Name:_____

Test #1: Reaction Rates and Equilibrium

1. List four factors that influence the rates of reaction and describe the effect of each, i.e., whether it will increase or decrease the reaction rate.

factor	effect
a)	
b)	
c)	
d)	

2. Consider the elementary reaction: A + B ------> C . Use the following data to determine the variables p, q, and k in the following rate equation: $R=k \bullet [A]^p \bullet [B]^q$. (Note: You may assume that the data contains no experimental errors , that is, your lab partner had nothing to do with this experiment, and that a graphical treatment is not necessary.)

[A]	[B]	Rate
2	2	17.6
3	1	4.4
3	2	26.4

3. A reaction characterized by the rate law, Rate = $k \bullet [A]^2 \bullet [B]$ is said to be _____ order in A, _____ order in B, and _____ order overall.

4. The decomposition reaction of substance A, A --------> B + C , is known to be first order with respect to the reactant. The data below was collected on the investigation of this reaction:

Time (min)	[A] (M)
0	1.0
10	0.1

a) Calculate the rate constant, k, and attach the proper units.

b) Calculate the halflife and attach the proper units.

5. Write the mathematical expression of the Law of Chemical Equilibrium for the following reversible reactions. [Note: **(l)** means liquid, **(g)** means gaseous, **(s)** means solid, and **(aq)** means aqueous state.]

a) $C_3H_7OH(l) + CH_3COOH(l) \leftrightharpoons CH_3COOC_3H_7(l) + H_2O(l)$

$K_{eq} =$ _____

b) $2H_2(g) + O_2(g) \leftrightharpoons 2H_2O(g)$

$K_{eq} =$ _____

c) $NH_4Cl(s) \leftrightharpoons NH_3(g) + HCl(g)$

$K_{eq} =$ _____

6. At 25 °C, K_{eq}=0.0146 for the following reaction:
PCl_5 <======> PCl_3 + Cl_2

If, at equilibrium, the molar concentrations for PCl_5 and PCl_3 are 0.500 M and 0.200 M respectfully, calculate the concentration of chlorine gas.

7. Consider the reaction: CO + $2H_2$ <======> CH_3OH. All substances are in the gaseous state and the change in enthalpy is -92 kJoules, that is, $\Delta H = -92$ kJ. Predict whether the reactants (left side) or the products (right side) will be favored by the following changes (consider each change independently):

a) increased pressure _____

b) increased temperature _____

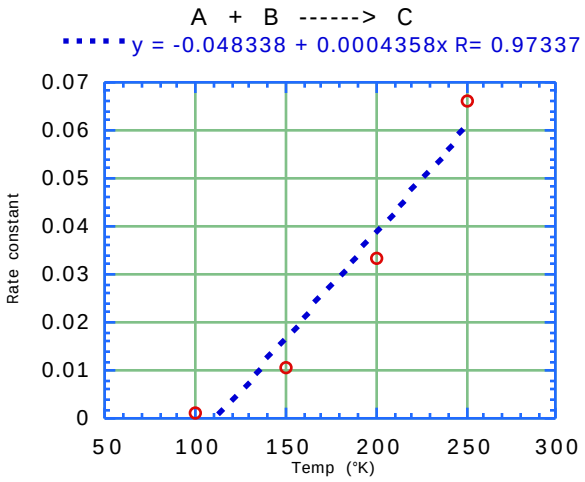
c) addition of hydrogen _____

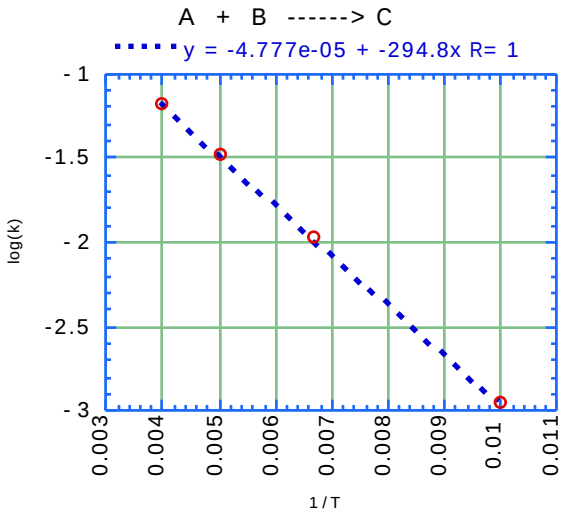
d) removal of the product, CH_3OH _____

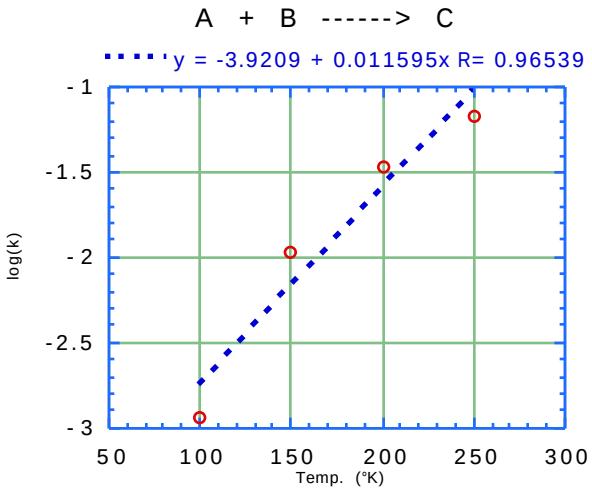
8. An experiment was carried out to determine the activation energy of the following reaction: A + B -------> C. The following data was collected:

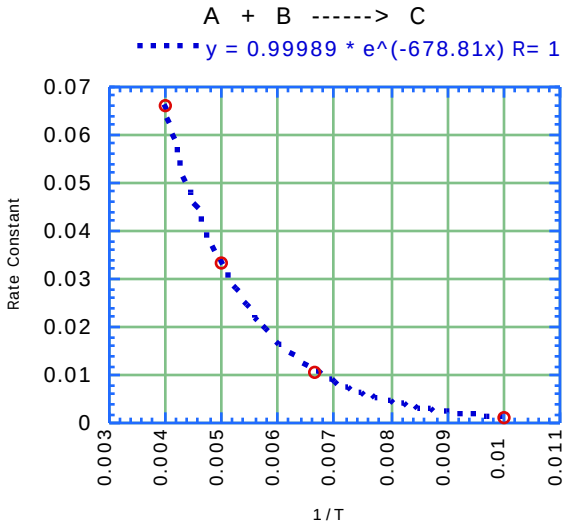
Trial	Rate constant (k)	Temp (°K)
1	0.001127	100.0
2	0.010830	150.0
3	0.033570	200.0
4	0.066180	250.0

Four graphs were constructed: log(k) vs. 1/T, log(k) vs. T, k vs. 1/T, and k vs. T. (These graphs can be found on the following page.) A regression equation was determined and is printed under the title of each graph. Determine the activation of energy for the reaction. **Clearly indicate which graph you worked with and the calculations used to determine the activation energy.**


A + B ------> C
y = -0.048338 + 0.0004358x R= 0.97337
Rate constant
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
50
100
150
200
250
300
Temp (°K)


A + B ------> C
y = -4.777e-05 + -294.8x R= 1
log(k)
- 1
-1.5
- 2
-2.5
- 3
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
1 / T


A + B ------> C
y = -3.9209 + 0.011595x R= 0.96539
log(k)
- 1
-1.5
- 2
-2.5
- 3
50
100
150
200
250
300
Temp. (°K)


A + B ------> C
y = 0.99989 * e^(-678.81x) R= 1
Rate Constant
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
1 / T

One Step Beyond (2 pts extra credit)

A mixture of ethyl propionate (an ester) and water is prepared in which the initial ester concentration is 6.0 M and the initial water concentration is 10.0 M. (You may assume that the initial concentration of each product is zero.) After equilibrium is established, the concentration of propionic acid is 3.0 M. The reaction is:

$C_3H_7COOC_2H_5 + H_2O \text{ <=======> } C_3H_7COOH + C_2H_5OH$

Calculate K (the equilibrium constant) for the reaction. (Note: water is **not** behaving as a solvent in this reaction.)

Twilight Zone (maybe 5 points extra credit)

Consider the reaction: $2A \text{ <======> } B + C$. Suppose the equilibrium constant for the reaction at 25 °C is 4.0×10^{-6}. If you allow 500 ml of a 2.00 M solution of A to come into equilibrium, how many moles of A, B, and C are present at equilibrium?