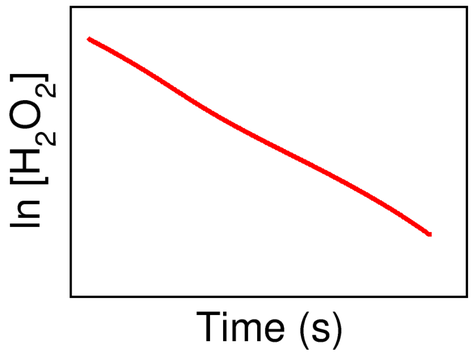
The following concentration-time data are plotted below for the decomposition of hydrogen peroxide ($H_2O_2$) at 298 K.

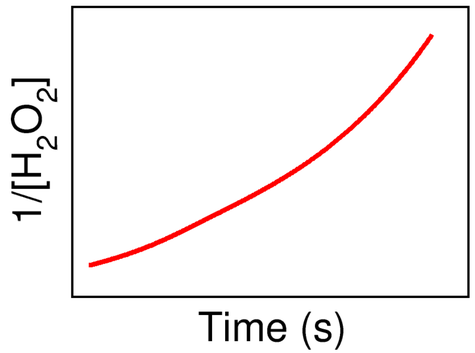
$$2\ H_2O_2\ (aq) \rightarrow 2\ H_2O\ (l) + O_2\ (g)$$

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 4.4

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 —*