D16-17 Unit 3 Rates HW

1.

Experiment	Initial Concentration of NO (mol/L)	Initial Concentration of O_2 (mol/L)	Initial Rate of Formation of NO_2 (mol L^{-1} s^{-1})
1	0.0200	0.0300	$8.52 * 10^{-2}$
2	0.0200	0.0900	$2.56 * 10^{-1}$
3	0.0600	0.0300	$7.67 * 10^{-1}$

a. Determine the order of the reaction with respect to each of the following reactants. Give details of your reasoning, clearly explaining or showing how you arrive at your answers. (i) NO (ii) O_2
b. Write the expression for the rate law for the reaction as determined from the experimental data.
c. Determine the value of the rate constant for the reaction, clearly indicating the units.

2. $2\ NO(g) + Br_2(g) \rightarrow 2\ NOBr(g)$

A rate study of the reaction represented above was conducted at 25°C. The data that were obtained are shown in the table below.

Experiment	Initial Concentration of NO (mol L^{-1})	Initial Concentration of Br_2 (mol L^{-1})	Initial Rate of Formation of NOBr
1	0.016	0.0120	$3.24 * 10^{-4}$
2	0.016	0.024	$6.38 * 10^{-4}$
3	0.0320	0.0060	$6.42 * 10^{-4}$

a. Calculate the initial rate of disappearance of Br_2 in experiment 1
b. Determine the order of the reaction with respect to each reactant, Br_2 and NO. In each case explain your reasoning.
c. For the reaction write the rate law that is consistent with the data and calculate the value of the specific rate constant, k, and specify units.

3.

Experiment	Initial Concentration of NO (mol/L)	Initial Concentration of O_2 (mol/l)	Initial Rate of Formation of NO_2
1	0.10	0.10	$2.5 * 10^{-4}$
2	0.20	0.10	$5.0 * 10^{-4}$
3	0.20	0.40	$8.0 * 10^{-3}$

The initial rate data in the table above were obtained for the reaction represented below. What is the experimental rate law for the reaction?

$$2NO\ (g)\ +\ O_2\ (g)\ \rightarrow NO_2\ (g)$$

4. What would one have to plot in order to determine that a decomposition reaction is zero order? What would the slope of the line be equal to?

5. What would one have to plot in order to determine that a decomposition reaction is first order? What would the slope of the line be equal to?

6. What would one have to plot in order to determine that a decomposition reaction is second order? What would the slope of the line be equal to?

7. If 87.5 % of a sample of pure ^{131}I decays in 24 days, what is the half-life of ^{131}I?

8. An environmental concern is the depletion of O_3 in the Earth's upper atmosphere, where O_3 is normally in equilibrium with O_2 and O. A proposed mechanism for the depletion of O_3 in the upper atmosphere is shown below:

Step I: $O_3 + Cl \rightarrow O_2 + ClO$
Step II: $ClO + O \rightarrow Cl + O_2$

a. Write a balanced equation for the overall reaction represented by step I and step II above.
b. Clearly identify the catalyst in the mechanism above. Justify your answer.
c. Clearly identify the intermediate in the mechanism above. Justify your answer.
d. If the rate law for the overall reaction is found to be rate = k $[O_3]$ [Cl], determine the following.

(i) the overall order of the reaction.
(ii) appropriate units for the rate constant, k.
(iii) the rate determining step of the reaction, along with justification for your answer.

$$BF_3\,(g) \quad + \quad NH_3\,(g) \quad \rightarrow \quad BF_3NH_3\,(g)$$

9.

Experiment	Initial Concentration of BF_3 (mol/L)	Initial Concentration of NH_3(mol/L)	Initial Rate (mol L^{-1} s^{-1})
1	0.100	0.100	0.0341
2	0.200	0.233	0.159
3	0.200	0.0750	0.0512
4	0.300	0.100	0.102

a. Determine the order of the reaction with respect to each reactant, BF_3 and NH_3. In each case explain your reasoning.
b. For the reaction write the rate law that is consistent with the data
c. Calculate the value of the specific rate constant, k, and specify units.
d. When $[BF_3]$ = .533 M and $[NH_3]$ = 0.300 M what is the rate of the reaction at the temperature of the experiment?

10. The equation for the reaction between iodide and bromate ions in acidic solution is

$$6I^-\,(aq) \; + \; BrO_3^-\,(aq) \; 6H^+ \; \rightarrow \; 3I_2\,(aq) \; + \; Br^-\,(aq) \; + \; 3H_2O$$

The rate of the reaction is followed by measuring the appearance of I_2. The following data are obtained:

Experiment	$[I^-]$	$[BrO_3^-]$	$[H^+]$	Initial Rate (mol/L*s)
1	0.00200	0.0080	0.020	$8.89 * 10^{-5}$
2	0.00400	0.0080	0.020	$1.78 * 10^{-4}$
3	0.0020	0.0160	0.020	$1.78 * 10^{-4}$
4	0.0020	0.0080	0.040	$3.56 * 10^{-4}$
5	0.0015	0.0040	0.030	$7.51 * 10^{-5}$

a. What is the order of the reaction with respect to each reactant?
b. Write the rate expression for the reaction
c. Calculate k and specify the units
d. What is the hydrogen ion concentration when the rate is $5.00 * 10^{-4}$ mol/L*s and $[I^-] = \frac{1}{2}[BrO_3] = 0.0075$ M?
e. What is the initial rate for the disappearance of BrO_3^- for experiment 1?

11. Factors that affect the rate of a chemical reaction include which of the following?
I. Frequency of collisions of reactant particles
II. Kinetic energy of collisions of reactant particles.
III. Orientation of reactant particles during collisions

Extra:

$$2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$$

A proposed mechanism for the overall reaction represented above is the following:

$NO\ (g) + NO\ (g) \rightarrow N_2O_2\ (g)$ slow
$N_2O_2\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$ fast

What might the rate law be for this overall reaction?