Chem 150 – Exam 2a *Name:* _____
Fall 2010

Chemistry 150 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 non-multiple choice 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} units/mol
$32.00^{o}F = 0.000^{o}C = 273.15K$
1 foot = 12 inches
1 inch = 2.54cm (exactly)
1 pound = 453.6 g = 16 ounces
1 amu = 1.6605×10^{-24} g
Masses of subatomic particles:
Proton 1.00728amu = 1.6726×10^{-24} g
Neutron 1.00866amu = 1.6749×10^{-24} g
Electron 0.000549amu = 9.1094×10^{-28} g
Density of Water = 1.000 g/mL
R = 0.08206 L•atm/mol•K
PV=nRT

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. Consider the following reaction:

$$a\ K_2CO_3(aq) + b\ Co(NO_3)_3(aq) \rightarrow c\ Co_2(CO_3)_3(s) + d\ KNO_3(aq)$$

For every mol of $Co_2(CO_3)_3(s)$ that forms, how many mols of $K_2CO_3(aq)$ have reacted?
   a. 0.33 mols
   b. 0.5 mols
   c. 1 mol
   d. 2 mols
   e. 3 mols

2. Which of the following reactions would form only water and a salt?
   a. $HNO_3(aq) + Na_2SO_3(aq)$
   b. $HClO_4(aq) + Mg(OH)_2(aq)$
   c. $Ni(C_2H_3O_2)_2(aq) + Zn(s)$
   d. $HCl(aq) + Pb(NO_3)_2(aq)$
   e. $Fe(NO_3)_3(aq) + Mg(OH)_2(aq)$

3. Which of the following statements is ***true***?
   a. Oxidation can happen without reduction
   b. Oxidation is losing electrons
   c. Increasing charge is a reduction
   d. Loss of electrons is reduction
   e. Oxidizing agents are oxidized in a reaction

4. In which of the following formulas does sulfur (S) have the ***highest*** oxidation number?
   a. $H_2S(g)$
   b. $S(s)$
   c. $SO_4^{2-}(aq)$
   d. $SO_2(g)$
   e. $SF_3(g)$

5. Which of the following would you expect to be ***soluble*** in water?
   a. $AgC_2H_3O_2$
   b. $BaSO_4$
   c. $Mg_3(PO_4)_2$
   d. $Pb(OH)_2$
   e. $CrCO_3$

6. Consider the following reaction:

$$Cu(NO_3)_2(aq) + Zn(s) \rightarrow Zn(NO_3)_2(aq) + Cu(s)$$

What is being ***oxidized*** in this reaction?
   a. $Cu(NO_3)_2(aq)$
   b. Zn(s)
   c. $Zn(NO_3)_2(aq)$
   d. $Cu(s)$
   e. This is not a redox reaction

Score

Chemical Equations: For each of the following, write a correctly balanced chemical equation and identify the reaction type. Be sure to include state labels. (12pts each)

Potassium phosphate (aq) + Nickel(II) acetate(aq) → Nickel(II) phosphate + Potassium acetate

$2\ K_3PO_4(aq) + 3\ Ni(C_2H_3O_2)_2(aq) \rightarrow Ni_3(PO_4)_2(s) + 6\ KC_2H_3O_2(aq)$
Metathesis/Exchange/Double displacement reaction
Precipitation Reaction

Hydrobromic acid(aq) + Lead(II) perchlorate(aq) → Lead(II) bromide + Perchloric acid

$2\ HBr(aq) + Pb(ClO_4)_2(aq) \rightarrow PbBr_2(s) + 2\ HClO_4(aq)$
Metathesis/Exchange/Double displacement reaction
Precipitation Reaction

Sulfuric acid(aq) + Ammonium hydroxide(aq) → Ammonium sulfate + Water

$H_2SO_4(aq) + 2\ NH_4OH(aq) \rightarrow (NH_4)_2SO_4(aq) + 2\ H_2O(l)$
Metathesis/Exchange/Double displacement reaction
Acid-base/Neutralization Reaction

Problems:

10. You have diluted 15.0mL of a 0.993M solution of barium nitrate with enough water to make 175.0mL of solution. What is the new concentration of *nitrate ions* in this solution? (10pts)

This is a dilution problem with an added bit, so we can start by using $C_1V_1=C_2V_2$ …
$(0.993M)(15.0mL) = C_2(175.0mL)$
C_2 = 0.0851M barium nitrate. We can think of barium nitrate in water with the following reaction:
$Ba(NO_3)_2(aq) \rightarrow Ba^{2+}(aq) + 2\ NO_3^-(aq)$
So for every "$Ba(NO_3)_2$" unit, there will be ***two*** nitrates in solution…

$$\left(\frac{0.0851\text{mols } Ba(NO_3)_2(aq)}{1\text{L solution}}\right)\left(\frac{2\text{mols } NO_3^-(aq)}{1\text{mol } Ba(NO_3)_2(aq)}\right) = 0.170M\ NO_3^-(aq)$$

11. You have dissolved 10.00g of lithium sulfate in enough water to make 150.00mL of solution. What is the concentration of the resulting solution? (10pts)

We have to start with the correct formula for lithium sulfate, Li_2SO_4, formula weight = $109.944\,g/mol$.

$$(10.00g)\left(\frac{1mol}{109.944g}\right)\left(\frac{1}{0.15000L}\right) = 0.6064M\ Li_2SO_4(aq)$$

Score

12. You have titrated 25.00mL of an unknown stock magnesium hydroxide solution to the second equivalence point with 42.96mL of 1.038M perchloric acid. What is the concentration of the stock magnesium hydroxide solution? (15pts)

$$2\ HClO_4(aq) + Mg(OH)_2(aq) \rightarrow Mg(ClO_4)_2(aq) + 2\ H_2O(l)$$

$$(0.04296L HClO_4(aq))\left(\frac{1.038mols HClO_4(aq)}{1L\ HClO_4(aq)}\right)\left(\frac{1mol Mg(OH)_2(aq)}{2mols HClO_4(aq)}\right)\left(\frac{1}{0.02500L Mg(OH)_2(aq)}\right) = 0.8918M Mg(OH)_2(aq)$$

13. You would like to produce 28.372g of solid palladium metal by the following reaction:

$$a\ Pd(NO_3)_2(aq) + b\ Fe(s) \rightarrow c\ Fe(NO_3)_3(aq) + d\ Pd(s)$$

How many milliliters of 1.283M palladium nitrate solution are required to produce 28.372g of Pd(s)? How many grams of Fe(s) are required to produce 28.372g of Pd(s)? (20pts)

$$3\ Pd(NO_3)_2(aq) + 2\ Fe(s) \rightarrow 2\ Fe(NO_3)_3(aq) + 3\ Pd(s)$$

$$(28.372g Pd(s))\left(\frac{1mol Pd}{106.42g Pd}\right)\left(\frac{3mol Pd(NO_3)_2(aq)}{3mols Pd(s)}\right)\left(\frac{1L\ Pd(NO_3)_2(aq)}{1.283mols Pd(NO_3)_2(aq)}\right)\left(\frac{1000mL}{1L}\right) = 207.8mL\ Pd(NO_3)_2(aq)$$

$$(28.372g Pd(s))\left(\frac{1mol Pd}{106.42g Pd}\right)\left(\frac{2mol Fe(s)}{3mols Pd(s)}\right)\left(\frac{55.847g Fe(s)}{1mol Fe(s)}\right) = 9.9260g\ Fe(s)$$

14. 75.0mL of 0.882M lead(II) acetate solution is combined with 75.0mL of 1.334M potassium carbonate solution. Write a correctly balanced equation and net ionic equation for the reaction that takes place. How many grams of precipitate can this reaction form? You recover 14.938g of precipitate. What is the percent yield? (25pts)

$$Pb(C_2H_3O_2)_2(aq) + K_2CO_3(aq) \rightarrow PbCO_3(s) + 2\ KC_2H_3O_2(aq)$$

$$Pb^{2+}(aq) + 2\ C_2H_3O_2^-(aq) + 2\ K^+(aq) + CO_3^{2-}(aq) \rightarrow PbCO_3(s) + 2\ K^+(aq) + 2\ C_2H_3O_2^-(aq)$$

$$Pb^{2+}(aq) + CO_3^{2-}(aq) \rightarrow PbCO_3(s)$$

$$(0.0750L Pb(C_2H_3O_2)_2(aq))\left(\frac{0.882mols Pb(C_2H_3O_2)_2}{1L\ Pb(C_2H_3O_2)_2(aq)}\right)\left(\frac{1mol PbCO_3}{1mol Pb(C_2H_3O_2)_2}\right)\left(\frac{267.2g PbCO_3(s)}{1mol PbCO_3}\right) = 17.7g PbCO_3(s)$$

$$(0.0750L K_2CO_3(aq))\left(\frac{1.334mols K_2CO_3}{1L\ K_2CO_3(aq)}\right)\left(\frac{1mol PbCO_3}{1mol K_2CO_3}\right)\left(\frac{267.2g PbCO_3(s)}{1mol PbCO_3}\right) = 26.7g\ PbCO_3(s)$$

Lead(II) acetate is the limiting reagent so the theoretical yield for this reaction is 17.7g $PbCO_3(s)$

(14.938g / 17.7g) x 100% = 84.4% yield

Score