Due: Wednesday, 28-September-2005 at the beginning of class. Please remember, this is to be your own work.

1) An organic compound contains C, H, N, and O. Combustion of 0.1023 g of the compound in excess oxygen yielded 0.2766 g of CO$_2$ and 0.0991 g of H$_2$O. A sample of 483.1 mg of the compound was analyzed for nitrogen by the Dumas method (shown below), and 27.6 mL of dry N$_2$ at STP was obtained. In a third experiment, the density of the compound as a gas was determined to be 4.02 g/L at 127°C and 256 torr. What are the empirical and molecular formulas of the compound?

\[
\text{Compound} \xrightarrow{\text{CuO heat}} N_2 + CO_2 + H_2O
\]

2) Natural gas is a mixture of hydrocarbons, primarily methane (CH$_4$) and ethane (C$_2$H$_6$). A typical mixture might have $\chi_{\text{methane}} = 0.915$ and $\chi_{\text{ethane}} = 0.085$. Let’s assume that we have a 15.50 g sample of natural gas in a volume of 15.00 L at a temperature of 20.00°C.

a) How many total moles of gas are there in the sample?
b) What is the pressure of the sample (in atmospheres)?
c) What is the partial pressure of each compound in the sample (in atmospheres)?

3) A 49.80-mL sample of a 0.2003 M acid reacts with an excess of Na$_2$CO$_3$ to form 125.0 mL of CO$_2$ gas at 722 mm Hg and 17°C. If the acid is either HCl or H$_2$SO$_4$, which is it? Be sure to support your answers with equations and calculations as appropriate.

4) A chemist massed out 5.14 g of a mixture containing unknown amounts of BaO(s) and CaO(s) and placed the sample in a 1.50-L flask containing CO$_2$(g) at 30.0°C and 750 torr. After the reaction to form BaCO$_3$(s) and CaCO$_3$(s) was completed, the pressure of CO$_2$(g) remaining was 230 torr. Calculate the mass percentages of CaO(s) and BaO(s) in the mixture.

5) As you increase the temperature of a gas in a sealed, rigid container, what happens to the density of the gas? Would the result be the same if you did the same experiment in a container with a piston at constant pressure?