Chemistry 142 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Exam 2 April 1, 2009

Page 1 (15 points)

Page 2 (20 points)

Page 3 (18 points)

Page 4 (20 points)

Page 5 (18 points)

Page 6 (9 points)

Total (100 points)

Percent (100 %)

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

**Constants**

R = 8.3145 J/(mol K) = 0.08206 L atm/(mol K) = 1.9872 cal/(mol K)

NA = 6.022 x 1023 mol-1 Density of water = 1.00 g/mL Kw = 1x 10-14 M2

**Equations**

x=-b ± (b2 – 4ac)½ PV = nRT PT = P1 + P2 + P3 + ..............

2a

ΔG = ΔH – TΔS ΔGo = ΔHo – TΔSo  ΔGo = –2.303 RT Log Keq = – RT Ln Keq

pH= -Log[H+] Log [A] = Log[A]o – kt Ln [A] = Ln [A]o – kt

2.303

[A] = [A]o e- kt  t1/2 = [A]o t1/2 = Ln2 2k k

1 = 1 + kt 1 = 1 + 2kt t½ = 3

[A] [A]o [A]2 [A]o2 2k[A]o2

t½ = 1 Ln k = Ln A - Ea k = A e-Ea/RT

k [A]o RT

Xi = Pi/PT Kw=Ka\*Kb sg = kHPg

Grossmont College

Periodic Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IA |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  | VIIA | NOBLE GASES |
| 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 A: Multiple Choice (15 pts)

1. ΔH° = −92.5 kJ for the following reaction: PCl3*(g)* + Cl2*(g)-🡪* PCl5*(g)*This reaction is most likely to be

A. spontaneous at all temperatures

B. spontaneous at high temperatures but nonspontaneous at low temperatures

C. spontaneous at low temperatures but nonspontaneous at high temperatures

D. nonspontaneous at all temperatures

1. Which of the following processes would have a negative ΔS° value?

1. CO2*(g)* → CO2*(s)*

2. CH4*(g)* + H2O*(g)* → CO2*(g)* + 3H2*(g)*

3. SO3(*g*) + H2O(*l*) → H2SO4(*l*)

4. NH4HS*(s)* → NH3*(g)* + H2S*(g)*

A. 1 only B. 1 and 3 only C. 3 only

D. 1, 2, and 3 only E. 1, 2, 3, and 4

1. What is the effect on the pH of an NH3 *(aq)* solution upon addition of NH4NO3 *(aq)*?

A. pH will not change B. pH will decrease

C. pH will increase D. need more information to tell

1. When HCN*(aq)* is titrated by NaOH*(aq)*, the pH at the equivalence point is

A. 7 B. less than 7 C. greater than 7 D. need more information

1. Which of the following mixtures is suitable for making a buffer solution with an optimum pH of 4.6-4.8?

A. NaC2H3O2 / HC2H3O2 B. NH3 / NH4+ C. NaOCl / HOCl

D. NaNO2 / HNO2 E. NaClO4/HClO4

Part B: Short answer and Essay

1. A 30.0-mL sample of 0.400 M benzoic acid is titrated with 0.275-M sodium hydroxide. Determine the pH after 21.6 mL of the base have been added to the acid. Using HA to represent benzoic acid: (must do by ICE Tables) (10 pts)
2. Explain why most solutions are not neutral at the equivalence point in an acid base titration, even though the acid and base have been “neutralized” (4 pts)
3. Label the titration curves of aspirin (HC9H9O4) with NaOH and. Clearly indicate the locations and chemical species at the ½ equivalence point(s) (also circle and label buffer range(s)), equivalence point(s) and 1.5 times equivalence point (6 pts)

Aspirin

pH

Volume of NaOH

1. A solution of 1.35 M CH3CH2NH2 is treated with 0.25 M HNO3
2. Determine the volume of HNO3 required to reach the equivalence point if 300 ml CH3CH2NH2 are used (4 pts)
3. Determine pH of solution at the equivalence point (must do by ICE Tables) (8 pts)
4. What is the solubility (in mol/L) of Ba3(PO4)2 in a solution that is 1.0 x 10-5 M in Na3PO4? (6 pts)
5. Will Magnesium carbonate precipitate if 3 drops (0.6 mL) of 0.010 M Mg(NO3)2 is added to 3.0 mL of 0.075 M Na2CO3? Show your work clearly and explain reasoning. (6 pts)
6. Calculate the molar solubility of Cd(OH)2 in 2.0 M NaCN. (8 pts)

Kf = 6.0×1018; KSP=7.2 ×10-15

Cd(OH)2(s) + 4 CN- <====> [Cd(CN)4]2–+ 2 OH-

1. State the First, Second, and Third laws of Thermodynamics.(6 pts)
2. For the vaporization of benzene ∆Hvap =30.7 kJ/mol and ∆Svap =87.0 J/mol\*K. Calculate ∆Stotal at 70oC. (6 pts)
3. Calculate to three significant figures, the normal boiling point for benzene in oC (6 pts)
4. Consider the graph shown. (6 pts)

Products

Reactants



* 1. Is the reaction for which G is shown spontaneous or non-spontaneous? Very briefly explain.
  2. If a reaction mixture is prepared that has the composition that corresponds to the location of the arrow, how will the system shift to reach equilibrium? Very briefly explain.
  3. Place an “X” on the curve above to indicate the extent of reaction that corresponds to equilibrium.

1. Consider the reaction

H2 (g) + Br2 (g) 🡨🡪 2 HBr (g) ∆Ho = -103.8 kJ/mol

In a particular experiment, equal moles of H2 (g) at 1.00 atm and Br2 (g) at 1.00 atm were mixed in a 1.00 L flask at 25oC and allowed to reach equilibrium. The moles of H2 (g) were determined at equilibrium to be 1.83 x10-11 moles H2 (g) for the reaction, calculate K and ∆Go (if you can not determine K use 1.2 x 1010 as a default value) (9 pts)

**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 |  |

**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 |

**Solubility Constants at 25****C**

|  |  |  |
| --- | --- | --- |
| Name | Formula | Ksp |
| Barium carbonate | BaCO3 | 5.0 x 10-9 |
| Barium fluoride | BaF2 | 1.7 x 10-6 |
| Barium phosphate | Ba3(PO4)2 | 6 x 10-39 |
| Barium sulfate | BaSO4 | 1.1 x 10-10 |
| Iron (II) carbonate | FeCO3 | 2.1 x 10-11 |
| Iron (II) hydroxide | Fe(OH)2 | 7.9 x 10-16 |
| Magnesium carbonate | MgCO3 | 3.5 x 10-8 |
| Manganese (II) carbonate | MnCO3 | 5.0 x 10-10 |
| Manganese (II) hydroxide | Mn(OH)2 | 1.6 x 10-13 |