Name: ____

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
$32.00^oF = 0.000^oC = 273.15K$
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. (7pts. per question)

1. Which of the following combinations of aqueous solutions would you expect to form a precipitate?
   a. Hydrochloric acid + Lithium sulfite
   b. Sodium acetate + Nickel(II) nitrate
   c. Silver(I) nitrate + Potassium carbonate
   d. Ammonium phosphate + Potassium carbonate
   e. Sodium hydroxide + Nitric acid

2. Which of the following is ***not*** a redox reaction?
   a. $Mg(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
   b. $NH_4NO_3(aq) + NaC_2H_3O_2(aq) \rightarrow NH_4C_2H_3O_2(aq) + NaNO_3(aq)$
   c. $2\ CuNO_3(aq) + Sn(s) \rightarrow 2\ Cu(s) + Sn(NO_3)_2(aq)$
   d. $4\ Fe(s) + 3\ O_2(g) \rightarrow 2\ Fe_2O_3(s)$
   e. $2\ C_2H_2(g) + 5\ O_2(g) \rightarrow 4\ CO_2(g) + 2\ H_2O(g)$

3. Under which of the following conditions is a gas most "ideal"?
   a. High temperature, high pressure
   b. High volume, low pressure
   c. Low pressure, high temperature
   d. High pressure, high volume
   e. Room temperature, 25ºC

4. Consider the following reaction:
   $$a\ K_3PO_4(aq) + b\ Ca(NO_3)_2(aq) \rightarrow c\ Ca_3(PO_4)_2(s) + d\ KNO_3(aq)$$
   For every mol of $K_3PO_4(aq)$ that reacts, how many mols of $Ca_3(PO_4)_2(s)$ are formed?
   a. 0.25 mols
   b. 0.5 mols
   c. 1 mol
   d. 2 mols
   e. 3 mols

5. Consider the following reaction:
   $$Mn(NO_3)_3(aq) + CrSO_4(aq) \rightarrow MnSO_4(aq) + Cr(NO_3)_3(aq)$$
   What is being ***reduced*** in this reaction?
   a. $Mn(NO_3)_3(aq)$
   b. $CrSO_4(aq)$
   c. $MnSO_4(aq)$
   d. $Cr(NO_3)_3(aq)$
   e. This is not a redox reaction

6. Which of the following is a correct gas law relationship?
   a. $PT = nRV$
   b. $n_1T_1 = n_2T_2$
   c. $V_1n_1 = V_2n_2$
   d. $P_1T_1 = P_2T_2$
   e. $P_1 / V_1 = P_2 / V_2$

Score

7. In which of the following formulas does phosphorus have the ***highest*** oxidation number?
   a. Na_3PO_4
   b. PH_3
   c. H_3PO
   d. P_4
   e. KH_2PO_3

8. Which of the following would you expect to be ***insoluble*** in water?
   a. $FeSO_4$
   b. NaI
   c. $Pb(NO_3)_2$
   d. $NH_4C_2H_3O_2$
   e. $BaSO_4$

Multiple Choice Calculations (12pts each):

9. What is the pressure of 5.612mols of ideal gas at 13.64ºC in a 50.0L vessel?
   a. 7.94atm
   b. 6.28atm
   c. 2.64atm
   d. 0.159atm
   e. 0.126atm

10. A 3.98L steel tank contains an ideal gas at 26.81ºC and 3.94atm. What is the temperature of the tank if the pressure changes to 1.48atm?
    a. 909°C
    b. 525°C
    c. 71.4°C
    d. 10.1°C
    e. -160.°C

11. A reaction produces 762.8mL of ideal gas at 1.06atm pressure and 26.94°C. How many mols of gas did the reaction produce?
    a. 366 mols
    b. 32.8 mols
    c. 1.06 mols
    d. 0.366 mols
    e. 0.0328 mols

12. You have dissolved 15.00g of magnesium acetate in enough water to make 200.00mL of solution. What is the concentration of the resulting solution?
    a. 0.8998 M
    b. 0.5267 M
    c. 0.1800 M
    d. 0.1053 M
    e. 5.267×10^{-4} M

Score

Problems: (23pts each)

13. You would like to take some atmospheric measurements. You fill a weather balloon to a volume of 338.0L at 20.91°C and 0.959atm pressure. How many mols of gas are contained in the balloon? After you release the balloon, it rises to an altitude where the temperature is -11.67°C and the pressure is 0.567atm. A small hole in the balloon has allowed 14.30% of the original gas to escape. What is the volume of the balloon at this altitude?

The first part is an ideal gas law problem, PV = nRT. Let's organize our variables: P_1 = 0.959atm, V_1 = 338.0L, T_1 = 20.91 + 273.15 = 294.06K. Plugging in:

$$(0.959\text{atm})(338.0\text{L}) = n(0.08206\ ^{\text{L.atm}}/_{\text{mol.K}})(294.06\text{K})$$

$$n = 13.4\text{mols}$$

The second half of the problem has multiple conditions changing, so we should use the comparative form of the ideal gas law. Again, let's start by organizing our variables: P_1 = 0.959atm, V_1 = 338.0L, T_1 = 20.91 + 273.15 = 294.06K, n_1 = 13.4mols, P_2 = 0.567atm, T_2 = -11.67 + 273.15 = 261.48K, n_2 = (13.4mols)(0.857) = 11.5mols. Plugging in:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

$$\frac{(0.959atm)(338.0L)}{(13.4mols)(294.06K)} = \frac{(0.567atm)V_2}{(11.5mols)(261.48K)}$$

$$V_2 = 436\text{L}$$

14. 100.0mL of 1.299M iron(III) nitrate solution is combined with 100.0mL of 1.491M sodium carbonate solution.
    a. Write a correctly balanced net ionic equation for the reaction that takes place.
    b. How many grams of precipitate will this reaction form?
    c. You recover 9.614g of precipitate. What is the percent yield?

$$2\ Fe(NO_3)_3(aq) + 3\ Na_2CO_3(aq) \rightarrow Fe_2(CO_3)_3(s) + 6\ NaNO_3(aq)$$

$$2\ Fe^{3+}(aq) + 6\ NO_3^-(aq) + 6\ Na^+(aq) + 3\ CO_3^{2-}(aq) \rightarrow Fe_2(CO_3)_3(s) + 6\ Na^+(aq) + 6\ NO_3^-(aq)$$

$$2\ Fe^{3+}(aq) + 3\ CO_3^{2-}(aq) \rightarrow Fe_2(CO_3)_3(s)$$

The first equation is the "full molecular" equation, the second is the "full ionic" equation, the third is the net ionic. Now that we have a balanced equation, we can use the stoichiometry to determine the limiting reagent:

If Fe^{3+}(aq) is limiting:

$$(0.1000\text{L Fe(NO}_3)_3\text{(aq)})\left(\frac{1.299\text{mols Fe(NO}_3)_3\text{(aq)}}{1\text{L Fe(NO}_3)_3\text{(aq)}}\right)\left(\frac{1\text{mol Fe}_2\text{(CO}_3)_3\text{(s)}}{2\text{mol Fe(NO}_3)_3\text{(aq)}}\right)\left(\frac{291.718\text{g Fe}_2\text{(CO}_3)_3\text{(s)}}{1\text{mol Fe}_2\text{(CO}_3)_3\text{(s)}}\right) = 18.95\text{g Fe}_2\text{(CO}_3)_3\text{(s)}$$

If CO_3^{2-}(aq) is limiting:

$$(0.1000\text{L Na}_2\text{CO}_3\text{(aq)})\left(\frac{1.491\text{mols Na}_2\text{CO}_3\text{(aq)}}{1\text{L Na}_2\text{CO}_3\text{(aq)}}\right)\left(\frac{1\text{mol Fe}_2\text{(CO}_3)_3\text{(s)}}{3\text{mol Na}_2\text{CO}_3\text{(aq)}}\right)\left(\frac{291.718\text{g Fe}_2\text{(CO}_3)_3\text{(s)}}{1\text{mol Fe}_2\text{(CO}_3)_3\text{(s)}}\right) = 14.50\text{g Fe}_2\text{(CO}_3)_3\text{(s)}$$

Since the amount of carbonate we're using produces less product, it must be limiting, so the theoretical yield of precipitate for this mixture is 14.50g of $Fe_2(CO_3)_3$(s).

To calculate the percent yield,

$$(9.614\text{g} / 14.50\text{g})\text{x}100\% = 66.31\%\ \text{yield.}$$

Score