Quiz: Ch 14 & 15 **Name:**
Version I (33 pts) **I have not received or given, nor will give any aid on this exam.**
AP Chemistry **February 11, 2005** **Period: 5 6 7**

Show your work for all problems and be sure to box your final answer and include sensible units. No work (i.e., no reasonable justification) = no credit.

1. (15 pts) One of the major eye irritants in smog is formaldehyde, CH_2O, formed by reaction of ozone with ethane:

$$2\ C_2H_4\ (g) + 2\ O_3\ (g) \rightarrow 4\ CH_2O\ (g) + O_2\ (g)$$

The following data were collected at 25.0°C:

Initial $[O_3]$, mol/L	Initial $[C_2H_4]$, mol/L	Initial rate of formation of CH_2O, $mol \cdot L^{-1} \cdot s^{-1}$
5.0×10^{-4}	1.0×10^{-4}	1.0×10^{-12}
1.0×10^{-3}	3.0×10^{-4}	1.8×10^{-11}
1.0×10^{-3}	1.5×10^{-4}	4.5×10^{-12}

a. (4 pts) Calculate the orders of reaction for C_2H_4 (g) and O_3 (g).

Order of C_2H_4 =

Order of O_3 =

b. (3 pts) Calculate the rate constant, k (with units).

k =

c. (3 pts) The following mechanism has been suggested for the above reaction.

Step 1: $2\ C_2H_4 + O_3 \rightarrow C_2H_4O_2 + C_2H_4O$ FAST

Step 2: $C_2H_4O_2 + C_2H_4O + O_3 \rightarrow 4\ CH_2O + O_2$ SLOW

Is it consistent with the calculated rate law? Why or why not?

d. (1 pt) What is the molecularity of Step 1?

e. (4 pts) When the temperature of the reaction is changed to 50.0°C, the rate constant is calculated to be 4.0. What is the activation energy of the reaction?

2. (12 pts) A 1.00 mole sample of CO_2 is heated to 1000. K with excess solid graphite in a 40.0-L container. At 1000. K, $K_C = 1.90 \times 10^{-3}$ for the reaction:

$$C\ (graphite, s) + CO_2\ (g) \leftrightarrow 2\ CO\ (g) \qquad \Delta H_{reaction} = -172\ kJ/mol$$

a. (2 pts) Write the equilibrium constant expression, K_C.

$K_C =$

b. (2 pts) Calculate the value of the equilibrium constant, K_P.

$K_P =$

c. (4 pts) Calculate the equilibrium concentration of $CO_2\ (g)$ if 0.250 moles of CO (g) are present at equilibrium.

$[CO_2\ (g)] =$

d. (4 pts) If the volume of the flask is changed, and a new equilibrium is established in which the quantity of $CO_2\ (g)$ is equal to that of CO (g) (not necessarily the quantity stated in part c), what is the new volume of the flask?

Volume =

(6 pts) Consider the equilibrium in Question 3. Circle the component (products, reactants, neither, or more info is needed) that would be favored if the following conditions were changed.

3. Volume of the container is decreased: Products / Reactants / Neither / More info needed

4. The temperature is decreased: Products / Reactants / Neither / More info needed

5. The pressure is increased by adding 5 moles of neon gas:

Products / Reactants / Neither / More info needed

Quiz: Ch 14 & 15 **Name:**
Version J (33 pts) **I have not received or given, nor will give any aid on this exam.**
AP Chemistry **February 11, 2005** **Period: 5 6 7**

Show your work for all problems and be sure to box your final answer and include sensible units. No work (i.e., no reasonable justification) = no credit.

1. (15 pts) One of the major eye irritants in smog is formaldehyde, CH_2O, formed by reaction of ozone with ethane:

$$2\ C_2H_4\,(g) + 2\ O_3\,(g) \rightarrow 4\ CH_2O\,(g) + O_2\,(g)$$

The following data were collected at 25.0°C:

Initial $[O_3]$, mol/L	Initial $[C_2H_4]$, mol/L	Initial rate of formation of CH_2O, $mol \cdot L^{-1} \cdot s^{-1}$
1.0×10^{-4}	5.0×10^{-4}	2.0×10^{-12}
3.0×10^{-4}	1.0×10^{-3}	3.6×10^{-11}
1.5×10^{-4}	1.0×10^{-3}	9.0×10^{-12}

a. (4 pts) Calculate the orders of reaction for C_2H_4 (g) and O_3 (g).

Order of C_2H_4 =

Order of O_3 =

b. (3 pts) Calculate the rate constant, k (with units).

k =

c. (3 pts) The following mechanism has been suggested for the above reaction.

Step 1: $2\ C_2H_4 + O_3 \rightarrow C_4H_8O_3$ FAST

Step 2: $C_4H_8O_3 + O_3 \rightarrow C_4H_8O_4 + O_2$ SLOW

Step 3: $C_4H_8O_4 \rightarrow 4\ CH_2O$ FAST

Is it consistent with the calculated rate law? Why or why not?

d. (1 pt) What is the molecularity of Step 2?

e. (4 pts) When the temperature of the reaction is changed to 150.0°C, the rate constant is calculated to be 6.0. What is the activation energy of the reaction?

2. (12 pts) A 2.00 mole sample of CO_2 is heated to 1500. K with excess solid graphite in a 50.0-L container. At 1500. K, $K_C = 1.33 \times 10^{-4}$ for the reaction:

$$C\ (graphite, s) + CO_2\ (g) \leftrightarrow 2\ CO\ (g) \qquad \Delta H_{reaction} = 172\ kJ/mol$$

   a. (2 pts) Write the equilibrium constant expression, K_C.

   $K_C =$

   b. (2 pts) Calculate the value of the equilibrium constant, K_P.

   $K_P =$

   c. (4 pts) Calculate the equilibrium concentration of $CO_2\ (g)$ if 0.100 moles of CO (g) are present at equilibrium.

   $[CO_2\ (g)] =$

   d. (4 pts) If the volume of the flask is changed, and a new equilibrium is established in which the quantity of $CO_2\ (g)$ is twice that of CO (g) (not necessarily the quantity stated in part c), what is the new volume of the flask?

   Volume =

(6 pts) Consider the equilibrium in Question 3. Circle the component (products, reactants, neither, or more info is needed) that would be favored if the following conditions were changed.

3. The pressure is increased by adding 5 moles of argon gas:
   Products / Reactants / Neither / More info needed

4. Volume of the container is increased: Products / Reactants / Neither / More info needed

5. The temperature is increased: Products / Reactants / Neither / More info needed

Quiz: Ch 14 & 15 **Name:**
Version K (33 pts) **I have not received or given, nor will give any aid on this exam.**
AP Chemistry **February 11, 2005** **Period: 5 6 7**

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1. (15 pts) One of the major eye irritants in smog is formaldehyde, CH_2O, formed by reaction of ozone with ethane:

$$2\ C_2H_4\,(g) + 2\ O_3\,(g) \rightarrow 4\ CH_2O\,(g) + O_2\,(g)$$

The following data were collected at 25.0°C:

Initial $[O_3]$, mol/L	Initial $[C_2H_4]$, mol/L	Initial rate of formation of CH_2O, $mol \cdot L^{-1} \cdot s^{-1}$
1.0×10^{-4}	5.0×10^{-4}	7.50×10^{-13}
3.0×10^{-4}	1.0×10^{-3}	2.70×10^{-11}
1.5×10^{-4}	1.0×10^{-3}	6.75×10^{-12}

a. (4 pts) Calculate the orders of reaction for C_2H_4 (g) and O_3 (g).

Order of C_2H_4 =

Order of O_3 =

b. (3 pts) Calculate the rate constant, k (with units).

k =

c. (4 pts) When the temperature of the reaction is changed to -50.0°C, the rate constant is calculated to be 6.0. What is the activation energy of the reaction?

2. (12 pts) A 2.00 mole sample of CO_2 is heated to 1500. K with excess solid graphite in a 50.0-L container. At 1500. K, $K_C = 1.33 \times 10^{-4}$ for the reaction:

$$C\ (graphite, s) + CO_2\ (g) \leftrightarrow 2\ CO\ (g) \qquad \Delta H_{reaction} = 172\ kJ/mol$$

   a. (2 pts) Write the equilibrium constant expression, K_C.

   $K_C =$

   b. (2 pts) Calculate the value of the equilibrium constant, K_P.

   $K_P =$

   c. (4 pts) Calculate the equilibrium concentration of CO_2 (g) if 0.100 moles of CO (g) are present at equilibrium.

   $[CO_2\ (g)] =$

   d. (4 pts) If the volume of the flask is changed, and a new equilibrium is established in which the quantity of CO_2 (g) is half that of CO (g) (not necessarily the quantity stated in part c), what is the new volume of the flask?

   Volume =

(6 pts) Consider the equilibrium in Question 3. Circle the component (products, reactants, neither, or more info is needed) that would be favored if the following conditions were changed.

3. The pressure is increased by adding 5 moles of carbon dioxide gas:
   Products / Reactants / Neither / More info needed
4. Volume of the container is decreased: Products / Reactants / Neither / More info needed
5. A catalyst is added Products / Reactants / Neither / More info needed