NAME: **HONORS CHEMISTRY**

SECTION: Rate Law Problem Set

1. The following reaction was studied at 10oC: 2 NO(g) + Cl2(g) → 2 NOCl(g)

The results of the kinetics study are shown below.

[NO] [Cl2] initial rate (M/min)

0.10 0.10 0.18

0.10 0.20 0.35

0.20 0.20 1.45

1. What is the rate law for this reaction? What is the overall reaction order?
2. Determine the value of the rate constant for this reaction.
3. The following reaction was studied at 5oC? 2 ClO2(aq) + 2 OH- → ClO3-(aq) + ClO2-(aq) + H2O(l)

The kinetics data are shown below:

[ClO2] [OH-] Initial rate (M/sec)

0.0500 0.100 5.75 x 10-2

0.100 0.100 2.30 x 10-1

0.100 0.050 1.15 x 10-1

* + 1. What is the rate law for this reaction? What is the overall reaction order?
    2. Determine the value of the rate constant for this reaction.

1. The following reaction was studied at 15oC: 2 I- (aq) + S2O82-(aq) → I2(aq) + 2 SO42-(aq)

[I-] [S2O82-] initial rate (M/sec)

0.080 0.040 12.50 x 10-6

0.040 0.040 6.251 x 10-6

0.080 0.020 6.248 x 10-6

0.032 0.040 4.350 x 10-6

0.060 0.030 6.410 x 10-6

* 1. What is the rate law for this reaction?
  2. Determine the value of the rate constant for this reaction.
  3. If the same reaction was run at 15oC, with [I-] = 0.050 M and [S2O82-] = 0.95 M, what would the rate have been?

1. The following mechanism has been proposed for the destruction of ozone, O3, in the upper atmosphere:

Step 1 Cl + O3 → ClO + O2 (slow)

Step 2 ClO + O → Cl + O2 (fast)

* 1. Write the net equation.
  2. Which species is a catalyst? How do you know?
  3. Which species is an intermediate? How do you know?

1. The mechanism proposed for the decomposition of hydrogen peroxide is:

Step 1 H2O2 → 2 OH (slow)

Step 2 H2O2 + OH → H2O + HO2 (fast)

Step 3 HO2 + OH → H2O + O2 (fast)

1. Write the net equation.
2. Write the expected rate law.
3. What will be the effect on the reaction rate if the concentration of H2O2 is increased? Explain your answer in terms of collision theory.
4. What will be the effect on the reaction rate if the concentration of HO2 is decreased? Why?

**Answers:**

1. rate = k[NO]2[Cl2]1; k = 180; 3rd order overall (2nd order wrt NO; 1st order wrt Cl2)
2. rate = k[ClO2]2[OH-]1; k = 230; 3rd order overall (2nd order wrt ClO2; 1st order wrt OH-)
3. rate = k[I-][S2O82-]; 2nd order overall; k = 0.0039; rate = 0.000185 mol/sec
4. overall rxn: O3 + O 🡪 2 O2; rate law = k[H2O2]; catalyst = NO; intermediate = NO2