Name: _____

Chemistry 150 Exam 1

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

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. (5pts. per question)

1. Which of the following sets of elements contains a metal, a metalloid and a nonmetal?
   a. Na, Mg, Al
   b. N, O, F
   c. Cu, Ni, Fe
   d. Ar, Si, Ag
   e. H, He, Cl

2. Which of the following organic molecules has the most carbon atoms?
   a. Methanol
   b. Pentyne
   c. Butane
   d. Ethyl amine
   e. Propene

3. Which of the following formulas is ***most ionic***?
   a. PbO
   b. RbBr
   c. Fe_2S_3
   d. SF_6
   e. ZnSe

   In general, the farther apart 2 elements are on the Periodic Table, the more ionic their interaction will be.

4. Different isotopes of an element:
   a. Have the same number of protons
   b. Have the same mass number
   c. Have the same number of neutrons
   d. Have the same charge
   e. Have the same number of electrons

   If we are very strictly talking about *atoms* of an element, then they would also have the same number of electrons and the same charge (zero), but the definition of isotope doesn't restrict us to only atoms. $^{55}Fe^{2+}$ and $^{56}Fe^{3+}$ are different isotopes of iron, they're also different ions.

5. Which of the following represents the ***largest mass***?
   a. $1.4x10^{-3}$ kg
   b. $8.82x10^{-8}$ mg
   c. 29.2 kg
   d. $3.6x10^{8}$ mg
   e. 785 g

6. Which of the following polyatomic ions has the ***fewest oxygen atoms***?
   a. sulfate
   b. hypochlorite
   c. cyanide
   d. phosphate
   e. nitrite

   Some people thought I was trying to make this a "trick" question, but I wasn't. Cyanide ions (CN^-) have ***no*** oxygen atoms, the rest all have at least one oxygen.

Score

7. Complete the following table (3pts per box):

Symbol	***Number of Protons***	***Number of Neutrons***	***Number of Electrons***	***Atomic Number***	***Mass Number***	***Charge***
Sc	21	24	19	***21***	***45***	***+2***
In	***49***	***63***	49	***49***	112	***0***
N	***7***	***7***	***10***	7	14	-3
Mg	***12***	13	10	***12***	***25***	***+2***

Multiple Choice Calculations (9pts each):

8. What is the formula weight of magnesium carbonate?
   a. 36.316 $^{g}/_{mol}$
   b. 84.313 $^{g}/_{mol}$
   c. 100.312 $^{g}/_{mol}$
   d. 108.618 $^{g}/_{mol}$
   e. 144.321 $^{g}/_{mol}$

Mg is in the second column of the P.T., so we expect +2 charge
Carbonate is CO_3^{2-}
The balanced formula of magnesium carbonate is $MgCO_3$.
Formula weight = 24.305 + 12.011 + 3(15.999) = 84.313 $^{g}/_{mol}$

9. How many titanium atoms are present in a 8.313g sample of titanium (Atomic # = 22)?
   a. 0.1736 atoms
   b. 398.0 atoms
   c. 1.046×10^{23} atoms
   d. 2.275×10^{23} atoms
   e. 5.006×10^{24} atoms

The atomic mass of Ti is 47.88 $^{g}/_{mol}$ (from the P.T.)
(8.313g Ti) / (47.88 $^{g\ Ti}/_{mol\ Ti}$) = 0.1736mols Ti
(0.1736mols Ti) (6.022×10^{23} $^{Ti\ atoms}/_{mol\ Ti}$) = 1.046×10^{23} Ti atoms

10. 4.842mols of silicon (Atomic # 14) has a mass of how many grams?
    a. 0.1724 g
    b. 4.842 g
    c. 67.79 g
    d. 136.0 g
    e. 2.916×10^{24} g

The atomic mass of Si is 28.086 $^{g}/_{mol}$ (from the P.T.)
(4.842mols Si) (28.086 $^{g\ Si}/_{mol\ Si}$) = 135.9924g Si
Rounding to a reasonable number of sig figs, 136.0g Si

11. What is the mass of a sample of copper (Atomic # = 29) that contains 1.31×10^{24} Cu atoms?
    a. 2.18 g
    b. 29.2 g
    c. 63.1 g
    d. 138 g
    e. 163 g

The atomic mass of Cu is 63.546 $^{g}/_{mol}$ (from the P.T.)
(1.31×10^{24} Cu atoms) / (6.022×10^{23} $^{Cu\ atoms}/_{mol\ Cu}$) = 2.175mols Cu
(2.175mols Cu) (63.546 $^{g\ Cu}/_{mol\ Cu}$) = 138g Cu

Score

12. A block of wood has a mass of 3.991 pounds. What is its mass in milligrams?
    a. 8.799×10^{-6} mg
    b. 1.810 mg
    c. 8.799 mg
    d. 113.7 mg
    e. 1.810×10^{6} mg

Conversion factors are on the first page of the exam...
(3.991pounds) (453.6 $^{g}/_{pound}$) (1000 $^{mg}/_{g}$) = 1810000mg

Problems:

13. The newly discovered element Dragonium (Dg) has two stable isotopes. ^{318}Dg has a mass of 318.813amu and ^{315}Dg has a mass of 315.864amu. If the average atomic mass of Dg is 317.061amu, what is the percent abundance of the heavier isotope? (13pts)

This is a weighted average problem.
(Average mass of Dg) = (fraction ^{318}Dg)(mass ^{318}Dg) + (fraction ^{315}Dg)(mass ^{315}Dg)
Since we're looking for the percent of the heavier element, let's call (fraction ^{318}Dg) "x"
317.061amu = (x)(318.813amu) + (1-x)(315.864amu)
After some algebra, x = 0.405900, so the % ^{318}Dg = 40.5900%
The average is slightly closer to the mass of the lighter isotope, so this answer is reasonable.

14. A number of biologically important structures and processes rely on the formation of disulfide bonds. You have isolated a natural product that has a disulfide bond and has been analyzed to have the following composition: %C = 35.81, %H = 6.01, %O = 23.85, %N = 10.44, %S = 23.90. What is the *empirical* formula of this substance? Disulfide bonds always contain 2 sulfur atoms. What is the molecular formula and molecular weight of this substance? (14pts)

Assume 100g of sample:
35.81g C / 12.011 $^{g}/_{mol}$ = 2.98mols C → 2.98mols C / 0.745mols S = 4 $^{mol\ C}/_{mol\ S}$
6.01g H / 1.0079 $^{g}/_{mol}$ = 5.96mols H → 5.96mols H / 0.745mols S = 8 $^{mol\ H}/_{mol\ S}$
23.85g O / 15.999 $^{g}/_{mol}$ = 1.49mols O → 1.49mols O / 0.745mols S = 2 $^{mol\ O}/_{mol\ S}$
10.44g N / 14.007 $^{g}/_{mol}$ = 0.745mols N → 0.745mols N / 0.745mols S = 1 $^{mol\ N}/_{mol\ S}$
23.90g S / 32.066 $^{g}/_{mol}$ = 0.745mols S → 0.745mols S / 0.745mols S = 1

The empirical formula is: $C_4H_8O_2N_1S_1$

Since the problem tells us that disulfide bonds always contain 2 sulfurs, we know that the empirical formula has to be doubled to give us a molecular formula with two sulfur atoms.

The molecular formula is: $C_8H_{16}O_4N_2S_2$

Molecular weight = 8(12.011 $^{g}/_{mol}$) + 16(1.0079 $^{g}/_{mol}$) + 4(15.999 $^{g}/_{mol}$) + 2(14.007 $^{g}/_{mol}$) + 2(32.006 $^{g}/_{mol}$)
= 269.494 $^{g}/_{mol}$
{Since the molecular formula is 2x the empirical formula, the molecular weight is 2x the empirical formula mass.}

Score