CHEM 120
Fall 2009
Quiz 2

Name: _____

1. (3 Points) Fill in the blanks.

The **atomic number** is equal to the number of protons in the nucleus.

The **mass number** is the total number of neutrons and protons in the nucleus.

A(n) **extensive** property depends on the amount of material.

2. (8 Points) The data shown below were obtained for three compounds of nitrogen and hydrogen. Show that these data are consistent with the law of multiple proportions.

Compound	*Mass of Nitrogen (g)*	*Mass of Hydrogen (g)*
A	0.500	0.108
B	1.000	0.0720
C	0.750	0.108

To obey the law of multiple proportions the masses of one element combined with a fixed mass of the second are in the ratio of small whole numbers. To do this we need to make all the masses of one element that same, which can do by dividing the masses by 0.500 for compound A and by 0.750 for compound C. We then divide by the smallest mass to give the mass ratio of hydrogen in the compounds. This is summarized below.

Compound	*Mass of Nitrogen (g)*	*Mass of Hydrogen (g)*	*Mass Ratio of Hydrogen*
A	**1.00**	**0.216**	**3.00**
B	**1.000**	**0.0720**	**1.00**
C	**1.00**	**0.144**	**2.00**

As the mass ratios of hydrogen are small whole number when the mass of nitrogen is the same, the law of multiple proportions is obeyed.

3a. (10 Points) A pycnometer is a small bottle used in precise measurements of density. At a certain temperature the empty pycnometer has a mass of 25.601 g. When filled with water at this temperature, it has a mass of 35.552 g, but when filled with methanol it has a mass of 33.490 g. If the density of water at this temperature is known to be 0.99821 g/ml, what is the density of methanol?

The mass of water added to the pycnometer is $35.552\,\text{g} - 25.601\,\text{g} = 9.951\,\text{g}$**.**

From this mass and the given density of water, we can calculate the volume of the pycnometer by rearranging $\rho = \frac{m}{V}$**.**

$$V = \frac{m}{\rho} = \frac{9.951\,\text{g}}{0.99821\,\text{g/ml}} = 9.968_8\ \text{ml}$$

The mass of methanol added to the pycnometer is $33.490\,\text{g} - 25.601\,\text{g} = 7.889\,\text{g}$**.**

The density of methanol is thus

$$\rho = \frac{m}{V} = \frac{7.889\,\text{g}}{9.968_8\ \text{ml}} = 0.7914\,\text{g/ml}$$

The density of methanol is 0.7914 g/ml at this temperature.

b. (4 Points) The accepted density of methanol is 0.7914 g/ml at this temperature. Based only on the information given in part *a*, can you say that your answer is as precise as the accepted value? Explain. Note that you don't need an answer to part *a* to answer this part.

There is only one measurement given in part *a*. Although the value for the density matches the precision of the accepted value, we are still unsure of the precision for our measurement because we have only a single value. If we had multiple replicate measurements, then we could perform a statistical analysis and determine the actual precision of our measurement, but as we haven't, we can't conclude anything.

c. (3 Points) If the uncertainty in the density of methanol given in part *b* is ±2 in the last decimal place at 95% confidence, write the density as a confidence interval.

The density of methanol is 0.7914±0.0002 g/ml at the 95% confidence limit.