Chemistry 115 Name _____
Dr. Cary Willard
Exam 2B March 18, 2009

	Points Earned	Points Possible
Page 1 multiple choice		20
Page 2		24
Page 3		26
Page 4		24
Page 5		12
Total		106

Note: All work must be shown to receive credit. On calculation problems show answer with the correct number of significant figures using scientific notation if necessary.

Avogadro's number 6.022×10^{23}/mol

PERIODIC CHART

IA												IIIA	IVA	VA	VIA	VIIA	NOBLE GASES
1 **H** 1.008	IIA															1 **H** 1.008	2 **He** 4.002
3 **Li** 6.941	4 **Be** 9.012	Transition Metals»										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	ÉÍÍÍVIIIBÍÍÍÍ»				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** (268)	110 **??** (???)								

Lanthanide series	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
Actinide series	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 1 - Multiple Choice (20 points)

1. Each atom of a specific element has the same
   a. Atomic mass
   b. Mass number
   c. Number of neutrons
   d. Number of protons
   e. None of the above

2. What charge does an anion possess?
   a. Neutral
   b. Positive
   c. Negative
   d. Unable to determine

3. Which pair of symbols represents isotopes?
   a. $^{22}_{11}Na$ and $^{23}_{12}Na$
   b. $^{7}_{3}Li$ and $^{6}_{3}Li$
   c. $^{63}_{29}Cu$ and $^{29}_{64}Cu$
   d. $^{12}_{24}Mg$ and $^{12}_{26}Mg$
   e. all of the above

4. The mass of an atom is primarily determined by the mass of its
   a. Protons
   b. Neutrons
   c. Electrons
   d. Both neutrons and electrons
   e. Both protons and neutrons

5. An atom of atomic number 53 and mass number 127 contains how many neutrons
   a. 53
   b. 127
   c. 74
   d. 180

6. Which of the following contains the largest number of moles?
   a. 1.0 go Na
   b. 1.0 g Al
   c. 1.0 g Ag
   d. 1.0 g Li

7. The reaction
$BaCl_2 + (NH_4)_2CO_3 \rightarrow BaCO_3 + 2\ NH_4Cl$
   is an example of
   a. A single displacement reaction
   b. A double displacement reaction
   c. A combination reaction
   d. A decomposition reaction

8. The reaction
$2\ PbO_2 \rightarrow 2\ PbO + O_2$
   is an example of
   a. A double displacement reaction
   b. A single displacement reaction
   c. A combination reaction
   d. A decomposition reaction
   e. Unable to determine

Given the activity series Mg>Zn>Cu>Ag, predict the products of the following reactions.

9. $Mg + Cu(NO_3)_2 \rightarrow$
   a. $MgNO_3 + Cu$
   b. $Mg(NO_3)_2 + Cu$
   c. $MgCu + 2\ NO_3$
   d. No reaction
   e. Unable to determine based on information provided

10. $Ag + Zn(NO_3)_2 \rightarrow$
   a. $AgNO_3 + Zn$
   b. $Ag(NO_3)_2 + Zn$
   c. $Ag_2Zn + NO_3$
   d. No reaction
   e. Unable to determine based on information provided

Part 2 – Nomenclature (8 points) Fill in the following table with the correct IUPAC name or formula

IUPAC Name	Chemical Formula
Aluminum phosphite	$AlPO_3$
Chromium(II) bromide	$CrBr_2$
Ammonium chlorate	NH_4ClO_3
Sodium carbonate	Na_2CO_3
Calcium hypobromite	$Ca(BrO)_2$
Zinc iodide	ZnI_2
Barium hydroxide	$Ba(OH)_2$
Sulfur trioxide	SO_3

Part 3 – Problems (68 points)

1. (4 points) What particles in an atom contain practically all of its mass?

   The protons and neutrons comprise all of the mass of an atom. These particles may be found in the nucleus of the atom.

2. (4 points) How is it possible for there to be more than one kind of atom of the same element?

   In order to have more than one kind of atom of the same element you must have a particle with the same number of protons but different number of neutrons.

3. (4 points) Explain why the name for $MgCl_2$ is magnesium chloride but the name for $CuCl_2$ is copper(II) chloride.

   Magnesium has only one possible charge or oxidation state and therefore the charge of the atom magnesium ion does not need to be included in the name. Copper has 2 possible charges or oxidation states and therefore the charge on the ion must be specified in the name.

4. (4 points) What is meant by the physical state of a substance? What symbols are used to represent these physical states and what does each symbol mean?

   The physical state of the substance refers to whether the substance is a gas, liquid, or solid (or aqueous solution). The symbols for each of these states are:

   Solid (s)
   Liquid (l)
   Gas (g)

5. (6 points) Balance the equations below

a. $P_4 + Cl_2 \rightarrow PCl_3$

b. $H_2SO_4 + Al(OH)_3 \rightarrow H_2O + Al_2(SO_4)_3$

6. (20 points) Given a 6.24 g sample of the acetylsalicylic acid ($C_9H_8O_4$) or aspirin, calculate the following:

a. molar mass of aspirin

$$9(C) + 8(H) + 4(O)$$
$$= 9(12.01) + 8(1.008) + 4(16.00)$$
$$= 108.09 + 8.064 + 64.00 = \boxed{108.15\ g/mol}$$

b. moles of aspirin

$$?\ mol\ C_9H_8O_4 = 6.24\ g\ C_9H_8O_4 \times \frac{1\ mol\ C_9H_8O_4}{108.15\ g\ C_9H_8O_4} = \boxed{0.0577\ mol\ C_9H_8O_4}$$

c. moles of carbon atoms

$$?\ mol\ C = 0.0577\ mol\ C_9H_8O_4 \times \frac{9\ mol\ C}{1\ mol\ C_9H_8O_4} = \boxed{0.519\ mol\ C}$$

d. molecules of aspirin

$$?\ molec\ C_9H_8O_4 = 0.0577\ mol\ C_9H_8O_4 \times \frac{6.022 \times 10^{23} molec\ C_9H_8O_4}{1\ mol\ C_9H_8O_4}$$
$$= \boxed{3.47 \times 10^{22} molec\ C_9H_8O_4}$$

e. number of oxygen atoms

$$?\ O\ atoms = 3.47 \times 10^{22} molec\ C_9H_8O_4 \times \frac{4\ atom\ O}{1\ molec\ C_9H_8O_4}$$
$$= \boxed{1.39 \times 10^{23} atom\ O}$$

7. (24 points) Trinitrotoluene, $C_7H_5N_3O_6$, is an explosive otherwise known as TNT. The equation for its combustion is

$$4\ C_7H_5N_3O_6 + 33\ O_2 \longrightarrow 28\ CO_2 + 10\ H_2O + 6\ N_2$$

a. How many moles of oxygen are required to react with 6.20 mol $C_7H_5N_3O_6$?

$$?\ mol\ O_2 = 6.20\ mol\ C_7H_5N_3O_6 \times \frac{33\ mol\ O_2}{4\ mol\ C_7H_5N_3O_6} = \boxed{51.2\ mol\ O_2}$$

b. How many grams of carbon dioxide will be produced when 3.68 mol of $C_7H_5N_3O_6$ are burned?

$$?\ g\ CO_2 = 3.68\ mol\ C_7H_5N_3O_6 \times \frac{28\ mol\ CO_2}{4\ mol\ C_7H_5N_3O_6} \times \frac{44.01\ g\ CO_2}{1\ mol\ CO_2} = \boxed{1130\ g\ CO_2}$$

c. If 1020 grams of CO_2 are produced in part b, what is the percent yield of the reaction?

$$?\ \%\ yield = \left(\frac{actual\ yield}{theoretical\ yield}\right) \times 100\% = \left(\frac{1020\ g}{1130\ g}\right) \times 100\% = \boxed{90.3\%\ yield}$$

d. How many molecules of TNT will react with 99.0 molecules of oxygen gas?

$$?\ molec\ TNT = 99.0\ molec\ O_2 \times \frac{4\ molec\ TNT}{33\ molec\ O_2} = \boxed{12.0\ molec\ TNT}$$

e. How many molecules of water will be produced by the combustion of 2.00 g of TNT?

$$?\ molec\ H_2O$$
$$= 3.00\ g\ C_7H_5N_3O_6 \times \frac{1\ mol\ C_7H_5N_3O_6}{227.14\ g\ C_7H_5N_3O_6} \times \frac{6.022 \times 10^{23} molec\ C_7H_5N_3O_6}{1\ mol\ C_7H_5N_3O_6}$$
$$\times \frac{10\ molec\ H_2O}{4\ molec\ C_7H_5N_3O_6} = \boxed{1.33 \times 10^{22} molec\ H_2O}$$

f. How many moles of CO_2 will be produced by the reaction of 8.00 moles of TNT with 92.0 moles of oxygen gas?

$$?\ mol\ CO_2 = 8.00\ mol\ C_7H_5N_3O_6 \times \frac{28\ mol\ CO_2}{4\ mol\ C_7H_5N_3O_6} = \boxed{56.0\ mol\ CO_2}$$

$$?\ mol\ CO_2 = 92.0\ mol\ O_2 \times \frac{28\ mol\ CO_2}{33\ mol\ O_2} = 78.1\ mol\ CO_2$$

8. (7 points) Calculate the empirical formula of nicotine which is composed of 74.09% C, 8.65% H, and 17.35% N.

$$74.09\ g\ C \times \frac{1\ mol\ C}{12.01\ g\ C} = 6.169\ mol\ C$$
$$8.65\ g\ H \times \frac{1\ mol\ H}{1.008\ g\ H} = 8.58\ mol\ H$$
$$17.35\ g\ N \times \frac{1\ mol\ N}{14.01\ g\ N} = 1.238\ mol\ N$$

$$C_{\frac{6.169}{1.238}} H_{\frac{8.58}{1.238}} N_{\frac{1.238}{1.238}} = C_4H_7N_1 \ \ or \ \boxed{C_4H_7N}$$

9. (5 points) A compound with empirical formula C_2H_4O has a molar mass of 220 g/mol. Determine the molecular formula for the compound.

$$C_2H_4O \ \rightarrow 2(12) + 4(1) + 16 = 44$$

$$\frac{220\ amu}{44\ amu} = 5 \ \ need\ 5\ units\ or\ C_{10}H_{20}O_5$$