Name: _____ 8 Digit ID Number: _____

Some Useful and Useless Information:

R: 8.314 $J.mol^{-1}.K^{-1}$, 0.08205 $L.atm.mol^{-1}.K^{-1}$	$N = 6.023 \times 10^{23}$
$(1/[R]_t) - (1/[R]_o) = -kt$	$pX = -\log_{10}[X]$
$K_w = 1 \times 10^{-14}$ @ 25°C	$t_{1/2}$: $1/k[R]_o$ $\ln 2/k$ $[R]_o/2k$
$k = Ae^{-E_a/RT}$	$\ln[R]_t - \ln[R]_o = -kt$
$\ln(k_2/k_1) = (-E_a/R)\,[(1/T_2) - (1/T_1)]$	$[R]_o - [R]_t = kt$

Question 1
6 Points

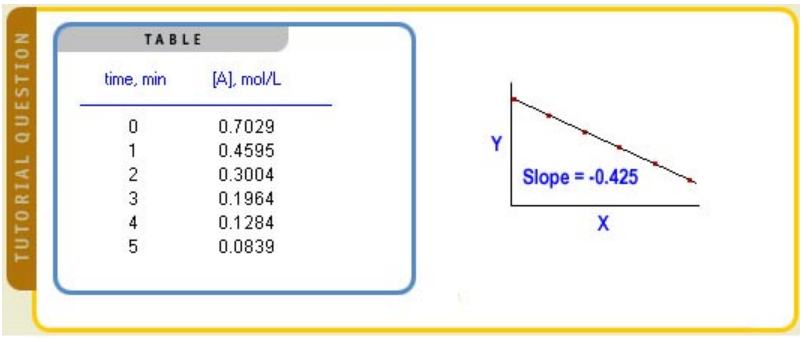
The decomposition of dinitrogen pentoxide in carbon tetrachloride solution at 30 °C

$2\ N_2O_5 = 4\ NO_2 + O_2$

is first order in N_2O_5 with a rate constant of $4.10 \times 10^{-3}\ min^{-1}$.

If the initial concentration of N_2O_5 is 0.693 M, how long (in minutes) will it take for the concentration of N_2O_5 to reach 0.148 M. *[For Full Credit You Must Show Work]*

Question 2
10 Points



Concentration time data for the reaction of A = Products is depicted above. The order of the reaction is either Zero, 1st or 2nd. What labels should appear on the X and Y axis if the reaction is:

Zero Order X: _____ Y: _____

First Order X: _____ Y: _____

Second Order X: _____ Y: _____

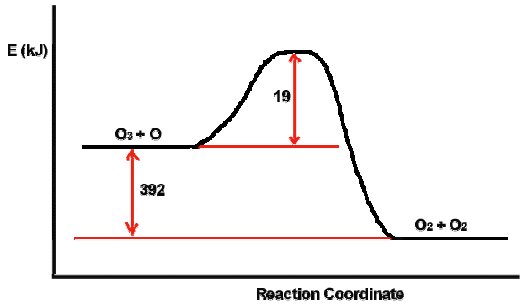
If the reaction was found to be first order with the slope depicted what is the value for the rate constant k?

k = _____

What would the half life for this reaction be? $t_{\frac{1}{2}}$ = _____

Question 3
8 Points

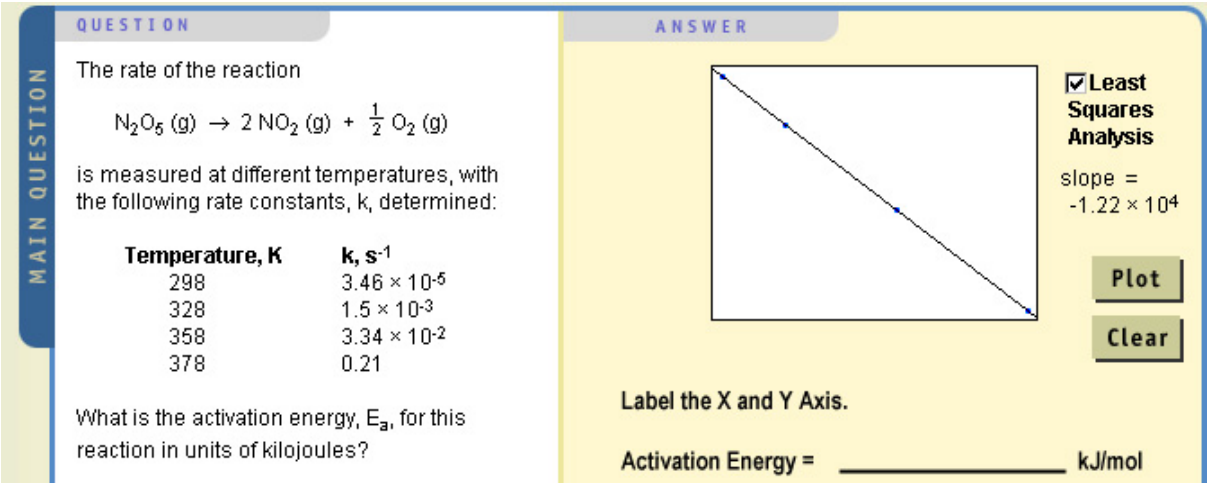
A reaction profile (not to scale!) for the reaction $O_3 + O = 2\ O_2$ is shown below:



Circle those of the following that are false?

1. The magnitude of Ea for the reverse reaction is less than 392.0 kJ.
2. The energy of the products is lower than the energy of the reactants.
3. ΔE is positive.
4. The value of Ea in the presence of a catalyst would be larger than 19.0 kJ.
5. The value of ΔE in the presence of a catalyst would be smaller than -392kJ

Question 4
6 Points



Question 5
8 Points

The thermal decomposition of nitryl chloride is proposed to occur by the following mechanism:

slow: $NO_2Cl = NO_2 + Cl$
fast: $Cl + NO_2Cl = NO_2 + Cl_2$

What is the equation for the overall reaction? _____

Which species if any acts as a catalyst? _____

Which species if any acts as a reaction intermediate? _____

Write the rate law for the overall reaction that is consistent with this mechanism.

Rate = _____

Question 6
6 Points

Write the equilibrium constant expression, K, for the following reaction:

1. $NH_4I(s) \Leftrightarrow NH_3(g) + HI(g)$ _____
2. $2NO_2(g) \Leftrightarrow N_2O_4(g)$ _____
3. $HNO_2(aq) + H_2O(l) \Leftrightarrow H_3O^+(aq) + NO_2^-(aq)$ _____

Question 7 (4 Points) The equilibrium constant, K, for the following reaction is 8.37 at 736 K:

$2\ NH_3(g) \Leftrightarrow N_2(g) + 3\ H_2(g)$

Calculate K at this temperature for: $1/2\ N_2(g) + 3/2\ H_2(g) \Leftrightarrow NH_3(g)$

Question 8 (7 Points) The equilibrium constant, K, for the following reaction is 77.5 at 600 K:

$CO(g) + Cl_2(g) \Leftrightarrow COCl_2(g)$

Calculate the equilibrium concentrations of reactant and products when 0.470 moles of CO and 0.470 moles of Cl_2 are introduced into a 1.00 L vessel at 600 K.

Help! The two solutions to the quadratic equation associated with this problem are: x = 0.555 and 0.398

$[CO]$ _____ $[Cl_2]$ _____ $[COCl_2]$ _____

Question 9 (10 Points) Consider the following reaction where K = 10.5 at 350 K:

$2\ CH_2Cl_2(g) \Leftrightarrow CH_4(g) + CCl_4(g)$

A reaction mixture was found to contain 1.10×10^{-2} moles of $CH_2Cl_2(g)$, 2.30×10^{-2} moles of $CH_4(g)$, and 4.09×10^{-2} moles of $CCl_4(g)$, in a 1.00 Liter container.

Indictate True or False:

1. In order to reach equilibrium $CH_2Cl_2(g)$ must be consumed. _____
2. In order to reach equilibrium K must decrease. _____
3. In order to reach equilibrium CH_4 must be consumed. _____
4. Q is greater than K. _____
5. The reaction is at equilibrium. No further reaction will occur. _____

Question 10
12 points

Consider the following system at equilibrium where $K = 1.80 \times 10^{-2}$ and $\Delta H^\circ = 10.4$ at 698K:
$2\ HI(g) \Leftrightarrow H_2(g) + I_2(g)$

Indictate True or False:

1. The reaction is product favored. _____

The production of $H_2(g)$ is favored by:

2. Decreasing the temperature. _____

3. Increasing the pressure (by changing the volume). _____

4. Increasing the volume. _____

5. Removing HI. _____

6. Adding I_2. _____

Question 11
5 points

The hypothetic reaction, $A \Leftrightarrow B$, after reaching equilibrium at 25°C is heated to 100°C. When equilibrium is reestablished it is found that the concentration of B has decreased. Is this enthalpy change associated with this reaction >0 or <0. Briefly justify your choice.

Question 12
5 Points

The formula for:

the conjugate base of HF is. _____

the conjugate acid of NO_2^- is. _____

the conjugate base of $H_2PO_4^-$ is. _____

the conjugate acid of HCO_3^- is. _____

the conjugate base of NH_4^+ is. _____

Question 13
8 Points

The hydronium concentration in an aqueous solution @ 25°C is 4.9×10^{-2} M.

The hydroxide ion concentration is: _____

The pH of this solution is: _____

The pOH is: _____

The solution is (acidic/basic) _____

Question 14 5 Points

If instead of $1x10^{-14}$ @ 25°C, the K_w for water was determined to be $1x10^{-16}$ @ 25°C.

1. What would the pH of distilled water be @ 25°C? _____

2. Would water still be considered neutral? _____
   Briefly Justify your choice?