Chemistry 2 Second Lecture Exam Spring 2012

Name_____

Circle the name of your recitation/lab instructor:

Eisenberg Kahanda Kelebeyev Levine Mathias

Before you begin the exam, write your name on this page and the next

The exam is printed on **both sides** of the paper. If you need more space use page 2 or the last page.

For questions 13-26, show all work. Express answers with the proper units.

You have 90 minutes. Do not spend too much time on one question.

This exam has 5 sheets and 10 pages. Make sure you have all of them. Calculators may be inspected.

Use of cell phones is forbidden.

IA	IIA											IIIA	IVA	VA	VIA	VIIA	0
1 H 1.0079																1 H 1.0079	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.989	12 Mg 24.305											13 Al 26.981	14 Si 28.086	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.88	23 V 50.941	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 65.38	31 Ga 69.72	32 Ge 72.59	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 91.22	41 Nb 92.905	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 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 * La 138.90	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	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 226.0	89 # Ac 227.03															

* Lanthanides	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 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
# Actinides	90 Th 232.03	91 Pa 231.03	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 (254)	100 Fm (257)	101 Md (257)	102 No (255)	103 Lr (256)

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NAME_____

Useful and useless information

R = 8.314 J/mol-K = 0.08206 L-atm/mol-K F = 96,485 C/mol

$\Delta G° = -RT \ln K$ $\Delta G = \Delta G° + RT \ln Q$

$E = E° - \frac{0.059\ \text{V}}{n} \log Q$ at 25°C $\Delta G° = -nFE°$

1. (3 pts.) Give the oxidation number of the underlined element in each of the following:

(a) $\underline{S}_2O_3^{2-}$

(b) Na$\underline{H}$

(c) $F_2\underline{O}$

2. (3 pts.) State whether ΔS is positive, negative, or zero for each of the following processes:

(a) $N_2(g)$ reacts with $H_2(g)$ at constant temperature and volume to produce $NH_3(g)$

(b) 24 g of liquid water freezes to ice at 0°C and 1 atm

3. (2.5 pts.) The solubility of Ag_2CO_3 in $Na_2CO_3(aq)$ is

(a) the same as its solubility in pure water

(b) greater than its solubility in pure water

(c) less than its solubility in pure water

4. (2.5 pts.) Which one of the following solids will be more soluble in $HNO_3(aq)$ than in water?

(a) $CuCl_2$ (b) $Ba(NO_3)_2$ (c) $AgNO_2$ (d) none of these

Exam continued on the back

5. (3 pts.) If a reaction has ΔG° greater than zero, then the equilibrium constant will be

(a) Negative

(b) Less than 1 but greater than zero

(c) Greater than 1

(d) We need to know what the reaction is in order to answer this.

6. (4 pts.) For a reaction that has a positive value of ΔH° and a negative value of ΔS°, which statement is true at equilibrium?

a) Reactants are favored at very low temperatures and reactants are favored at very high T

b) Reactants are favored at very low temperatures and products are favored at very high T

c) Products are favored at very low temperatures and reactants are favored at very high T

d) Products are favored at very low temperatures and products are favored at very high T

Note: "Reactants are favored" means they are present at equilibrium in greater amounts than products.

7. (2 pts) If the entropy of an isolated system increases in a process, then the final state of the system

(a) has a greater probability than the initial state.
(b) has a smaller probability than the initial state.
(c) There is no relation between entropy and probability.

8. (1 pt.) Give the <u>coordination</u> number of Ni in $[Ni(en)Cl_2]^+$

9 (3 pts) While a chemical reaction is going on (before equilibrium has been reached), which statement is true?

(a) The entropy of the system must be decreasing.

(b) The entropy of the system must remain constant.

(c) The entropy of the system must be increasing.

(d) The entropy of the universe must be decreasing.

(e) The entropy of the universe must remain constant.

(f) The entropy of the universe must be increasing.

10. (3 pts) When NaOH(aq) is titrated with $HC_2H_3O_2$(aq) at 25°C, the pH at the equivalence point is

(a) less than 7.0 (b) equal to 7.0 (c) greater than 7.0

11. (3 pts) A certain $FeCl_3$(aq) solution has a molarity of 0.40 M when used in the oxidation-reduction reaction

$$2FeCl_3(aq) + 3Zn \rightarrow 2Fe(s) + 3ZnCl_2(aq)$$

Find the normality of this $FeCl_3$solution. Hint: This problem is a bit tricky, so think carefully about the definitions of things involved here.

12. (4 pts) State whether each of the following is True or False. Write True or False, not T or F.

(a) Two isomers must have the same molecular weight.

(b) When a complex ion is formed, the central metal atom acts as a Lewis acid.

13 (?? points) Draw all the isomers that have the formula $[PtF_2Br_2]$ with a square-planar structure.

14. (2 points) HCF_3 has a tetrahedral structure. How many different molecules can be drawn that have this formula? C is the central atom.

(a) one (b) two (c) three (d) four (e) 267

EXAM continued on the back.

For questions 15-26 show all work. You are forbidden from using the Henderson-Hasselbalch equation. See formulas on page 3.

15. (6 pts.) 200.0 mL of a saturated solution of SrF_2 in water at 25°C contains 0.011 g of SrF_2 . Find K_{sp} for SrF_2 in water at 25°C. Sr is in Group IIA on the periodic table on page 1.

16. (6 points) How many grams of CaF_2 can be dissolved in 200 mL of 0.25 M KF(aq) at 25°C if $K_{sp} = 3.4 \times 10^{-11}$ for CaF_2?

17. (6 pts.) For what length of time must a 15.0 A current flow to deposit 65.4 g of Ca from molten $CaCl_2$?

18 (6 pts) Find the pH when 40.0 mL of 0.200 M NaOH(aq) is added to 60.0 mL of 0.300 M $HC_2H_3O_2$(aq) at 25°C. For $HC_2H_3O_2$(aq), $K_a = 1.8 \times 10^{-5}$ at 25°C.

19 (3 pts) Use data in Problem 18 to find ΔG° for the ionization of $HC_2H_3O_2$(aq).

20. (3 pts.) Give the formula of

triamminediaquabromocobalt(III) nitrate

21. (3 pts.) A cell with the reaction

$$3Zn(s) + 2Cr^{3+}(aq) \rightarrow 3Zn^{2+}(aq) + 2Cr(s)$$

has E° = 0.0180 V at 25°C. Find ΔG° for the cell's reaction at 25°C.

Exam continued on the back

22. (4 pts.) Given this data at 25°C,

	ΔH_f° (kJ/mol)	S° (J/mol–K)
CO(g)	–110.5	197.9
CO_2(g)	–393.5	213.6
O_2(g)	0	205.0

find $\Delta G°$ at 25°C for the reaction $2\ CO_2(g) \rightarrow 2\ CO(g) + O_2(g)$

23. (5 pts) Consider the reaction

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

For N_2O_4(g) at 25°C, ΔG_f° = 98.28 kJ/mol. For NO_2(g) at 25°C, ΔG_f° = 51.84 kJ/mol.

(a) Find ΔG° for this reaction.

(b) Calculate ΔG at 25°C in a system where the NO_2 partial pressure is 0.60 atm and the N_2O_4 partial pressure is 1.80 atm.

24. (6 pts.) A galvanic cell is constructed from a Cr(s), $Cr(NO_3)_3$(aq) half-cell and a Mg(s), $MgSO_4$(aq) half-cell connected by a salt bridge. The following standard reduction potentials at 25°C are given:

$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$ –0.74 V and $Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$ –2.37 V

a) Write the spontaneous net ionic reaction for this cell.

b) Find E° for this cell at 25°C

c) When the cell is operating, electrons flow out of which electrode (Cr or Mg) into the wire connecting the electrodes?

25 (8 pts.) Balance this reaction in **acidic** aqueous solution using the method of half-reactions (You must use the method of half-reactions.)

$H_2SO_3(aq) + BrO_3^-(aq) \rightarrow Br^-(aq) + SO_4^{2-}(aq)$ Note the –1 charges on two of the species.

26. (4 pts) Balance this **half-reaction** in **basic** aqueous solution (use space on the back)

$$Bi_2O_3 \rightarrow Bi$$

Continued on the back

Extra Credit

EC1 (1 pt) (a) Give the first name of Boltzmann.

(b) Name the city where he is buried.

EC2 (1 pt) Is this motion in CO_2 a translation, a rotation, or a vibration: $\leftarrow$O—C—O$\rightarrow$ (The arrows show the direction of motion of the O atoms at one moment in time; the C atom is not moving.)