CHEM 35

General Chemistry

EXAM #2

October 18, 2000

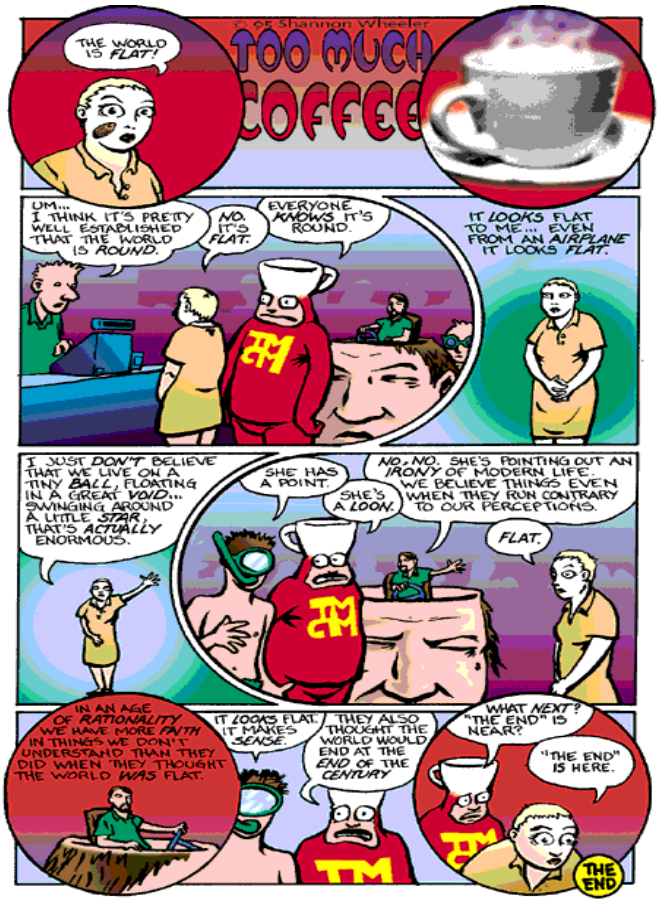
Name:_____

SSN:_____

Lab T.A.:_____

INSTRUCTIONS: Read through the entire exam before you begin. Answer all of the questions. For questions involving calculations, show **all** of your work -- **HOW** you arrived at a particular answer is **MORE** important than the answer itself! Circle your final answer to numerical questions.

The entire exam is worth a total of 150 points. Attached are a periodic table and a formula sheet jam-packed with useful stuff. Good Luck!



Page	Possible Points	*Points Earned*
2	20	
3	30	
4	15	
5	20	
6	15	
7	20	
8	30	
TOTAL:	***150***	

1. *(10 pts)* Pure acetic acid ($HC_2H_3O_2$; MW = 60.05 g/mol) is a liquid with a density of 1.049 g/mL at 25 ^oC. Calculate the molarity (mol/L) of a solution of acetic acid made by dissolving 15.00 mL of pure acetic acid at 25 ^oC in enough water to make 100.0 mL of solution.

2. *(10 pts)* How many mL of 0.155 *M* HCl are needed to react completely with 35.0 mL of a 0.101 *M* $Ba(OH)_2$ solution? The ***unbalanced*** reaction equation is:

$$HCl(aq) + Ba(OH)_2(aq) \rightarrow H_2O(l) + BaCl_2(aq)$$

3. *(10 pts)* The *Hindenburg* was a famous hydrogen-filled dirigible that exploded in 1937. If the *Hindenburg* held 2.0 x 10^5 m^3 of hydrogen gas (H_2) at 25. ^oC and 1.0 atm, what mass (kg) of hydrogen was present?

4. *(10 pts)* Calculate the molar mass (g/mol) of a gas if 3.75 g occupies 0.935 L at 430. torr at 35.0 ^oC.

5. A mixture containing 0.538 mol He(*g*), 0.315 mol Ne(*g*), and 0.103 mol Ar(*g*) is confined in a 5.00-L vessel at 25.0 ^oC.

    a. *(5 pts)* Calculate the total pressure (atm) of the mixture.

    b. *(5 pts)* Calculate the partial pressure (atm) of He in the mixture.

6. *(5 pts)* A balloon made of rubber that is permeable to small molecules is filled with helium to a pressure of 1 atm. This balloon is then placed in a box that contains pure hydrogen (H_2), also at a pressure of 1 atm. Will the balloon expand or contract? Explain.

7. Vessel A contains CO gas at 0 ^{o}C and 1 atm. Vessel B contains CO_2 gas at 20 ^{o}C and 0.5 atm. The two vessels have the same volume.

    a. *(3 pts)* Which vessel contains more molecules? Briefly explain.

    b. *(3 pts)* In which vessel is the average kinetic energy of the molecules greater? Briefly explain.

    c. *(4 pts)* In which vessel is the rms speed of the molecules greater? Briefly explain.

8. The ideal gas law is often used under conditions in which gases are unlikely to behave in an ideal fashion.

    a. *(5 pts)* Calculate, using the ideal gas law, the pressure (atm) of 40.0 mol of argon gas contained in a volume of 2.00 L at 300 K.

    b. *(8 pts)* Now, using the van der Waals equation, calculate the pressure (atm) of the same argon gas sample.

    c. *(7 pts)* If there is a greater than 10% difference in the two pressure values, explain why the ideal gas law fails. If there is less than a 10% difference in the two pressure values, indicate under what conditions you would expect to find a more significant difference between the two calculated pressures.

9. Consider two gas samples: He and Ar at 300 K.

    a. *(10 pts)* Sketch the Maxwell-Boltzmann speed distribution profile for both gases; use the same set of axes for both gases. Calculate the rms speed for both gases and indicate the location of these values on the plot. Please note: the ONLY quantitative aspect of this plot should be these rms speeds – the rest should be strictly a qualitative sketch showing clearly any differences between the two gases.

    b. *(5 pts)* How would the speed distribution for Ar be affected by an increase in temperature to 1000 K? Sketch speed distribution profiles for Ar (on a new set of axes, please) at the initial temperature (300 K) and at 1000 K. As before, use the calculated rms speed as the sole quantitative calibration point for these qualitative speed distribution plots.

10. Each of the following reactions produces a gas as one of its products. For each reaction: write a balanced reaction equation, classify the reaction as being a *precipitation*, *acid/base*, or *oxidation/reduction* reaction, and give evidence to support your classification by either identifying the precipitate compound, the acid and the base, or by indicating which of the reactants are oxidized and which are reduced.

    a. $CaCO_3(s) + HNO_3(aq) \rightarrow$ products

    Balanced reaction equation *(3 pts)*:

    Reaction type *(1 pt)*: **precipitation** or **acid/base** or **redox** (circle one)

    Evidence *(1 pt)*:

    b. $Cu(s) + HNO_3(aq) \rightarrow$ products

    Balanced reaction equation *(3 pts)*:

    Reaction type *(1 pt)*: **precipitation** or **acid/base** or **redox** (circle one)

    Evidence *(1 pt)*:

11. *(2 pts each)* Determine the oxidation state of sulfur in each of the following compounds:

    a. H_2S

    b. S_8

    c. SCl_2

    d. Na_2SO_3

    e. SO_4^{2-}

12. A sample of 70.5 mg of K_3PO_4 (MW = 212.266 g/mol) is added to 15.0 mL of 0.050 *M* $AgNO_3$, resulting in the formation of a precipitate.

    a. *(5 pts)* Write a balanced net ionic equation for this reaction.

    b. *(5 pts)* What is the limiting reactant in this reaction.

    c. *(5 pts)* Calculate the mass (g) of precipitate formed in this reaction

13. a. *(10 pts)* Determine the Lewis structures (yes, there is more than one) for SO_2, and compute oxidation numbers and formal charges for the sulfur and oxygen atoms.

    b.*(5 pts)* Do the oxidation numbers or the formal charges more realistically indicate the charge distribution within the molecule? Explain.

Betcha thought that I forgot all about the

EXTRA CREDIT! – *10 pts*

A newspaper article about the danger of global warming from the accumulation of greenhouse gases such as carbon dioxide states that "reducing driving your car by 20 miles a week would prevent release of over 1000 pounds of CO_2 per year into the atmosphere." Is this a reasonable statement? Assume that gasoline is octane (C_8H_{18} - MW = 114.1502 g/mol) and that it is burned completely to CO_2 and H_2O in the engine of your car. Note that you will need to make some reasonable guesses as to the gas mileage of your car, the density of octane, etc.