DO NOT OPEN

UNTIL INSTRUCTED TO DO SO

CHEM 111 – Dr. McCorkle – Exam #1

While you wait, please complete the following information:

Name: _____

Student ID: _____

Turn off cellphones and stow them away. No headphones, mp3 players, hats, sunglasses, food, drinks, restroom breaks, graphing calculators, programmable calculators, or sharing calculators.

Periodic Table of the Elements

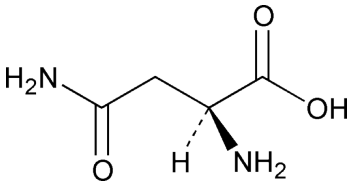
PERIOD	GROUP 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 H 1.01																	2 He 4.00
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	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 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
6	55 Cs 132.91	56 Ba 137.33	57 La * 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	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)
7	87 Fr (223)	88 Ra (226)	89 Ac ** (227)	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Uut (284)	114 Fl (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

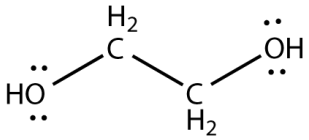
Lanthanide Series *	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
Actinide Series **	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

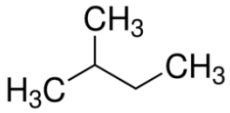
Multiple Choice – Choose the answer that best completes the question. Use an 815-E Scantron to record your response. [2 points each]

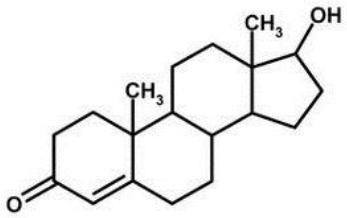
For the molecules 1-4, would you expect greater solubility in:

A) water B) benzene (C_6H_6)?

1. 

2. 

3. 

4. 

5. Which substance would you expect to be the most soluble in water?

A) $CH_3CH_2CH_3$ B) $CH_3CH(OH)CH_3$ C) $HOCH_2CH_2OH$

D) $HOCH_2CH_2CH_2OH$ E) $CH_3CH_2CH_2COOH$

6. Which aqueous solution would you expect to produce the lowest freezing point? Assume all are ideal, non-volatile, 1.0 L solutions.

A) 0.750 *m* KCl B) 1.200 *m* $CH_3CH_2CH_3$ C) 0.600 *m* Li_2SO_4

D) 0.400 *m* Na_3PO_4 E) 0.800 *m* $HOCH_2CH_2OH$

7. When lithium iodide dissolves in water the solution becomes hotter. Which of the following is NOT true about the solution?

A) The solution is exothermic.

B) The lattice energy is smaller in magnitude than the heat of hydration.

C) The solution forms because the system tends towards greater entropy.

D) The solution forms because the system tends towards greater energy.

E) The ΔH_{mix} must be larger in magnitude than the sum of $\Delta H_{solvent}$ and ΔH_{solute}.

8. Solutions having osmotic pressure less than those of bodily fluids are called _____.

A) isosmotic B) hyposmotic C) hyperosmotic

D) hemosmotic E) perosmotic

9. The Tyndall effect is due to:

A) blockage of a beam of light an aerosol

B) bending of light by an emulsion

C) light passing through a solution

D) scattering of a beam of light by a colloid

E) light refracting through a suspension

10. Consider the reaction: $2\ C_4H_{10}(g) + 13\ O_2(g) \rightarrow 8\ CO_2(g) + 10\ H_2O(g)$

If the rate of loss of O_2 is 0.32 *M*/s, what is rate of formation of CO_2?

A) 2.6 *M*/s B) 0.20 *M*/s C) 0.52 *M*/s

D) 0.025 *M*/s E) 0.32 *M*/s

Calculations – Write your initials in the upper-right corner of every page that contains work. For full credit show all work and write neatly; give answers with correct significant figures and units. Place a box around your final answer.

11. Ascorbic acid (vitamin C, $C_6H_8O_6$) is a water-soluble vitamin. A solution containing 80.5 g of ascorbic acid dissolved in 210.0 g of water has a density of 1.22 g/mL at 55°C. Calculate the following quantities for ascorbic acid in this solution: [3 points each]

    a. mass percentage

    b. mole fraction

    c. molality

    d. molarity

12. Nitric acid is usually purchased in a concentrated form that is 70.3% HNO_3 by mass and has a density of 1.41 g/mL. How many mL of concentrated solution would you take to prepare 1.50 L of 0.125 *M* HNO_3 by mixing with water? [4]

13. Calculate the vapor pressure in atm of a solution containing 25.1 g of glycerin ($C_3H_8O_3$) in 115 mL of water at 30.0 °C. The vapor pressure of pure water at this temperature is 31.8 torr. Assume that glycerin is not volatile and dissolves molecularly (i.e., it is not ionic); use a density of 1.00 g/mL for the water. [5]

14. An aqueous solution containing 15.6 g of an unknown molecular (nonelectrolyte) compound in 109.5 g of water was found to have a freezing point of −1.6 °C. Calculate the molar mass of the unknown compound. (K_f = 1.86 °C/*m*) [3]

15. The decomposition of dinitrogen pentoxide ($N_2O_5 \rightarrow N_2O_3 + O_2$) obeys the rate-law expression, Rate = 0.080 $min^{-1}[N_2O_5]$. If the initial concentration of N_2O_5 is 0.30 *M*, what is the concentration after 2.6 minutes? [3]

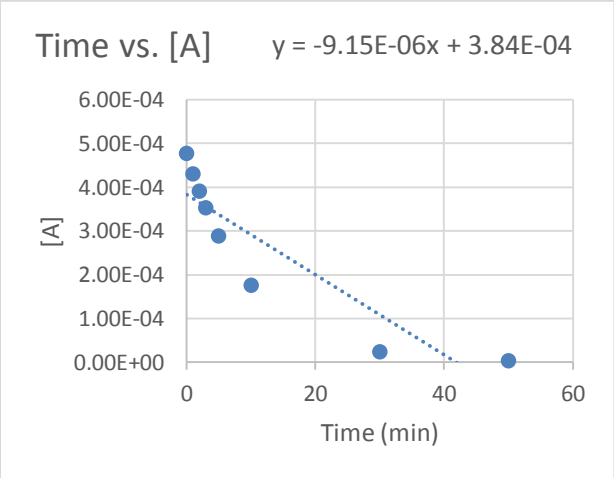
16. Consider the reaction: $2B \rightarrow C + 3D$. In one experiment it was found that at 27 °C the rate constant is 0.134 $M^{-1}\cdot s^{-1}$. A second experiment showed that at 177 °C, the rate constant was 0.569 $M^{-1}\cdot s^{-1}$. Determine the activation energy for the reaction in joules. [3]

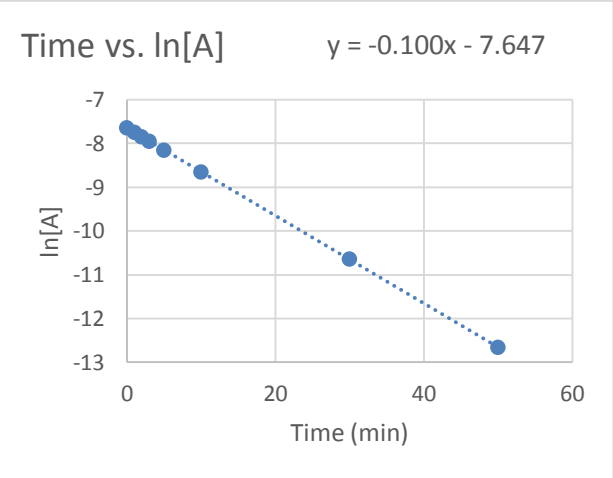
17. Consider the following reaction:

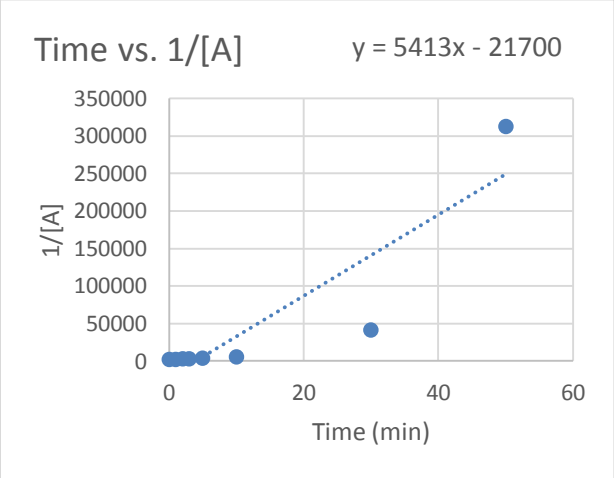
$$A(aq) \rightarrow B(aq) + C(aq)$$

The concentration of A was measured over time and the following data collected.

Time (min)	0.00	1.00	2.00	3.00	5.00	10.00	30.00	50.00
[A] (*M*)	4.77×10^{-4}	4.31×10^{-4}	3.91×10^{-4}	3.53×10^{-4}	2.89×10^{-4}	1.76×10^{-4}	2.40×10^{-5}	3.20×10^{-6}







a. Determine the rate constant: [2]

b. Write the rate law: [2]

18. The following data were measured for the reaction:

$$BF_3(g) + NH_3(g) \rightarrow F_3BNH_3(g)$$

Experiment	$[BF_3]$ (M)	$[NH_3]$ (M)	Initial rate ($M \cdot s^{-1}$)
1	0.250	0.250	0.2130
2	0.250	0.125	0.1065
3	0.200	0.100	0.0682
4	0.350	0.100	0.1193
5	0.175	0.100	0.0596

a. Determine the rate law for the reaction. [4]

b. What is the overall order of the reaction? [2]

c. Determine the rate constant. [3]

19. ***Challenge Question:*** For the reaction $Cl_2 + CO \rightleftharpoons Cl_2CO$, the following three-step mechanism has been proposed:

step 1	$Cl_2 \rightleftharpoons 2\ Cl$	(fast)
step 2	$Cl + CO \rightleftharpoons ClCO$	(fast)
step 3	$ClCO + Cl_2 \rightarrow Cl_2CO + Cl$	(slow)

(Hint: Remember that orders do not have to be whole numbers.)

a) Identify the intermediates, if any, in the mechanism. [2]

b) What is the rate law expression for the overall reaction? [5]

Extra Credit: When molecules with hydrophilic heads and long hydrophobic tails are placed in water they often cluster together in spheres. What are these spheres called? [2 points]

Formulas & Constants

$M = \frac{\text{mol solute}}{\text{liters solution}}$ $m = \frac{\text{mol solute}}{\text{kg solvent}}$ $\chi_A = \frac{\text{mol A}}{\text{total moles}}$

$P_A = \chi_A \cdot P_A^o$ $R = 0.08206 \frac{\text{L·atm}}{\text{mol·K}}$ $R = 8.314 \frac{\text{J}}{\text{mol·K}}$

$\Delta T_f = \underline{m} \cdot K_f$ $\Delta T_b = \underline{m} \cdot K_b$ $\Pi = \underline{M}RT$

$\Delta T_f = i \cdot \underline{m} \cdot K_f$ $\Delta T_b = i \cdot \underline{m} \cdot K_b$ $\Pi = i \cdot \underline{M}RT$

$K = °C + 273.15$ 1 atm = 760 torr = 760 mmHg $S_{gas} = k_H \cdot P_{gas}$

$\Delta H_{sol'n} = \Delta H_{hydration} - \Delta H_{lattice}$ $f = e^{-Ea/RT}$ $k = Ae^{-Ea/RT}$

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

$K_p = K_c(RT)^{\Delta n}$ $K_w = 1.0 \times 10^{-14}$ $K_a \times K_b = K_w$

$K_w = [H_3O^+][OH^-]$ $pH = pK_a + \log \frac{[base]}{[acid]}$ $pH = -\log[H_3O^+]$

$pOH = -\log[OH^-]$ $\Delta G = \Delta G° + RT \ln Q$ $\Delta G° = \Delta H° - T\Delta S°$

$K = e^{-\Delta G°/RT}$ $\Delta G° = -nFE°$ F = 96,485 J/V·mol

$E°_{cell} = E°(cathode) - E°(anode)$ $E = E° - (0.0592/n) \log Q$ $E = E° - (RT/nF) \ln Q$

1 V = 1 J/C

Order in [A]	Rate Law	Integrated Form, $y = mx + b$	Straight Line Plot	Half-Life $t_{1/2}$
zero-order (n = 0)	rate = $k\,[A]^0 = k$	$[A]_t = -kt + [A]_0$	$[A]_t$ vs. t	$t_{½} = \frac{[A]_0}{2k}$
first-order (n = 1)	rate = $k\,[A]^1$	$\ln[A]_t = -kt + \ln[A]_0$	$\ln[A]_t$ vs. t	$t_{½} = \frac{\ln 2}{k} = \frac{0.693}{k}$
second-order (n = 2)	rate = $k\,[A]^2$	$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$	$\frac{1}{[A]_t}$ vs. t	$t_{½} = \frac{1}{k[A]_0}$

Scratch Page
(to be handed in)