Chem 150 – Exam 2a *Name:* _____
Fall 2011

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 = $1.000\ ^{g}/_{mL}$
$R = 0.08206\ ^{L \cdot atm}/_{mol \cdot K}$
PV=nRT
1 calorie = 4.184 J = 0.001Calorie

$h = 6.626 \times 10^{-34}$ Jsec
$\lambda = {}^{h}/_{mv}$
$1\ J = 1\ kg\ ({}^{m}/_{sec})^{2}$
$c = \lambda\nu = 3.00 \times 10^{8}\ {}^{m}/_{sec}$
$E_{photon} = h\nu$

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	71 **Lu** 174.97	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	103 **Lr** (260)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 **Ds** (269)	111 **Rg** (272)	112 **Cn** (277)	113	114	115	116	117	118

57 **La** 138.91	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
89 **Ac** 227.03	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)

Score

Multiple Choice: Circle the letter of the most correct response. (4pts. per question)

1. Consider the following reaction:

$$a\ K_3PO_3(aq) + b\ Co(NO_3)_3(aq) \rightarrow c\ CoPO_3(s) + d\ KNO_3(aq)$$

For every mol of $CoPO_3(s)$ that forms, how many mols of $K_3PO_3(aq)$ 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. Reduction is losing electrons
   c. Increasing positive charge is a reduction
   d. Loss of electrons is reduction
   e. Oxidizing agents are reduced in a reaction

4. In which of the following formulas does phosphorus (P) have the ***lowest*** oxidation number?
   a. $H_3P(g)$
   b. P(s)
   c. $PO_4^{3-}(aq)$
   d. $Na_3PO_3(s)$
   e. $PF_5(l)$

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:

$$Mn(NO_3)_2(aq) + Ni(s) \rightarrow Ni(NO_3)_2(aq) + Mn(s)$$

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

Score

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

Potassium sulfide (aq) + Cobalt(III) acetate(aq) → Cobalt(III) sulfide + Potassium acetate

{Cobalt atomic # = 27}

$3\ K_2S(aq) + 2\ Co(C_2H_3O_2)_3(aq) \rightarrow Co_2S_3(s) + 6\ KC_2H_3O_2(aq)$

Exchange/Precipitation reaction

$3\ S^{-2}(aq)\ 2\ Co^{+3}(aq) \rightarrow Co_2S_3(s)$

Titanium(IV) nitrate(aq) + Gallium(s) → Titanium(s) + Gallium(III) nitrate

{Titanium atomic # = 22; Gallium atomic # = 31}

$3\ Ti(NO_3)_4(aq) + 4\ Ga(s) \rightarrow 3\ Ti(s) + 4\ Ga(NO_3)_3(aq)$

Displacement/Redox reaction

$3\ Ti^{+4}(aq) + 4\ Ga(s) \rightarrow 3\ Ti(s) + 4\ Ga^{+3}(aq)$

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

$H_2SO_4(aq) + 2\ NH_4OH(aq) \rightarrow (NH_4)_2SO_4(aq) + 2\ H_2O(l)$

Exchange/Molecule-forming/Acid-base reaction

$2\ H^+(aq) + 2\ NH_4OH(aq) \rightarrow 2\ NH_4^+(aq) + 2\ H_2O(l)$

$H^+(aq) + NH_4OH(aq) \rightarrow NH_4^+(aq) + H_2O(l)$

Problems:

10. You have diluted 25.0mL of a 0.993M solution of copper(II) acetate with enough water to make 125.0mL of solution. What is the new concentration of *acetate ions* in this solution? (8pts)

We can use $C_1V_1=C_2V_2$ for this… $(0.993M)(25.00mL)=C_2(125.0mL)$
$C_2 = 0.1986M$ = molarity of $Cu(C_2H_3O_2)_2$
Since there are 2 moles of acetate ions for every mole of copper(II) acetate, the concentration of acetate is twice the concentration of copper(II) acetate, so…

Answer 10:

$[C_2H_3O_2^{-1}] = 0.397M$

11. You have dissolved 10.00g of calcium nitrate in enough water to make 150.00mL of solution. What is the concentration of the resulting solution? (8pts)

Calculating moles of $Ca(NO_3)_2$…
$(10.00g\ Ca(NO_3)_2) / (164.086g/mol) = 0.060944mols$
$(0.060944mols) / 0.15000L = 0.4063M$

Answer 11:

$[Ca(NO_3)_2] = 0.4063M$

12. You have titrated 25.00mL of an unknown stock potassium hydroxide solution to the equivalence point with 42.96mL of 1.183M nitric acid. What is the concentration of the stock potassium hydroxide solution? (15pts)

$KOH(aq) + HNO_3(aq) \rightarrow H_2O(l) + KNO_3(aq)$
Moles of acid = $(0.04296L)(1.183M) = 0.05082mols\ HNO_3$
$(0.05082mols\ HNO_3) (1mol\ KOH / 1mol\ HNO_3) = 0.05082mols\ KOH$
$(0.05082mols\ KOH) / 0.02500L = 2.033M\ KOH(aq)$

Answer 12:

$[KOH] = 2.033M$

13. How many grams of sodium carbonate solid are required to react with 35.88g of nitric acid? (12pts)

$2\ HNO_3(aq) + Na_2CO_3(s) \rightarrow 2\ NaNO_3(aq) + H_2O(l) + CO_2(g)$
$(35.88g\ HNO_3) / (63.012g/mol) = 0.56942mol\ HNO_3$
$(0.56942mols\ HNO_3) (1mol\ Na_2CO_3 / 2mol\ HNO_3) = 0.2847mol\ Na_2CO_3$
$(0.2847mol\ Na_2CO_3) (105.988g/mol) = 30.17g\ Na_2CO_3$

Answer 13:

$30.17g\ Na_2CO_3$

Score

14. You would like to prepare 25.00g of lead(II) bromide solid. How many grams of potassium bromide are required if you have unlimited lead(II) nitrate solution? (12pts)

$Pb(NO_3)_2(aq) + 2\ KBr(s) \rightarrow PbBr_2(s) + 2\ KNO_3(aq)$
(25.00g $PbBr_2$) / (367.008g/mol) = 0.06812mol $PbBr_2$ needed
(0.06812mol $PbBr_2$) (2mol KBr / 1mol $PbBr_2$) = 0.1362mol KBr
(0.1362mol KBr) (119.002g/mol) = 16.21g KBr

Answer 14:
16.21g KBr

15. You would like to produce 50.00L of hydrogen gas at 14.39°C and 1.852atm by the following reaction:

$$a\ Ru(s) + b\ HClO_4(aq) \rightarrow c\ H_2(g) + d\ Ru(ClO_4)_3(aq)$$

How many milliliters of 1.283M perchloric acid solution are required to produce 50.00L of $H_2(g)$? How many grams of Ru(s) are required to produce 50.00L of $H_2(g)$? (20pts)

$2\ Ru(s) + 6\ HClO_4(aq) \rightarrow 3\ H_2(g) + 2\ Ru(ClO_4)_3(aq)$
Get moles of $H_2(g)$ from the Ideal Gas Law, PV=nRT
$(1.852atm)(50.00L) = n(0.08206\ ^{L\cdot atm}/_{mol\cdot K})(287.54K)$
n = 3.92447mols $H_2(g)$ needed
(3.92447mols H_2) (6mols $HClO_4$ / 3mols H_2) / (1.283M) = 6.118L $HClO_4(aq)$
(3.92447mols H_2) (2mols Ru / 3mols H_2) ($101.07\ ^{g}/_{mol}$) = 264.4g Ru(s)

16. 75.0mL of 1.552M barium(II) acetate solution is combined with 75.0mL of 1.334M sodium phosphate 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? (20pts)

$3\ Ba(C_2H_3O_2)_2(aq) + 2\ Na_3PO_4(aq) \rightarrow Ba_3(PO_4)_2(s) + 6\ NaC_2H_3O_2(aq)$
If $Ba(C_2H_3O_2)_2(aq)$ is the limiting reagent:
(0.0750L $Ba(C_2H_3O_2)_{2(aq)}$) (1.552M $Ba(C_2H_3O_2)_2$) (1mols $Ba_3(PO_4)_2$ / 3mols $Ba(C_2H_3O_2)_2$) ($601.93\ ^{g}/_{mol}$ $Ba_3(PO_4)_2$) = 23.35g $Ba_3(PO_4)_2(s)$
If $Na_3PO_4(aq)$ is the limiting reagent:
(0.0750L Na_3PO_4 (aq)) (1.334M Na_3PO_4) (1mols $Ba_3(PO_4)_2$ / 2mols Na_3PO_4) ($601.93\ ^{g}/_{mol}$ $Ba_3(PO_4)_2$) = 30.11g $Ba_3(PO_4)_2$ (s)
Since $Ba(C_2H_3O_2)_2$ produces less product, it is the limiting reagent and the theoretical yield of the reaction is 23.35g

(14.938g/23.35g)*100% = 63.98% yield

Score