Chem 210 – Exam 2b
Spring 2008

Name: _____

Chemistry 210 Exam 2

Be sure to put your name on each page. This page can be removed from your exam so that you will have a Periodic Table handy throughout the exam, it does not need to be turned in. Show all your work for problems which require any sort of calculation, no credit will be given for answers without work shown. If you have shown a significant amount of work or multiple drawings for a problem, draw a box around what you consider your final answer.

Avogadro's Number = 6.022×10^{23} $^{\text{units}}/_{\text{mol}}$
$32.00^{\circ}\text{F} = 0.000^{\circ}\text{C} = 273.15\text{K}$
Density of Water = $1.000\ ^{\text{g}}/_{\text{mL}}$
$R = 0.08206\ ^{\text{L•atm}}/_{\text{mol•K}} = 8.314\ ^{\text{J}}/_{\text{mol•K}}$
$PV=nRT$
$\Delta T_{fp/bp} = k_{fp/bp} \bullet m \bullet i$
For water, $k_{fp} = -1.86\ ^{\circ\text{C}}/_{\text{m}}$; $k_{bp} = 0.52\ ^{\circ\text{C}}/_{\text{m}}$
$P_1 = X_1 P_1^{\circ}$
$P = cRTi$
$C_1V_1 = C_2V_2$
Quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Integrated Rate Laws:

0^{th} order	$[A]_t = -kt + [A]_o$
1^{st} order	$\ln[A]_t = -kt + \ln[A]_o$
2^{nd} order	$1/[A]_t = kt + 1/[A]_o$

$$k = Ae^{-Ea/RT}$$

$$\ln(k) = \left(\frac{-E_a}{R}\right)\left(\frac{1}{T}\right) + \ln(A)$$

$$\ln\left(\frac{k_1}{k_2}\right) = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

1 **H** 1.0079																	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305											13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.88	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.847	27 **Co** 58.933	28 **Ni** 58.69	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.03	89 **Ac** 227.03	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 (269)	111 (272)	112 (277)		114		116		

58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.94	70 **Yb** 173.04	71 **Lu** 174.97
90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (258)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

Score

Multiple Choice: Circle the letter of the most correct response. (6pts. per question)

1. If the rate of a reaction increases by a factor if 4 when the initial concentration of reactant "A" is increased by a factor of 4, the reaction must be:
   a. 1st order with respect to[A]o
   b. 2nd order with respect to [A]o
   c. The order of the reaction depends on the balanced chemical equation
   d. 2nd order overall
   e. 4th order with respect to [A]o

2. For a first order reaction:
   a. The slope of the integrated rate law plot is equal to k
   b. The intercept of the integrated rate law is equal to the *ln* of the initial concentration
   c. The slope of the integrated rate law plot is equal to $(-E_a/R)$
   d. The intercept of the integrated rate law plot is equal to the initial concentration
   e. The slope of the integrated rate law is equal to the frequency factor, A.

3. Which of the following does ***not*** affect the rate of a reaction?
   a. The frequency of collisions between reacting particles
   b. The orientation of colliding particles
   c. The energy of collisions between reacting particles
   d. The coefficients of the reactants in the balanced equation
   e. The temperature of the system

4. For the generic equation:

   $$aA + bB \rightarrow cC + dD$$

   Which of the following is a correct expression of the rate of the reaction:
   a. $^{-1}/_{a}\ ^{\Delta[A]}/_{\Delta t}$
   b. $^{-1}/_{b}\ ^{\Delta[B]}/_{\Delta t}$
   c. $k[A]^a[B]^b$
   d. $^{1}/_{d}\ ^{\Delta[D]}/_{\Delta t}$
   e. $k[C]^c[D]^d$

5. Which of the following is ***true*** regarding catalysts and catalyzed reactions?
   a. The presence of a catalyst does not change the mechanism of a reaction
   b. The concentration of a catalyst cannot appear in the rate law for a reaction
   c. The presence of a catalyst changes the equilibrium constant for a reaction
   d. The presence of a catalyst changes the energy of the products and reactants in a reaction
   e. The presence of a catalyst changes the activation energy for a reaction

6. Which of the following is ***false*** regarding equilibrium?
   a. Equilibrium can be shifted by changing pressure or temperature
   b. The forward and reverse reactions stop when a system reaches equilibrium
   c. The concentrations of products and reactants does not change once the reaction has reached equilibrium
   d. The rates of the forward and reverse reactions are equal
   e. Equilibrium concentrations do not depend upon whether you approach equilibrium from the left or the right

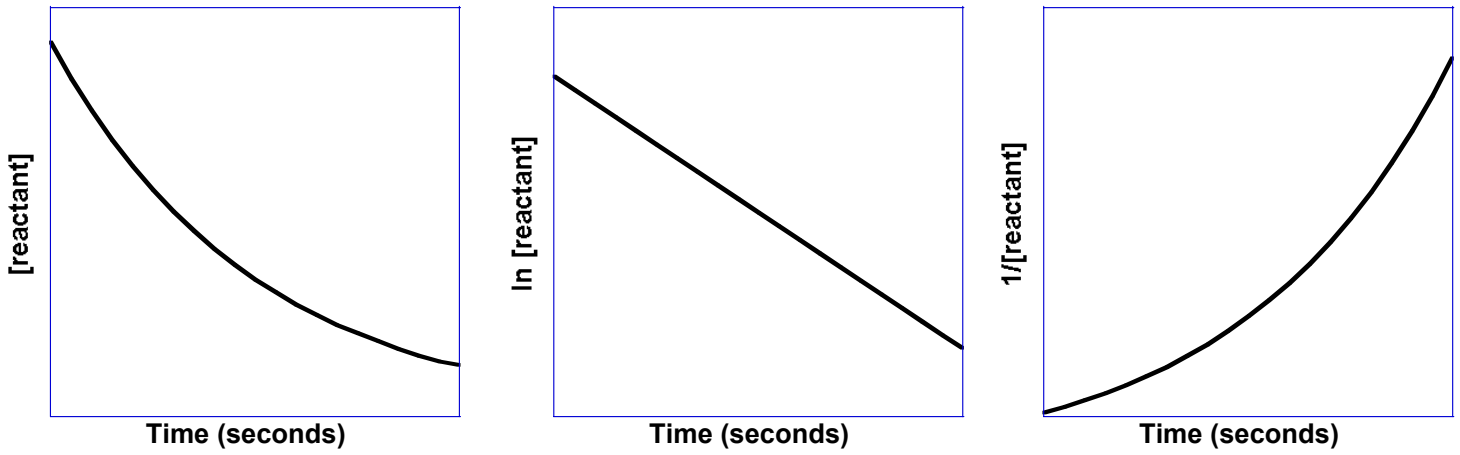
Score

7. Which of the following is ***false*** regarding reaction mechanisms?
   a. Catalysts can appear in the steps of a mechanism
   b. A mechanism must be composed of elementary reactions
   c. The steps of the mechanism can contain chemical species that do not appear in the overall correctly balanced chemical equation
   d. The observed rate law is equal to the sum of the rate laws from all steps
   e. The observed rate law must agree with the rate law of the slowest step

8. For the generic equation

$$aA(g) + bB(g) \leftrightarrows cC(g) + dD(g)$$

   The value of the equilibrium constant, K_c:
   a. Must be measured, it cannot be derived from the balanced equation
   b. Is equal to $([C]^c[D]^d)/([A]^a[B]^b)$
   c. Is equal to $k[A]^a[B]^b$
   d. Is equal to $([A]^a[B]^b)/([C]^c[D]^d)$
   e. Is not affected by temperature



9. The reaction represented by the plots above:
   a. Is zero order
   b. Is first order
   c. Is second order
   d. Is third order
   e. The order can't be determined by these graphs

10. Which of the following statements is ***false*** regarding the reaction quotient, Q?
    a. It tells the direction that the reaction must shift to reach equilibrium
    b. If $Q<K_c$, the system needs to shift toward the reactants to reach equilibrium
    c. If $Q=K_c$, the system is at equilibrium
    d. If $Q>K_c$, the system needs to shift toward the reactants to reach equilibrium
    e. It has the same mathematical form as the equilibrium constant

Score

Multiple Choice Calculations: (12pts each)

11. A reaction is found to be second order with respect to fluoride ion, a reactant. If $[F^-]_o$ = 2.91M and k = 7.47×10^{-3} $M^{-1}sec^{-1}$, what will the concentration be after 17 minutes have passed?
    a. 7.96 M
    b. 2.12 M
    c. 0.471 M
    d. 0.137 M
    e. 0.126 M

12. For the reaction:

$$CH_4(g) + H_2O(g) \leftrightarrows CO(g) + 3\,H_2(g) \qquad \Delta H = 206.2\ {}^{kJ}/_{mol}$$

The equilibrium concentrations have been found to be $[CO]_{eq}$ = 1.39M, $[H_2]_{eq}$ = 3.27M, $[CH_4]_{eq} = 4.54 \times 10^{-3}$ M, $[H_2O]_{eq} = 8.19 \times 10^{-4}$ M. What is the equilibrium constant?
    a. 7.65×10^{-8}
    b. 6.78×10^{3}
    c. 1.22×10^{6}
    d. 3.67×10^{6}
    e. 1.31×10^{7}

13. You have found the following value in a table of equilibrium constants at 25ºC:

$$Zn^{2+}(aq) + 4\,NH_3(aq) \leftrightarrows [Zn(NH_3)_4]^{2+}(aq) \qquad K_c = 3.6 \times 10^{-10}$$

What is the equilibrium constant for the reaction:

$$3\,[Zn(NH_3)_4]^{2+}(aq) \leftrightarrows 3\,Zn^{2+}(aq) + 12\,NH_3(aq)$$

    a. 2.1×10^{28}
    b. 2.8×10^{9}
    c. 9.3×10^{8}
    d. 1.1×10^{-9}
    e. 4.7×10^{-29}

14. A reaction is found to be first order with respect to reactant A and second order with respect to reactant B. If $[A]_o$ = 0.191M, $[B]_o$ = 0.228M and k = 7.38×10^{-2} $M^{-2}sec^{-1}$, what is the initial rate of the reaction?
    a. 6.14×10^{-4} ${}^{M}/_{sec}$
    b. 7.33×10^{-4} ${}^{M}/_{sec}$
    c. 3.21×10^{-3} ${}^{M}/_{sec}$
    d. 1.69 ${}^{M}/_{sec}$
    e. 7.43 ${}^{M}/_{sec}$

Score

Problems: (21pts each)

15. For the reaction:

$$Sn^{2+}(aq) + 3\ OH^-(aq) \rightarrow [Sn(OH)_3]^-(aq)$$

You have collected the following data at 12.64ºC:

Experiment	$[Sn^{2+}]_o$	$[OH^-]_o$	$Rate_{observed}$
1	0.481 M	1.143 M	$2.18 \times 10^{-2}\ ^{M}/_{sec}$
2	0.962 M	1.143 M	$8.72 \times 10^{-2}\ ^{M}/_{sec}$
3	0.481 M	3.429 M	$6.54 \times 10^{-2}\ ^{M}/_{sec}$

What are the rate law and the value of the rate law constant, k, for this reaction?
If you redo Experiment 2 at 31.56ºC, the rate is $0.323\ ^{M}/_{sec}$. What is the activation energy for this reaction?

16. When 1.624g of nitrogen dioxide {$NO_2(g)$} and 1.006g of fluorine gas {$F_2(g)$} are sealed together in a 1.500L vessel, they reach equilibrium with nitrogen trifluoride {$NF_3(g)$} and oxygen {$O_2(g)$}. If the equilibrium concentration of $F_2(g)$ is found to be 1.686×10^{-7} M:
    a. What are the equilibrium concentrations of all products and reactants?
    b. What is the value of K_c?
    c. Is the reaction Product-favored or reactant-favored?

Score