Quiz One - Kinetics 			Name <u>Key</u>

1. Consider the following reaction:

$$8A(g) + 5B(g) \rightarrow 8C(g) + 6D(g)$$

If [C] is increasing at the rate of 4.0 mol $L^{-1}s^{-1}$, at what rate is [B] changing?

a. -0.40 mol $L^{-1}s^{-1}$
(b.) -2.5 mol $L^{-1}s^{-1}$
c. -4.0 mol $L^{-1}s^{-1}$
d. -6.4 mol $L^{-1}s^{-1}$
e. None of these choices is correct, since its rate of change must be positive.

$\text{rate} = \frac{1}{8}\frac{d[C]}{dt} = -\frac{1}{5}\frac{d[B]}{dt}$

$\frac{d[B]}{dt} = -\frac{5}{8}\left(4.0\ \frac{M}{s}\right)$

2. For the reaction:

$$3A(g) + 2B(g) \rightarrow 2C(g) + 2D(g)$$

the following data was collected at constant temperature. Determine the correct rate law for this reaction.

Trial	Initial [A] (mol/L)	Initial [B] (mol/L)	Initial Rate (mol/(L·min))
1	0.200	0.100	6.00×10^{-2}
2	0.100	0.100	1.50×10^{-2}
3	0.200	0.200	1.20×10^{-1}
4	0.300	0.200	2.70×10^{-1}

a. Rate = $k[A][B]$
b. Rate = $k[A][B]^2$
c. Rate = $k[A]^3[B]^2$
d. Rate = $k[A]^{1.5}[B]$
(e.) Rate = $k[A]^2[B]$

comparing trial 1 and 2 tell you the rate is 2nd order in A

comparing trial 1 and 3 tell you the rate is first order in B

3. Tetrafluoroethylene, C_2F_4, can be converted to octafluorocyclobutane which can be used as a refrigerant or an aerosol propellant. A plot of $1/[C_2F_4]$ vs. time gives a straight line with a slope of 0.0448 L $mol^{-1}s^{-1}$. What is the rate law for this reaction?

a. Rate = 0.0448 (L $mol^{-1}s^{-1}$)$[C_2F_4]$
b. Rate = 22.3 (mol L^{-1}s)$[C_2F_4]$
(c.) Rate = 0.0448 (L $mol^{-1}s^{-1}$)$[C_2F_4]^2$
d. Rate = 22.3 (mol L^{-1}s)$[C_2F_4]^2$
e. Rate = 0.0448 s^{-1} $[C_2F_4]$

For a second order reaction the linear plot is $\frac{1}{[A]}$ vs time with slope = K

4. Cyclopropane is converted to propene in a first-order process. The rate constant is 5.4×10^{-2} hr^{-1}. If the initial concentration of cyclopropane is 0.150 *M*, what will its concentration be after 22.0 hours?

a. 0.0457 *M*
b. 0.105 *M*
c. 0.127 *M*
d. 0.492 *M*
e. None of these choices is correct.

rate = k [cyclopropane]

$\ln\left(\frac{[A]_0}{[A]}\right) = kt \qquad \ln\left(\frac{0.150}{?}\right) = (.054)(22)$

5. Butadiene, C_4H_6 (used to make synthetic rubber and latex paints) dimerizes to C_8H_{12} with a rate law of rate = 0.014 L/(mol·s) $[C_4H_6]^2$. What will be the concentration of C_4H_6 after 3.0 hours if the initial concentration is 0.025 *M*?

a. 0.0052 *M*
b. 0.024 *M*
c. 43 *M*
d. 190 *M*
e. 0.0000 *M*

$\frac{1}{[A]} - \frac{1}{[A]_0} = kt$

6. Dinitrogen tetraoxide, N_2O_4, decomposes to nitrogen dioxide, NO_2, in a first-order process. If $k = 2.5 \times 10^3$ s^{-1} at -5°C and $k = 3.5 \times 10^4$ s^{-1} at 25°C, what is the activation energy for the decomposition?

a. 0.73 kJ/mol
b. 58 kJ/mol
c. 140 kJ/mol
d. 580 kJ/mol
e. Greater than 1000 kJ/mol

$\ln \frac{3.5 \times 10^4}{2.5 \times 10^3} = \frac{E_a}{R}\left(\frac{1}{268} - \frac{1}{298}\right)$ (8.314)

7. Consider the following mechanism for the oxidation of bromide ions by hydrogen peroxide in aqueous acid solution.

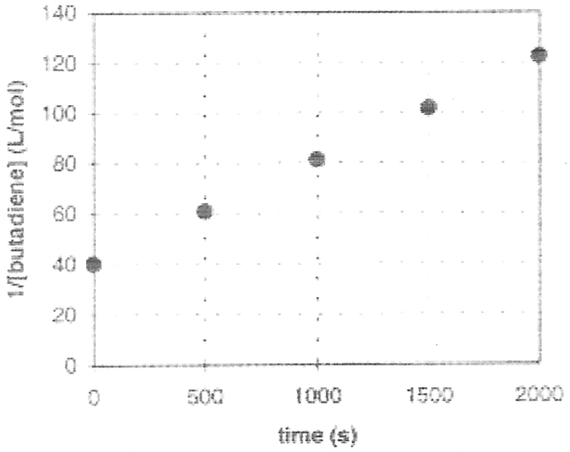
$H^+ + H_2O_2 \rightleftharpoons H_2O^+\text{-}OH$ (rapid equilibrium)
$H_2O^+\text{-}OH + Br^- \rightarrow HOBr + H_2O$ (slow)
$HOBr + H^+ + Br^- \rightarrow Br_2 + H_2O$ (fast)

Which of the following rate laws is consistent with the mechanism?

a. Rate = $k[H_2O_2][H^+]^2[Br^-]$
b. Rate = $k[H_2O^+\text{-}OH][Br^-]$
c. Rate = $k[H_2O_2][H^+][Br^-]$
d. Rate = $k[HOBr][H^+][Br^-][H_2O_2]$
e. Rate = $k[Br^-]$

8. The gas-phase conversion of 1,3-butadiene to 1,5-cyclooctadiene, $2C_4H_6 \rightarrow C_8H_{12}$ was studied, providing data for the plot shown below, of 1/[1,3-butadiene] versus time.

a. Explain how this plot confirms that the reaction is second order.
b. Calculate the second-order rate constant, k.
c. Determine the initial concentration of 1,3-butadiene in this experiment.



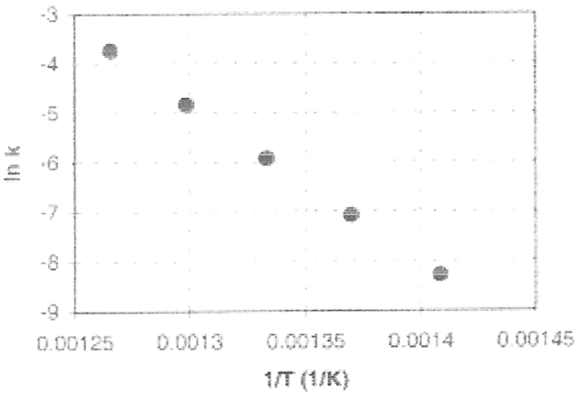
a. The fact that a plot of 1/[butadiene] vs. t gives a straight line proves that it is second order.
b. k = slope = 8.2×10^{-2} L mol^{-1}s^{-1}
c. 0.025 mol/L

9. At 25.0°C, a rate constant has the value 5.21×10^{-8} L mol^{-1} s^{-1}. If the activation energy is 75.2 kJ/mol, calculate the rate constant when the temperature is 50.0°C.

5.44×10^{-7} s^{-1}

10. Cyclobutane decomposes to ethene in a first-order reaction. From measurements of the rate constant (k) at various absolute temperatures (T), the accompanying Arrhenius plot was obtained (ln k versus $1/T$).

a. Calculate the energy of activation, E_a.
b. Determine the value of the rate constant at 740. K. (In the plot, the units of k are s^{-1}.)



a. 260 ± 20 kJ/mol
b. 1.6×10^{-3} s^{-1}