Chemistry 114
Third Hour Exam

Name:_____

(4 points)

1. (12 points) When you make taffy, you have a water-sugar solution that you boil for a long time to remove water and concentrate the sugar. If the water sugar mixture has a boiling point of 120^0C, and boiling point elevation constant (K_b) of water is 0.51 ^{o}C·kg/mole, what is the molality of the sugar in the solution.

$$\Delta T = K_b i m$$
$$\Delta T = 120 - 100 = 20$$
$$20 = 0.51(1)m$$
$$m = 20 / (.51 \times 1)$$
$$m = 39\ mole / kg$$

2. (12 points) I have a chemical reaction: A + B →C. From the following initial rates, determine the rate law and the rate constant for this reaction

[A] (mol/L)	[B] (mol/L)	Initial rate (mol/L·min)
.03	.03	.0101
.03	.05	.0195
.07	.05	.0456

Rate = k $[A]^x[B]^y$

Using Eqn2 / Eqn 1 for y

$$\frac{.0195}{.0101} = \frac{k[.03]^x[.05]^y}{k[.03]^x[.03]^y}$$
$$1.93 = \left(\frac{.05}{.03}\right)^y$$
$$1.93 = 1.67^y$$
$$\log(1.93) = y\log(1.67)$$
$$.286 = y(.223)$$
$$y = .286/.223 = 1.28$$

Using Eqn 3/Eqn 2 for x

$$\frac{.0456}{.0195} = \frac{k[.07]^x[.05]^y}{k[.03]^x[.05]^y}$$
$$2.33 = \left(\frac{.07}{.03}\right)^x$$
$$2.33 = 2.33^x$$
$$x = 1$$

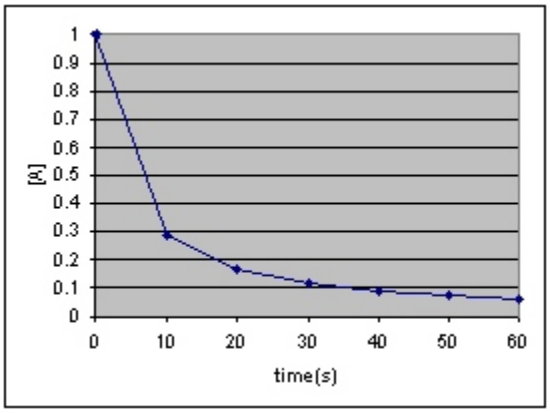
$.0101=k(.03)^1(.03)^{1.28}$

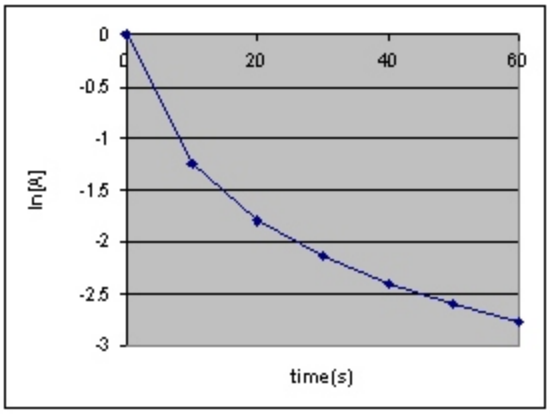
$.0101/[(.03)(.03)^{1.28}]=k$

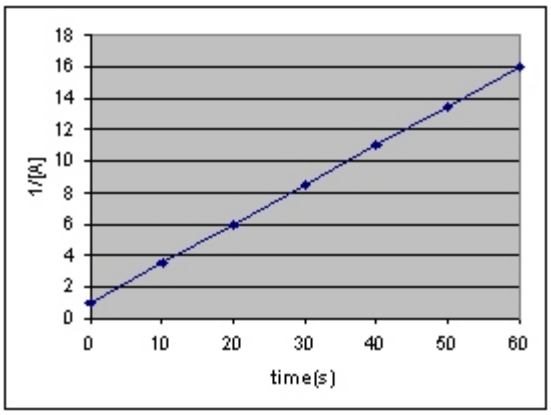
$k=30$

Complete rate equation: rate = 30 $[A]^1[B]^{1.28}$

]3. (12 points)The experimental data for the reaction A → B +2C have been plotted in the following three ways. What is the order of the reaction with respect to A, and what is the rate constant of this reaction?







The bottom plot is the only linear plot, and when a plot of 1/[] vs time is linear, this means that the equation must be second order. The rate fo the second order reaction = slope of the line

k = (16-1)/(60-0) = 0.25 Units for Y are 1/[] = l/mole, units of X is seconds
so overall units here are l/mole·seconds

4. (12 points) I have a reaction that is second order with respect to [A]. What is the rate constant for this reaction if the reaction is 75% complete in 5 minutes when the initial concentration of A is .065M?

If a reaction is 75% complete, then 75% of the reactant has been used up and only 25% remains

So $[A]_{5\ min}$ = .065x.25 = .01625

The integrated equation for a second order reaction is:
$1/[A]_T = kt + 1/[A]_0$
$1/.01625 = -k(5\ min) + 1/.065$
$61.54 = k(5) + 15.38$
$(61.54-15.38)/5 = k$
$k = 9.23$ l/mol·min

5. (12 points) Define the following terms:

steric factor

In the Arrhenius equation, it is th factor that takes into account the orientations of the molecules as they collide in a chemical reaction.

Arrhenius equation

An equation used in kinetics that relates the rate of a chemical reaction to the number of collisions, the orientation of the molecules as they collide, and the energy of the of the collision. $k=zpe^{-Ea/RT}$

catalyst

A material that is added to a chemical reaction tha increases the rate of the reaction, but is not consumed in the reaction.

transition state

A transition state is a high energy state in a reaction coordinate that represents a complex in a reaction that is neither reactant nor product, but is some high energy intermediate between the two state.

van't Hoff factor

A factor used in equation dealing with colligative properties that accounts for the number of particles or ions that are made when an ionic compounds separates into its component ions in solution.

homogeneous equilibria

An equilibrium that involves chemical species that are all in the same phase.

6. (12 points) Given that the equilibrium constant for the reaction $Al(OH)_3(s) \rightleftharpoons Al^{3+}(aq) + 3OH^-(aq)$ is $2x10^{-32}$, calculate K for the following two reactions:

$3Al(OH)_3(s) \rightleftharpoons 3Al^{3+}(aq) + 9[OH^-](aq)$

$3Al(OH)_3(s) \rightleftharpoons 3Al^{3+}(aq) + 9[OH^-](aq) = 3x[Al(OH)_3(s) \rightleftharpoons Al^{3+}(aq) + 3OH^-(aq)]$

there for $K_{new} = K_{old}^3$

$K=(2x10^{-32})^3$

$=8x10^{-96}$

$Al^{3+}(aq) + 3[OH^-](aq) \rightleftharpoons Al(OH)_3(s)$

This is the reverse of the original equation therefore

$K_{new} = 1/K_{old}$

$K = 1/(2x10^{-32}) = 5x10^{31}$

7. (12 points) Write an equilibrium expressions for the following reactions:

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

$$K = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$Al(OH)_3(s) \rightleftharpoons Al^{3+}(aq) + 3OH^-(aq)$

$K= [Al^{+3}][OH^-]^3$

$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

$K=[CO_2]$

$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$

$$K = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]}$$

8. (12 points) The reaction $S_8(g) \rightleftharpoons 4S_2(g)$ has K_p of $3.2x10^2$. What is the K_c for this reaction at 298K?

$K_p=K_c(RT)^{\Delta n}$

$\Delta n = 4-1 =3$
$R=.08206$
$T =298$

$3.2x10^2 = K_c[.08206(298)]^3$
$K_c = 3.2x10^2/K_c[.08206(298)]^3$
$=2.19x10^{-2}$