Chemistry 1410 Spring 2005
Quiz 2, Section 1, 15 pts

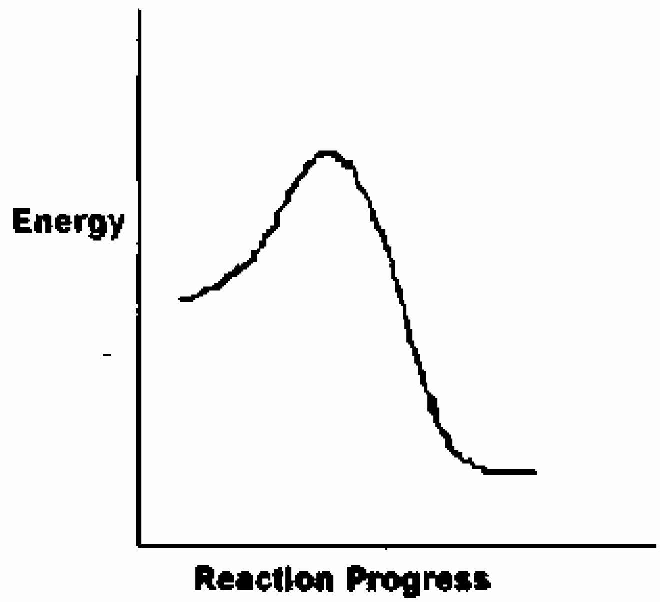
Name ____________________________(please print)

Rate $= k[A]^x[B]^y$; $\ln [A]_t/[A]_o = -kt$; $\ln[A]_t = -kt + \ln[A]_o$; $t_{1/2} = 0.693/k$;

$1/[A]_t = kt + 1/[A]_o$; $k = A\exp(-E_a/RT)$ $\ln k = (-E_a/R)(1/T) + \ln A$;

$\ln\frac{k1}{k2} = \frac{Ea}{R}\left(\frac{T1-T2}{T1T2}\right)$ $R = 8.31$ J/mol.K; $R = 0.082$ L.atm/mole.K

1. (2) For the chemical reaction system described by the diagram below, which statement is true?



A. The forward reaction is endothermic.
B. The activation energy for the forward reaction is greater than the activation energy for the reverse reaction.
C. At equilibrium, the activation energy for the forward reaction is equal to the activation energy for the reverse reaction.
D. The activation energy for the reverse reaction is greater than the activation energy for the forward reaction.
E. The reverse reaction is exothermic.

2. (2) When the concentrations of reactant molecules are increased, the rate of reaction increases. The best explanation for this phenomenon is that as the reactant concentration increases,

A. the average kinetic energy of molecules increases.
B. the frequency of molecular collisions increases.
C. the rate constant increases.
D. the activation energy increases.
E. the order of reaction increases.

3. The first-order rate constant for the decomposition of N_2O_5:

$$N_2O_5(g) \rightarrow 2NO_2(g) + 1/2O_2(g)$$

At 70°C is $6.82 \times 10^{-3}\ s^{-1}$. Suppose we start with 0.0300 moles of $N_2O_5(g)$ in a volume of 2.5 liters.

a) (2) Find the half-life for this process.

$t_{1/2} = 0.693/k = \frac{0.693}{6.82 \times 10^{-3} s^{-1}} = 101.6$ seconds

b) (5) How many moles of N_2O_5 will remain after 2.5 minutes?

$[N_2O_5]_0 = 0.0300$ moles$/2.5\ L = 0.012M$

$\ln [A]_t = -kt + \ln [A]_0$

$\ln [A]_t = (-6.82 \times 10^{-3}\ s^{-1})(150\ s) + \ln (0.012)$

$\ln [A]_t = -1.023 + (-4.42)$

$\ln [A]_t = -5.44$

$[A]_t = 0.0043$ moles$/L \times 2.5\ L = 0.011$ moles

4. (4) Find the activation energy for the following reaction given the data below. (If you wish to find the slope (Δy/Δx), there is no need to plot it, just use the data below to define the straight line. There are two ways to do this problem, one requires the slope, the other does not.)

$$2NOCl \rightarrow 2NO + Cl_2$$

Temperature (K)	k (L/mol·s)	$\frac{1}{T}$	$\ln k$
400	6.6×10^{-4}	$2.5 \times 10^{-3} K^{-1}$	-7.32
500	2.9×10^{-1}	$2.0 \times 10^{-3} K^{-1}$	-1.24

slope $= \Delta y/\Delta x = \frac{-7.32 - (-1.24)}{2.5 \times 10^{-3} - 2.0 \times 10^{-3}} = \frac{-6.08}{5 \times 10^{-4}} = -12160 K$

slope $= -Ea/R$, $Ea = -mR$, $Ea = -(-12160K)(8.315\ J/mole \cdot K)$

$Ea = 101050\ J/mole = 101.05\ kJ/mole$

or plug into following equation and solve for Ea

$$\ln \frac{k_1}{k_2} = \frac{Ea}{R}\left(\frac{T_1 - T_2}{T_1 T_2}\right)$$