Chem 101 Test #1 review questions. Please don't look at the answers BEFORE

SAMPLE MIDTERM#1:

_____ 1) Determine the formula weight for an ionic compound made up of the following isotopes: $^{96}_{42}Mo$ and $^{129}_{52}Te$. The Mo ion has 37 electrons and the Te ion has 55 electrons. (use the A as the approx atomic mass)

OK, charge of Mo must be: 42-37 = +5 Mo^{5+} & that of Te is 52-55= -3. so Te^{3-}. The ionic formula must be: Mo_3T_5. So MW = 3(96)+5(129) = 933 g/mole

2) Name the following compounds or give the chemical formula:

a) P_4O_{10} = tetraphosphorus decoxide

b) HClO (in water) = hypochlorous acid

c) C_4H_{10} (alkane) = butane

d) Potassium dichromate = $K_2Cr_2O_7$

e) Aluminum carbonate = $Al_2(CO_3)_3$

3) In Paris, today's high was recorded to be 18°C. If the freezing point of a certain substance is 69°F, what is the state of the substance if it is in Paris?

Convert one of the temperatures to be the same unit as the other: °C=(69-32)(5/9)= 20.6°C

Since the temperature in Paris is 18°C, it must be less than the freezing point. The state of the substance must be that of a solid. (if it were higher than the freezing point, it would have been a liquid, right??).

4) Yellow orpiment (YO) is a mineral which contains sulfur and another element: X_2S_3, where X is the unknown element which you are to identify from the following information. If 1.52 millimoles (mmol) of yellow orpiment weighs 373.98 milligrams (mg), what is the element X?

To be able to determine the X, we need either its atomic number or its atomic mass. We can get its atomic by first determining the mass of S and subtracting that from the total:

#g S = 1.52 x10^{-3} moles X_2S_3 x (3 mol S/mol X_2S_3) x (32.006g S/mol S)= 0.14595 g S.

So X = mass of stribnite – mass of S = .37398 -0.14595 = 0.22803 g X

To get molar mass of X first, get moles X:

moles of X = (1.52 x10^{-3} moles X_2S_3)(2 mol/1 mol X_2S_3) = 0.00304 moles X

Therefore: molar mass = mass of X/moles of X = 0. 22803 g X /0.00304 moles X = 75.0101g/mol

Check the periodic table to find the closest element to be As (arsenic).

5) A) Name 4 postulates of Dalton's Theory. What conservation laws did they imply?

(see notes on this one)

B) What was the difference between Rutherford's Model of the Atom and that of Thomson's? Describe the experiment that supported Rutherford's hypothesis?

(discussion is according to our notes)

6) C A) (multiple choice) Choose the most correct phrase to complete the sentence: The element radium, $^{226}_{88}Ra^{+}$, has...

a) 226 neutrons and 88 protons. b) 226 neutrons and 89 protons

c) 138 neutrons and 87 electrons d) an atomic number of 226 e) none of the above

B) A metal cube of volume 1.55± .05 cm is found to weigh 21.0 ± .5 g.

a) What is the density of the metal in kg/m^3? (correct significant figures only) density = 14.0 kg/m^3

b) What is the relative uncertainty? ± .06 (dimensionless)

$\rho = 21.0/1.55 = 14.0\ kg/m^3$

relative uncertainty: $(\Delta\rho/\rho) = (\Delta V/V) + (\Delta m/m) = (.05/1.55)+(.5/21.0) = .06$ (no units)

Additional Problems

1) A 156.0 mg sample of a pure but unknown alcohol is analyzed by complete combustion. The carbon dioxide and water formed were collected and were found to have the following masses: 223.5 mg CO_2 and 120.7 mg H_2O. It is known that alcohols have the following general formula: $C_xH_yO_z$ where of course, the subscripts x, y and z are unknowns in this problem. 40 pts total]

a) How many moles of carbon and how many mgs of carbon are there in the 156.0 mg sample?

mol C=223.5mg CO_2 x (1 mol/44.0g)(1molC/1mol CO2)=5.080 mmol C= $5.080x10^{-3}$ mol

mg C = 5.080 mmol Cx (12.0g/mol)= 60.95 mg

b) How many moles of hydrogen and how many mgs of hydrogen are there in the 156.0 mg sample?

mol H=120.7mg CO_2 x (1 mol/18.0g)(2molH/1mol H_2O)=13.41 mmol C= $13.41\ x10^{-3}$ mol

c) What is the empirical formula of this alcohol? CH_2O

We need to know also the millimoles of O: mg O = total – (mmol C+mmol H)= 156.0-(60.95+13.41)=81.64mg O

mmol O = 81.64 mgx (1molO/16.0g)= 5.125 mmol O

So, our formula becomes: $C_{5.080}H_{13.41}O_{5.125}$. Or, dividing by the smallest number, it becomes CH_2O.

2) One mole of copper metal can react completely with four moles of nitric acid to form a blue solution containing the products: one mole of copper(II) nitrate, two moles of a brown gas known to be nitrogen dioxide and two moles of liquid water. If 0.15 cm^3 of copper metal are reacted with grams of nitric acid, how many liters of the brown gas do you expect to produce if you have 80% actual yield? [40 pts total] (Note the following densities: Cu = 8.95 g/cm^3; NO_2 gas = 2.05 g/L)

(OK, skip this since this is more for the next chapter)

3) A cube of metal which looks like gold (Au, 19.32 g/cm^3) is suspected by a modern Archimedes of being either iron (Fe, 7.90 g/cm^3) coated with gold or aluminum (Al, 2.72 g/cm^3) coated with gold. In air the metal cube is found to have a mass of 34.50 g. When totally immersed in a solvent of ethanol (density = 0.789 g/mL), the apparent mass of the metal cube is 24.49 g. (Recall Archimedes principle) All answers must be in correct # of significant figures.

a) What is the length of the metal cube (in cm) ? length = 2.33 cm

First, get the volume. Since the actual mass – apparent mass = mass of the liquid displaced, we can calculate the volume thus: (34.50g – 24.49 g) x (1 mL/.789 g) = 12.69 mL = 12.69 cm^3. Since it is a cube, $V = a^3$ where a= length of one side: $a = \sqrt[3]{(12.69\ cm^3)} = 2.33$ cm.

b) What is the metal cube made up of? (Show full calculations for credit.) _____

Ok, now we can solve for solid density: $\rho = m/v = 34.50\ g/12.69 cm^3 = 2.719\ g/\ cm^3$ or aluminum (Al, 2.72 g/cm^3)!

4) Consider the following *hypothetical* atoms: $^{139}_{57}X$ has 54 electrons, while atom $^{209}_{84}Y$ has 87 electrons. What is the approximate formula weight of the ionic compound made up of these atoms? _____

Well, the charge of X must be +3 and the charge of Y must be –3 so that the formula would be XY. Using the atomic mass numbers as a close approximation of the mass, we have: 139+209 = 348 g/mol

6) a) Determine the empirical and molecular formulas for naphthalene given that its molar mass is 128 g/mole and its composition is: 93.71% carbon and 6.29 % hydrogen. _____

Assuming 100 g of naphthalene: we have 93.71 g C, and 6.29 g H. Nothing else since these add up to 100%.

get moles: mol C = 93.71 g C x (1 mol/12.0g)=7.809 mol C, mol H = 6.29 g H x (1mol/1,0 g H)= 6.29 mol H

so, formula becomes: $C_{7.809}H_{6.29}$. Divide by smallest subscript: $C_{1.242}H$; multiply subcripts by 4: C_5H_4 .

Emp weight = 5(12.0)+4(1.0)=64 g/mol; MM/EW = 128 / 64 = 2: multiply all subscripts by 2 to get chemical formula: $C_{10}H_8$.

b) Determine the empirical and molecular formulas for vanillin given that its molar mass is 152 g/mole and its composition is: 63.15% carbon, 5.30 % hydrogen and the rest oxygen. $C_8H_8O_3$

First assuming 100 g of naphthalene: we have 63.15 g C, and 5.30 g H => g O = 100-(63.15 + 5.30)=31.55g O

get moles: mol C = 63.15 g C x (1 mol/12.0g)=5.263 mol C, mol H = 5.30 g H x (1mol/1,0 g H)= 5.30 mol H

mol O = 31.55 g O (1 mol/16.0) = 1.972 mol O.

so, formula becomes: $C_{5.263}H_{5.30}O_{1.972}$. Divide by smallest subscript: $C_{2.669}H_{2.688}O_1$. Try multiplying subscripts by 3: $C_{8.007}H_{8.064}O_3$, formula becomes $C_8H_8O_3$.

Emp weight = 8(12.0)+8(1.0)+ 3(16.0)=152 g/mol; MM/EW = 152 / 152 = 1: This is also the chemical formula: $C_8H_8O_3$.