*Chem 150 – Exam 1b* *Name:* _____

*Fall 2010*

# 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 = $6.022 \times 10^{23}$ 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 gallon = 3.785L
1 amu = $1.6605 \times 10^{-24}$ g
Masses of subatomic particles:

| | | |
|---|---|---|
| Proton | 1.00728amu = | $1.6726 \times 10^{-24}$ g |
| Neutron | 1.00866amu = | $1.6749 \times 10^{-24}$ g |
| Electron | 0.000549amu = | $9.1094 \times 10^{-28}$ 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. Cu, Te, N***
   b. Na, Sr, Co
   c. F, Ar, Ti
   d. Mg, Ru, Pb
   e. P, I, Ne

2. Which of the following organic molecules has the ***most carbon atoms***?
   ***a. Hexene***
   b. Butanol
   c. Ethane
   d. Methyl amine
   e. Propyne

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

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

5. Which of the following represents the ***smallest mass***?
   a. $1.62x10^{8}$ µg
   b. 7.25g
   c. $9.37x10^{-9}$ kg
   d. 0.112mg
   ***e. $4.38x10^{-7}$ g***

6. Which of the following polyatomic ions has the ***fewest oxygen atoms***?
   a. hydroxide
   ***b. cyanide***
   c. perchlorate
   d. phosphite
   e. nitrite



*Score*

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

| ***Symbol*** | ***Number of Protons*** | ***Number of Neutrons*** | ***Number of Electrons*** | ***Atomic Number*** | ***Mass Number*** | ***Charge*** |
|---|---|---|---|---|---|---|
| ***P*** | ***15*** | ***18*** | ***15*** | 15 | 33 | 0 |
| Fe | ***26*** | ***31*** | 23 | ***26*** | 57 | ***+3*** |
| ***Se*** | 34 | 46 | 36 | ***34*** | ***80*** | ***-2*** |
| Cu | ***29*** | 37 | 29 | ***29*** | ***66*** | ***0*** |

**Multiple Choice Calculations** (9pts each):

8. What is the formula weight of rubidium carbonate? (Atomic # of rubidium = 37)
   a. 316.412 $^{g}/_{mol}$
   b. 246.943 $^{g}/_{mol}$
   ***c. 230.944 $^{g}/_{mol}$***
   d. 145.476 $^{g}/_{mol}$
   e. 97.479 $^{g}/_{mol}$

9. How many vanadium atoms are present in a 17.681g sample of vanadium (Atomic # = 23)?
   a. $6.022x10^{23}$ atoms
   b. $4.629x10^{23}$ atoms
   ***c. $2.090x10^{23}$ atoms***
   d. 406.7 atoms
   e. 0.3471 atoms

10. 3.116mols of phosphorus (Atomic # = 15) has a mass of how many grams?
   ***a. 96.51 g***
   b. 46.74 g
   c. 30.974 g
   d. 9.940 g
   e. 0.1006 g

11. What is the mass of a sample of zirconium (Atomic # = 40) that contains $1.31x10^{24}$ Zr atoms?
   a. $7.20x10^{49}$ g
   b. $8.65x10^{45}$ g
   ***c. 198 g***
   d. 87.0 g
   e. 2.18 g



*Score*

12. The flow of the Red River yesterday was approximately $2.434 \times 10^4$ gallons every second. What is this volume in milliliters?
    ***a. $9.213 \times 10^7$ mL***
    b. $2.434 \times 10^7$ mL
    c. $6.431 \times 10^6$ mL
    d. 92.13mL
    e. 6.431mL

**Problems:**

13. The element Ubiquium (Ub) is found in all interstellar space and has two stable isotopes. $^{382}$Ub has a mass of 382.993amu and 18.374% abundant. If the average atomic mass of Ub is 385.114amu, what is the mass of the other isotope? (13pts)

(fraction $^{382}$Ub)(mass $^{382}$Ub) + (fraction $^{??}$Ub)(mass $^{??}$Ub) = average atomic mass of Ob
(0.18374)(382.993amu) + (1-0.18374)(X amu) = 385.114amu
(0.18374)(382.993amu) + (0.81626)(X amu) = 385.114amu
x = 385.59amu

As a self-check, since the average atomic mass is higher than the mass of $^{382}$Ub, the other isotope must be the heavier one, so the answer *should* be larger than 385.114amu.
Another self-check, since $^{382}$Ub is only 18% abundant, the mass of the other isotope should be quite a bit closer to the average. 385.59 is closer to 385.114 than 382.993, so this is also consistent.

14. You are working in a facility that produces a new energy drink and have found a barrel of one of the ingredients, but the label has fallen off. From inventory records, you know that it is either aspartame which has a molecular weight near $300\,^{g}/_{mol}$ or niacin which has a molecular weight of about $125\,^{g}/_{mol}$. You send a sample for analysis and receive the following results: %C = 57.14, %H = 6.16, %N = 9.52, %O = 27.18. What is the *empirical* formula of this substance? What is the molecular weight of this empirical formula? Does the barrel contain aspartame or niacin? Explain. (14pts)

What are the chemical formulas of aspartame and niacin? It doesn't matter! Assume 100g of sample, convert to moles, divide to get mole ratio of the empirical formula.

| | | |
|---|---|---|
| C: | 57.14g / $12.011\,^{g}/_{mol}$ = 4.76mols C | 4.76mols C / 0.680mols N = $7\,^{C}/_{N}$ |
| H: | 6.16g / $1.0079\,^{g}/_{mol}$ = 6.11mols H | 6.11mols H / 0.680mols N = $9\,^{H}/_{N}$ |
| N: | 9.52g / $14.007\,^{g}/_{mol}$ = 0.680mols N | 0.680mols N / 0.680mols N = $1\,^{N}/_{N}$ |
| O: | 27.18g / $15.999\,^{g}/_{mol}$ = 1.70mols O | 1.70mols O / 0.680mols N = $2.5\,^{O}/_{N}$ |

Since the oxygen ratio is a half-integer, we should double all the ratios to give all whole numbers.
So the empirical formula is: $C_{14}H_{18}N_2O_5$
The molecular weight of the empirical formula is:
$14(12.011\,^{g}/_{mol}) + 18(1.0079\,^{g}/_{mol}) + 2(14.007\,^{g}/_{mol}) + 5(15.999\,^{g}/_{mol}) = 294.305\,^{g}/_{mol}$
The *molecular* formula of a substance has to be a whole number multiple of the empirical formula, so for the substance that was tested, the molecular weight must be a whole number multiple of 294.305. Since niacin's molecular weight is much smaller than the empirically found molecular weight, the substance in the barrel cannot be niacin. 294 is near 300, so aspartame is reasonable.
I hope they do more tests before they dump this "mystery ingredient" in something *I'm* going to drink…



Score