Chemistry 142 Name

Martin Larter

Exam 2a April 15, 2015

Multiple Choice (20 points)

Page 5 (20 points)

Page 6 (20 points)

Page 7 (20 points)

Page 8 (16 points)

Total (96 points)

Percentage Grade \_\_\_\_\_\_\_\_\_\_\_\_

All work must be shown to receive credit. Give all answers to the correct number of significant figures

**Useful Information**

**R = 0.08206 L • atm / mol • K**

**R = 8.31451 J / mol • K**

***Kw* = 1.00 x 10-14**

**x = -b ± (b2 - 4ac)1/2**

**2a**

Grossmont College

Periodic Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IA |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  | VIIA | VIIIA |
| 1  **H**  1.008 | IIA |  |  |  |  |  |  |  |  |  | |  | IIIA | IVA | VA | VIA | 1  **H**  1.008 | 2  **He**  4.002 |
| 3  **Li**  6.941 | 4  **Be**  9.012 |  |  |  |  |  |  |  |  |  | |  | 5  **B**  10.81 | 6  **C**  12.01 | 7  **N**  14.01 | 8  **O**  16.00 | 9  **F**  19.00 | 10  **Ne**  20.18 |
| 11  **Na**  23.00 | 12  **Mg**  24.30 | IIIB | IVB | VB | VIB | VIIB | VIII VIII VIII | | | | IB | IIB | 13  **Al**  27.00 | 14  **Si**  28.09 | 15  **P**  30.97 | 16  **S**  32.06 | 17  **Cl**  35.45 | 18  **Ar**  39.95 |
| 19  **K**  39.10 | 20  **Ca**  40.08 | 21  **Sc**  44.96 | 22  **Ti**  47.90 | 23  **V**  50.94 | 24  **Cr**  52.00 | 25  **Mn**  54.94 | 26  **Fe**  55.85 | 27  **Co**  58.93 | 28  **Ni**  58.70 | | 29  **Cu**  63.55 | 30  **Zn**  65.38 | 31  **Ga**  69.72 | 32  **Ge**  72.59 | 33  **As**  74.92 | 34  **Se**  78.96 | 35  **Br**  79.90 | 36  **Kr**  83.80 |
| 37  **Rb**  85.47 | 38  **Sr**  87.62 | 39  **Y**  88.91 | 40  **Zr**  91.22 | 41  **Nb**  92.91 | 42  **Mo**  95.94 | 43  **Tc**  (99) | 44  **Ru**  101.1 | 45  **Rh**  102.9 | 46  **Pd**  106.4 | 47  **Ag**  107.9 | | 48  **Cd**  112.4 | 49  **In**  114.8 | 50  **Sn**  118.7 | 51  **Sb**  121.8 | 52  **Te**  127.6 | 53  **I**  126.9 | 54  **Xe**  131.3 |
| 55  **Cs**  132.9 | 56  **Ba**  137.3 | 57  **La**  138.9 | 72  **Hf**  178.5 | 73  **Ta**  180.9 | 74  **W**  183.9 | 75  **Re**  186.2 | 76  **Os**  190.2 | 77  **Ir**  192.2 | 78  **Pt**  195.1 | 79  **Au**  197.0 | | 80  **Hg**  200.6 | 81  **Tl**  204.4 | 82  **Pb**  207.2 | 83  **Bi**  209.0 | 84  **Po**  (209) | 85  **At**  (210) | 86  **Rn**  (222) |
| 87  **Fr**  (223) | 88  **Ra**  226.0 | 89  **Ac**  227.0 | 104  **Rf**  (261) | 105  **Db**  (262) | 106  **Sg**  (263) | 107  **Bh**  (262) | 108  **Hs**  (265) | 109  **Mt**  (266) | 110  **??**  (269) |  | |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58  **Ce**  140.1 | 59  **Pr**  140.9 | 60  **Nd**  144.2 | 61  **Pm**  (147) | 62  **Sm**  150.4 | 63  **Eu**  152.0 | 64  **Gd**  157.3 | 65  **Tb**  158.9 | 66  **Dy**  162.5 | 67  **Ho**  164.9 | 68  **Er**  167.3 | 69  **Tm**  168.9 | 70  **Yb**  173.0 | 71  **Lu**  175.0 |
| 90  **Th**  232.0 | 91  **Pa**  231.0 | 92  **U**  238.0 | 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**  (260) |

Part I – Multiple Choice (20 points)

1. The Common Ion Effect predicts that the solubility of a salt in a solution already containing one of the ions in the salt will be\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than the solubility in pure water. This is predictable, because
2. More; Le Chatelier's Principle predicts that the common ion will suppress precipitation.
3. More; the presence of the common ion will increase that concentration, hence Ksp will fall.
4. Less; Le Chatelier's Principle predicts that the common ion will suppress dissolving.
5. Less; the presence of the common ion will increase that concentration, hence Ksp will rise.
6. Less; at equilibrium, Q will be less than Ksp
7. For a solution containing a dissolved salt, if Q > Ksp
8. The solution is unsaturated and no precipitate forms.
9. The solution is unsaturated but is at the point of precipitation.
10. The solution is supersaturated and a precipitate forms.
11. A precipitate will form from the unsaturated solution.
12. The solution is saturated and a precipitate will form if more anions and/or cations are added
13. Which of the following equations describes the predominant reaction that occurs at the equivalence point of a titration between CH3COOH (aq) and NaOH (aq)?
14. H+ (aq) + OH- (aq) ↔ H2O(l)
15. CH3COO- (aq) + H2O(l) ↔CH3COOH(aq) + OH- (aq)
16. CH3COOH(aq) + NaOH(aq) ↔ NaCH3COO-(aq) + H2O(l)
17. H+ (aq) + CH3COO- (aq) + Na+ (aq) + OH- (aq) ↔Na+ (aq) CH3COO- (aq) H2O(l)
18. none of the above
19. For which type of titration will the pH be basic at the equivalence point?
20. strong acid/strong base
21. strong acid/weak base
22. weak acid/strong base
23. all of the above
24. none of the above
25. If a small amount of a strong acid is added to a buffer made up of a weak acid, HA, and the sodium salt of its conjugate base, NaA, the pH of the buffer solution does not change appreciably because:
26. No reaction occurs.
27. The strong acid reacts with HA to give HA+.
28. The Ka of HA is changed.
29. The strong acid reacts with HA to give H2A+.
30. The strong acid reacts with the A- of the salt to give HA.
31. Which one of the following reactions most likely has ΔS < 0?
32. I2(s) 🡪 I2(g)
33. NiO(s) + CO(g) 🡪Ni(s) + CO2(g)
34. 2N2(g) + O2(g) 🡪2 N2O(g)
35. N2(g) + O2(g) 🡪2 NO(g)
36. All of the above has a ΔS > 0
37. What can be said about a chemical system that has reached a minimum energy?
38. The temperature is 0K
39. The reaction is very fast
40. The systems entropy is zero
41. The system has achieved equilibrium
42. The reaction is complete
43. An employer is interviewing four applicants for a job as a laboratory technician and asks each how to prepare a buffer solution with a pH close to 9. Which of these applicants has given an appropriate procedure? (For acetic acid Ka= 1.8×10–5; for ammonia Kb= 1.8×10–5)
44. Archie A. says he would mix acetic acid and sodium acetate solutions.
45. Beula B. says she would mix NH4Cl and HCl solutions.
46. Carla C. says she would mix NH4Cl and NH3 solutions.
47. Dexter D. says he would mix NH3 and NaOH solutions.
48. None of the applicants prepare a buffer solution with a pH close to 9
49. The Second Law of Thermodynamics states that:
50. If two objects are in thermal contact, heat will flow from the object with higher temperature to the object with lower temperature until thermal equilibrium is reached.
51. Matter and energy can never be created or destroyed, only interconverted; ΔE = q + w
52. The entropy of a perfect crystal at 0 K is 0.
53. The entropy of the universe tends always to a maximum; ΔSuniverse > 0.
54. The free energy change of a reaction A 🡪 B is a measure of the tendency of the tendency of the reaction to proceed as written, spontaneously. ΔG = ΔH –TΔS.
55. A reaction is exothermic and has a negative value of ∆S°. The value of ∆G° for this reaction is therefore:
56. Negative at all temperatures.
57. Positive at all temperatures.
58. Positive above 0°C and negative below 0°C.
59. Positive above a certain temperature and negative below it.
60. Negative above a certain temperature and positive below it.

Short answer:

1. Consider the titration of 50.0 mL sample of 0.212 M lactic acid, HC3H5O3 with 0.186 M NaOH.
2. (8 points) What is the pH of the solution after 10.00 mL of NaOH have been added?
3. (12 points) What is the pH at the equivalence point?
4. (6 points) Calculate the molar solubility of Cu3(PO4)2 in a 0.25 M solution of Na3PO4. SHOW ALL REACTIONS and WORK!
5. (10 point) If you mix 225.0 mL of 0.015 M aqueous lead(II) nitrate with 125.0 mL of 0.045 M aluminum bromide, does a precipitate form? Must show your work mathematically by calculating - no guessing.
6. (4 points). Kinetics and thermodynamics both describe chemical reactions. Compare and contrast the two
7. For a particular reaction ΔH°rxn = -124 kJ, ΔS°rxn = 256 J/K, and T = 19 oC
8. (5 points) Calculate ΔSuniverse.
9. (4 points) Predict whether the reaction will be spontaneous or nonspontaneous. Show calculations to justify your answer.
10. (6 points) List the following substances in order of increasing molar entropy at 298 K: H2O (l), H2O (g), H2O (s), and C (s). Explain your reasoning.
11. (11 points):Consider the balanced equation

6 OH- (aq) + 3 I2 (s) 🡪 IO3- (aq) + 3 H2O (l) + 5 I- (aq)

1. Calculate ∆G° for the reaction at 25 °C.
2. Is the reaction spontaneous or nonspontaneous under standard-state conditions?
3. What pH is required for the reaction to be at equilibrium at 25 °C when [I-] = 0.10 M and [IO3-] = 0.50 M?
4. (10 points) Generate a flow chart to separate Al3+, Zn2+ and Mn2+. The Following reagents are available to you for this separation scheme

|  |  |  |  |
| --- | --- | --- | --- |
| 3 M H2SO4 | 1 M NH3 | 15 M NH3 | 3 M HCl |
| 3% H2O2 | 0.2 *M* KSCN | 6 *M* HC2H3O2 | 0.1 *M* Pb(C2H3O2)2 |
| K4Fe(CN)6. | 6 *M* HNO3 | 6 M NaOH |  |

**Base Dissociation Constants at 25****C**

|  |  |  |
| --- | --- | --- |
| Name | Formula | Kb |
| Ammonia | NH3 | 1.8 x 10-5 |
| Aniline | C6H5NH2 | 4.3 x 10-10 |
| Dimethylamine | (CH3)2NH | 5.4 x 10-4 |
| Ethylamine | C2H5NH2 | 6.4 x 10-4 |
| Hydrazine | H2NNH2 | 1.3 x 10-6 |
| Hydroxylamine | NH2OH | 1.1 x 10-8 |
| Methylamine | CH3NH2 | 4.4 x 10-4 |
| Pyridine | C5H5N | 1.7 x 10-9 |
| Trimethylamine | (CH3)3N | 6.4 x 10-5 |

**Acid Dissociation Constants at 25****C**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Formula | Ka1 | Ka2 | Ka3 |
| Acetic | HC2H3O2 | 1.8 x 10-5 |  |  |
| Arsenic | H3AsO4 | 5.6 x 10-3 | 1.0 x 10-7 | 3.0 x 10-12 |
| Ascorbic | H2C6H6O6 | 8.0 x 10-5 | 1.6 x 10-12 |  |
| Benzoic | HC7H5O2 | 6.3 x 10-5 |  |  |
| Butanoic | HC4H7O2 | 1.5 x 10-5 |  |  |
| Carbonic | H2CO3 | 4.3 x 10-7 | 5.6 x 10-11 |  |
| Chloroacetic | HC2H2O2Cl | 1.4 x 10-3 |  |  |
| Chlorous | HClO2 | 1.1 x 10-2 |  |  |
| Citric | H3C6H5O7 | 7.4 x 10-4 | 1.7 x 10-5 | 4.0 x 10-7 |
| Cyanic | HCNO | 3.5 x 10-4 |  |  |
| Formic | HCHO2 | 1.8 x 10-4 |  |  |
| Hydroazoic | HN3 | 1.9 x 10-5 |  |  |
| Hydrocyanic | HCN | 4.9 x 10-10 |  |  |
| Hydrofluoric | HF | 6.8 x 10-4 |  |  |
| Hydrosulfuric | H2S | 9.5 x 10-8 | 1 x 10-19 |  |
| Hypobromous | HBrO | 2.5 x 10-9 |  |  |
| Hypochlorous | HClO | 3.0 x 10-8 |  |  |
| Hypoiodous | HIO | 2.3 x 10-11 |  |  |
| Iodic | HIO3 | 1.7 x 10-1 |  |  |
| Lactic | HC3H5O3 | 1.4 x 10-4 |  |  |
| Nitrous | HNO2 | 4.5 x 10-9 |  |  |
| Oxalic | H2C2O4 | 5.9 x 10-2 |  |  |
| Phenol | HC6H5O | 1.3 x 10-10 |  |  |
| Phosphoric | H3PO4 | 7.5 x 10-3 | 6.2 x 10-8 | 4.2 x 10-13 |
| Propionic | HC3H5O2 | 1.3 x 10-5 |  |  |
| Sulfurous | H2SO3 | 1.7 x 10-2 | 6.4 x 10-8 |  |
| Tartaric | H2C4H4O6 | 1.0 x 10-3 | 4.6 x 10-5 |  |

|  |  |
| --- | --- |
| Substance | ∆G° f (kJ/mol) |
| I2 (s) | 0 |
| IO3- (aq) | -128.0 |
| I- (aq) | -51.57 |
| H2O (l) | -237.1 |
| OH- (aq) | -157.3 |

**Table of Formation Product Constants (Kf at 25 oC)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Complex Ion | Kf | Complex Ion | Kf | Complex Ion | Kf |
| [Ag(CN)2]– | 5.6×1018 | [Cr(OH)4]– | 8×1029 | [Hg(ox)2]2– | 9.5×106 |
| [Ag(EDTA)]3– | 2.1×107 | [CuCl3]2– | 5×105 | [Ni(CN)4]2– | 2×1031 |
| [Ag(en)2]+ | 5.0×107 | [Cu(CN)2]– | 1.0×1016 | [Ni(EDTA)]2– | 3.6×1018 |
| [Ag(NH3)2]+ | 1.6×107 | [Cu(CN)4]3– | 2.0×1030 | [Ni(en)3]2+ | 2.1×1018 |
| [Ag(SCN)4]3– | 1.2×1010 | [Cu(EDTA)]2– | 5×1018 | [Ni(NH3)6]2+ | 5.5×108 |
| [Ag(S2O3)2]3– | 1.7×1013 | [Cu(en)2]2+ | 1×1020 | [Ni(ox)3]4– | 3×108 |
| [Al(EDTA)]– | 1.3×1016 | [Cu(CN)4]2– | 1×1025 | [PbCl3]– | 2.4×101 |
| [Al(OH)4]– | 1.1×1033 | [Cu(NH3)4]2+ | 1.1×1013 | [Pb(EDTA)]2– | 2×1018 |
| [Al(ox)3]3– | 2×1016 | [Cu(ox)2]2– | 3×108 | [PbI4]2– | 3.0×104 |
| [Cd(CN)4]2– | 6.0×1018 | [Fe(CN)6]4– | 1×1037 | [Pb(OH)3]– | 3.8×1014 |
| [Cd(en)3]2+ | 1.2×1012 | [Fe(EDTA)]2– | 2.1×1014 | [Pb(ox)2]2– | 3.5×106 |
| [Cd(NH3)4]2+ | 1.3×107 | [Fe(en)3]2+ | 5.0×109 | [Pb(S2O3)3]4– | 2.2×106 |
| [Co(EDTA)]2– | 2.0×1016 | [Fe(ox)3]4– | 1.7×105 | [PtCl4]2– | 1×1016 |
| [Co(en)3]2+ | 8.7×1013 | [Fe(CN)6]3– | 1×1042 | [Pt(NH3)6]2+ | 2×1035 |
| [Co(NH3)6]2+ | 1.3×105 | [Fe(EDTA)]– | 1.7×1024 | [Zn(CN)4]2– | 1×1018 |
| [Co(ox)3]4– | 5×109 | [Fe(ox)3]3– | 2×1020 | [Zn(EDTA)]2– | 3×1016 |
| [Co(SCN)4]2– | 1.0×103 | [Fe(SCN)]2+ | 8.9×102 | [Zn(en)3]2+ | 1.3×1014 |
| [Co(EDTA)]– | 1×1036 | [HgCl4]2– | 1.2×1015 | [Zn(NH3)4]2+ | 4.1×108 |
| [Co(en)3]3+ | 4.9×1048 | [Hg(CN)4]2– | 3×1041 | [Zn(OH)4]2– | 4.6×1017 |
| [Co(NH3)6]3+ | 4.5×1033 | [Hg(EDTA)]2– | 6.3×1021 | [Zn(ox)3]4– | 1.4×108 |
| [Co(ox)3]3– | 1×1020 | **[Hg(en)2]2+** | 2×1023 |  |  |
| [Cr(EDTA)]– | 1×1023 | [HgI4]2– | 6.8×1029 |  |  |

**Table of Solubility Product Constants (Ksp at 25 oC)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Formula | Ksp | Formula | Ksp | Formula | Ksp |
| PbBr2 | 6.3 x 10-6 | PbF2 | 3.7 x 10-8 | Pb3(P04)2 | 3.0 x 10-44 |
| AgBr | 3.3 x 10-13 | MgF2 | 6.4 x 10-9 | Ag3P04 | 1.3 x 10-20 |
| BaCO3 | 8.1 x 10-9 | AgOH | 2.0 x 10-8 | Zn3(P04)2 | 9.1 x 10-33 |
| CaCO3 | 3.8 x 10-9 | Al(OH)3 | 1.9 x 10-33 | BaS04 | 1.1 x 10-10 |
| CoCO3 | 8.0 x 10-13 | Ca(OH)2 | 7.9 x 10-6 | CaS04 | 2.4 x 10-5 |
| CuCO3 | 2.5 x 10-10 | Cr(OH)3 | 6.7 x 10-31 | PbS04 | 1.8 x 10-8 |
| FeCO3 | 3.5 x 10-11 | Co(OH)2 | 2.5 x 10-16 | Ag2S04 | 1.7 x 10-5 |
| PbCO3 | 1.5 x 10-13 | Cu(OH)2 | 1.6 x 10-19 | CaS | 8 x 10-6 |
| MgCO3 | 4.0 x 10-5 | Fe(OH)2 | 7.9 x 10-15 | Cu3(PO4)2 | 1.4 x 10-37 |
| MnCO3 | 1.8 x 10-11 | Fe(OH)3 | 6.3 x 10-38 | CrP04 | 2.4 x 10-23 |
| NiCO3 | 6.6 x 10-9 | Pb(OH)2 | 2.8 x 10-16 | CoS | 5.9 x 10-21 |
| Ag2CO3 | 8.1 x 10-12 | Mg(OH)2 | 1.5 x 10-11 | CuS | 7.9 x 10-37 |
| ZnCO3 | 1.5 x 10-11 | Mn(OH)2 | 4.6 x 10-14 | FeS | 4.9 x 10-18 |
| PbCl2 | 1.7 x 10-5 | Ni(OH)2 | 2.8 x 10-16 | Fe2S3 | 1.4 x 10-88 |
| AgCl | 1.8 x 10-10 | Zn(OH)2 | 4.5 x 10-17 | PbS | 3.2 x 10-28 |
| BaCrO4 | 2.0 x 10-10 | PbI2 | 8.7 x 10-9 | MnS | 5.1 x 10-15 |
| CaCrO4 | 7.1 x 10-4 | AgI | 1.5 x 10-16 | NiS | 3.0 x 10-21 |
| PbCrO4 | 1.8 x 10-14 | BaC2O4 | 1.1 x 10-7 | Ag2S | 1.0 x 10-49 |
| Ag2CrO4 | 9.0 x 10-12 | CaC2O4 | 2.3 x 10-9 | ZnS | 2.0 x 10-25 |
| Ni(CN)2 | 3.0 x 10-23 | MgC2O4 | 8.6 x 10-5 | BaS03 | 8.0 x 10-7 |
| AgCN | 1.2 x 10-16 | AlP04 | 1.3 x 10-20 | CaS03 | 1.3 x 10-8 |
| Zn(CN)2 | 8.0 x 10-12 | Ba3(P04)2 | 1.3 x 10-29 | Ag2S03 | 1.5 x 10-14 |
| BaF2 | 1.7 x 10-6 | Ca3(P04)2 | 1.0 x 10-25 |  |  |
| CaF2 | 3.9 x 10-11 |  |  |  |  |