Exam 1
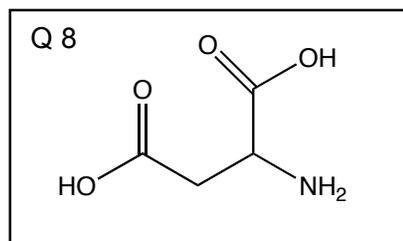**Chemistry 118**
January 14, 2009

Part I- Multiple Choice (2 points each). Please choose the **single** best answer.

1. The modern model of the atom puts electrons in
 a) linear paths called line spectra   b) spherical paths called orbits
 c) volumes of space called orbitals   d) the nucleus

2. You heat 10.0 grams of calcium carbonate in an open test tube. The heat causes the calcium carbonate to decompose into calcium oxide and carbon dioxide. When you weigh the test tube after heating, you find the mass of the contents is 5.61 grams. What is the best explanation for these observations?
 a) The products weigh less than the reactants.
 b) 4.39 grams of carbon dioxide gas are lost from the tube.
 c) You must have made an error during weighing.
 d) Atoms were destroyed during heating.

3. Which of the following is *false* about electromagnetic radiation?
 a) The sun is a significant source of electromagnetic radiation on Earth.
 b) The human eye responds only to visible light and no other types of electromagnetic radiation.
 c) Ultraviolet light is fairly low energy whereas microwaves are quite high energy.
 d) Different types of electromagnetic radiation differ in their wavelengths.

4. All of the following sets of elements would exhibit similar chemical properties *except*
 a) Sc, Y, La   b) Ga, B, Al   c) Ni, Pd, Pt   d) As, Se, Br

5. Which observation below conflicts with Dalton's proposal that atoms are indivisible?
 a) Burning a log results in a small pile of ashes.
 b) Water can be split into hydrogen and oxygen.
 c) Atoms are composed of protons, neutrons, and electrons.
 d) Food is broken down to release energy during metabolism.

6. All of the following might form +2 ions *except*
 a) Ca   b) H   c) Cu   d) Fe

7. For the reaction $A + 2 B_2 \rightarrow AB_4$, which of the following is *false*?
 a) A is a reactant   b) B is a reactant
 c) AB_4 is a product   d) The stoichiometric ratio of A to AB_4 is 1:1

8. What is the formula of the adjacent compound?
 a) H_4NO_4
 b) $C_4H_7NO_4$
 c) $C_4H_{10}NO_4$
 d) It is impossible to determine.

9. With respect to chemical reactivity of an element, which is the most important?
   a) the number of protons
   b) the number of neutrons
   c) the number of valence electrons
   d) the number of isotopes

10. A Lewis dot structure for this atom has six electrons around the atom. What is this atom?
   a) carbon   b) neon   c) sulfur   d) nitrogen

11. Which of the following would have the greatest attraction for a shared pair of electrons?
   a) C   b) Fr   c) O   d) H

12. Give (in order) the correct coefficients to balance the following reaction:
$$H_2SnCl_6 + H_2S \rightarrow SnS_2 + HCl$$
   a) 1, 2, 1, 6   b) 1, 2, 2, 2   c) 1, 1, 1, 6   d) 2, 4, 2, 6

13. What is the molar mass of vitamin C ($C_6H_8O_6$)?
   a) 29.02 g/mol   b) 86.06 g/mol   c) 96.06 g/mol   d) 176.1 g/mol

14. In the reaction, $Al \rightarrow Al^{3+}$, what has happened to the aluminum?
   a) it has been oxidized
   b) it has been reduced
   c) it has lost 3 amu
   d) it has gained three protons

15. Which of the following has the greatest number of particles?
   a) 12 grams of C-12
   b) 6.02×10^{23} atoms of C-12
   c) 5 moles of H_2
   d) 1 mole of Pt

Part II- Short Answer.

1. (13 pts) Fill in all missing information in the following table.

Symbol	H-1	H-3	Fe-56	Br-81
# protons	1	1	26	35
#neutrons	0	2	30	46
#electrons	1	1	26	35
mass number	1	3	56	81

2. (3 pts) Which two atoms in Question 1 represent a pair of isotopes?
H-1 and H-3 are isotopes.

3. (9 pts) Predict the chemical formulas for the compounds formed from the following pairs of elements.
   a) Na and O
   Na_2O
   b) Ca and Cl
   $CaCl_2$
   c) S and H
   SH_2

4. (8 pts) Identify all <u>chemical</u> and <u>physical</u> changes that occur in the following scenario.

While on your COOT at Mt. Katahdin, you build a small fire out of dry tree branches. The wood crackles and burns brightly. You get out your Jiffy-Pop and enjoy fresh popcorn in no time. Before going to sleep, you put out the fire by dousing it with cold water. Steam rises when the water hits the hot coals. You find your sleeping bag by snapping a glow stick to light up the way to your tent.

Chemical changes: burning wood, glow stick

Physical changes: popcorn popping, formation of steam

5. (22 pts) **a)** For each of the following, circle the correct type of compound. Electronegativity values are as follows: Cs = 0.7; Cl = 3.0; Si = 1.8; H = 2.1; N= 3.0; I= 2.4.

CsCl	ionic	polar covalent	nonpolar covalent
SiH$_4$	ionic	polar covalent	nonpolar covalent
NI$_3$	ionic	polar covalent	nonpolar covalent

b) Draw the Lewis dot structures for each of the compounds in part a).

CsCl	SiH$_4$	NI$_3$
Cs$^+$:Cl:$^-$	H:Si:H with H above and below	:I:N:I: with :I: below
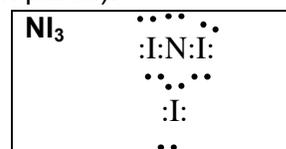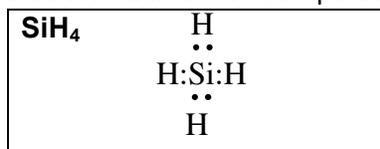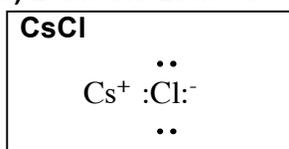
c) For any of the polar covalent bonds in part a, draw a dipole arrow above the atoms in your structures to show the direction of the electron density. Points from I to N in NI$_3$.

6. (18 pts) You are having a chemical party. From the guest list below, fill in each blank line with the element or compound that best fits each description.

Guest list: Argon (Ar), Fluorine (F), Francium (Fr), Nitrogen (N), Nitroglycerine (C$_3$H$_5$N$_3$O$_9$), Water (H$_2$O)

Good partner for the hydrogen triplets	N	
Least likely to interact with other guests	Ar	
"Explosive" personality!	Nitroglycerine	
Likely to react explosively when meeting a member of the IA family (two answers)	F	H$_2$O
These two guests form an ionic bond with each other	F/N	Fr
These two guests form a covalent bond with each other	F	N

7. (13 pts) **a)** Fill in the electronic configurations for *nitrogen* in the *ground state* and an *excited state*:

ground state for N   excited state for N

b) How many valence electrons does nitrogen have in the ground state? 5

c) Two different atoms, A and B, have the relative energy gaps between the ground state and an excited state shown here:

Given that one of the atoms absorbs blue light and the other absorbs orange light, circle the correct answer:

Atom A absorbs?   blue light   or   orange light

d) How does the Bohr theory of the atom explain the multiple lines in the line spectrum of hydrogen given that the hydrogen atom contains only one electron?

More than one possible excited state (lots of empty orbitals).

8. (6 pts) Circle any of the following that involves oxidation-reduction.

batteries   flame tests   rusting of iron

metabolism of food   Locard's exchange principle   photography

| Exam total (out of 146)____ |
| Exam %   ____ |

Part III- Problems (8 points each). <u>You must show your work for full credit</u>.

1. The most common isotopes of nitrogen are N-14 and N-15.
   a) Using the periodic table, decide which one is more abundant.

<div align="center">

Circle one: <mark>N-14</mark>   **N-15**

</div>

   b) Assuming that only N-14 and N-15 exist in nature, calculate the expected percentages of each in a sample of nitrogen.
   x + y = 1, so x = 1-y
   14 x + 15 y = 14.01, so 14 (1 – y) + 15y = 14.01
   14 + y = 14.01
   y = 0.01, x = 0.99
   99% N-14, 1% N-15

2. When iron (Fe) rusts, it reacts with oxygen (O_2) to form Fe_2O_3.
   a) Write a balanced equation for this reaction.

   $4\ Fe + 3\ O_2 \rightarrow 2\ Fe_3O_3$

   b) How many grams of oxygen are required to react completely with 125 grams of iron?

   125 g Fe x $\dfrac{1\ mol\ Fe}{55.85\ g}$ x $\dfrac{3\ mol\ O_2}{4\ mol\ Fe}$ x $\dfrac{32\ g\ O_2}{1\ mol\ O_2}$ **= 53.7 g O_2**

3. In the movie *Die Hard: With a Vengeance*, Bruce Willis tries to thwart a gold heist from the Federal Reserve. In this problem, you will calculate the weight of a bar of gold to see how easy it would be for a bad guy to walk off with one.

   a) The Federal Reserve gold bars on the right have the dimensions: 7.0 inches x 3.625 inches x 1.75 inches. If 1 inch= 2.54 cm, what is the volume of a gold bar in cm^3?

   {7 in x 2.54 cm/in} x {3.625 in x 2.54 cm/in} x {1.75 in x 2.54 cm/in} **= 728 cm^3**

   b) Calculate the mass of the gold bar in grams, given that the density of gold is 19.3 g/cm^3. (If you cannot calculate the volume, then use 999 cm^3 in this calculation.)

   728 cm^3 x 19.3 g/cm^3 **= 14,049 g**

   c) Calculate the weight of the gold bar in pounds (1 pound= 454 g). <u>Report your answer with the correct number of significant figures.</u> **(For partial credit: how many sig figs?)**

   14,049 g x 1 lb/454 g **= 31 lbs**