AP Chemistry - Kinetics Problems Part 3

1) Consider the reaction of nitrogen dioxide with carbon monoxide:

$$NO_2(g) + CO(g) \longrightarrow NO(g) + CO_2(g)$$

The proposed mechanisim for the reaction is two steps. Determine the rate expression for the reaction and identify any catalysts and/or intermediates involved in the reaction.

Step 1: $NO_2 + NO_2 \longrightarrow NO_3 + NO$ slow
Step 2: $NO_3 + CO \longrightarrow NO_2 + CO_2$ fast

2) Consider the reaction of nitrogen dioxide with fluorine gas:

$$2NO_2(g) + F_2(g) \longrightarrow 2NO_2F(g)$$

The proposed mechanisim for the reaction is two steps. Determine the rate expression for the reaction and identify any catalysts and/or intermediates involved in the reaction.

Step 1: $NO_2 + F_2 \longrightarrow NO_2F + F$ **(slow)**
Step 2: $F + NO_2 \longrightarrow NO_2F$ **(fast)**

3) Consider the proposed mechanisim for a given reaction.

$C_4H_9Br \longrightarrow C_4H_9^+ + Br^-$ Slow
$C_4H_9^+ + H_2O \longrightarrow C_4H_9OH_2^+$ Fast
$C_4H_9OH_2^+ + H_2O \longrightarrow C_4H_9OH + H_3O^+$ Fast

a. What would be the overall reaction?
b. Which species is a catalyst in the reaction?
c. Which species is an intermediate in the reaction?
d. What would be the rate equation?

4) One mechanism for the destruction of ozone in the upper atmosphere is:

$O_3(g) + NO(g) \longrightarrow NO_2(g) + O_2(g)$ Slow
$NO_2(g) + O(g) \longrightarrow NO(g) + O_2(g)$ Fast

a. What would be the overall reaction?
b. Which species is a catalyst in the reaction?
c. Which species is an intermediate in the reaction?
d. What would be the rate equation?

5) Consider the proposed mechanisim for a given reaction.

$$\textbf{Step 1: } B_2 + B_2 \longrightarrow E_3 + D \quad \text{slow}$$
$$\textbf{Step 2: } E_3 + A \longrightarrow B_2 + C_2 \quad \text{fast}$$

a. What would be the overall reaction?
b. Which species is a catalyst in the reaction?
c. Which species is an intermediate in the reaction?
d. What would be the rate equation?

6) Consider the proposed mechanisim for a given reaction.

$$2NO \rightarrow N_2O_2 \quad \text{(fast)}$$
$$N_2O_2 + H_2 \rightarrow N_2O + H_2O \quad \text{(slow)}$$
$$N_2O + H_2 \rightarrow N_2 + H_2O \quad \text{(fast)}$$

a. What would be the overall reaction?
b. Which species is a catalyst in the reaction?
c. Which species is an intermediate in the reaction?
d. What would be the rate equation?

7) It is believed that the following two elementary steps make up the mechanism for the reaction between nitrogen monoxide and chlorine:

$$NO(g) + Cl_2(g) \rightarrow NOCl_2(g) \quad \text{(slow)}$$
$$NOCl_2(g) + NO(g) \rightarrow 2NOCl(g) \quad \text{(fast)}$$

a. What would be the overall reaction?
b. Which species is a catalyst in the reaction?
c. Which species is an intermediate in the reaction?
d. What would be the rate equation?

8) Consider the proposed mechanisim for a given reaction.

Step 1: $2NO + H_2 \rightarrow N_2 + H_2O_2$ Slow
Step 2: $H_2 + H_2O_2 \rightarrow 2H_2O$ Fast

a. What would be the overall reaction?
b. Which species is a catalyst in the reaction?
c. Which species is an intermediate in the reaction?
d. What would be the rate equation?