Chemistry 350 Spring 2016
20 points Due In Class Friday, January 29

Problem Set # 2: Stoichiometry and Tools of the Trade

Complete all problems on separate paper. Show all work for credit. Correct use of significant figures is required for full credit.

1. What volume of 0.1092 M sodium hydroxide would be needed to quantitatively titrate 25.00 mL of 0.09884 M hydrochloric acid?

$$HCl + NaOH \rightarrow H_2O + NaCl$$

$$\frac{0.09884\ \text{mol HCl}}{1\ \text{L}} \times 25.00\ \text{mL} \times \frac{1\ \text{mol NaOH}}{1\ \text{mol HCl}} \times \frac{1\ \text{L}}{0.1092\ \text{mol NaOH}} = 22.63\ \text{mL}$$

2. How many milliliters of 3.00 M sulfuric acid are required to react with 4.35 g of solid containing 23.2 % w/w $Ba(NO_3)_2$ if the reaction is $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (s)?

$$\frac{23.2\ \text{g } Ba(NO_3)_2}{100\ \text{g sample}} \times 4.35\ \text{g sample} = 1.00_9\ \text{g } Ba(NO_3)_2 \text{ available to react}$$

$$1.00_9\ \text{g } Ba(NO_3)_2 \times \frac{1\ \text{mol}}{261.37\ \text{g}} \times \frac{1\ \text{mol } H_2SO_4}{1\ \text{mol } Ba(NO_3)_2} \times \frac{1000\ \text{mL}}{3.00\ \text{mol } H_2SO_4} = 1.29\ \text{mL}$$

3. Pentane is a liquid with a density of 0.626 g/mL. What is the true mass of pentane when the mass weighed in air is 15.682 g?

In order to do the buoyancy correction, you will need to assume a temperature to find a density of air. If we assume 25°C, the density of air is 0.00012 g/mL. The buoyancy calculation becomes:

$$m = \frac{15.682\text{g}(1 - [(0.0012\text{g/ml})/(8.0\ \text{g/mL})])}{(1 - [(0.0012\text{g/ml})/(0.626\ \text{g/mL})])} = 15.709_7\ \text{g} = 15.710\ \text{g}$$

4. A 2-mL Class A volumetric pipet is to be calibrated. It is filled to the mark with water which is then dispensed into a beaker that has a mass (when empty) of 10.4521 g. After the addition of water from the pipet, the beaker has a mass of 12.4235 g. If all of the measurements were carried out on a standard analytical balance (calibrated with 8.0 g/mL weights) at 20 °C, what is the true volume dispensed by the volumetric pipet at 20 °C? Is the value within the tolerance of the pipet?

   At 20°C, the buoyancy corrected volume of 1 g of water is 1.0029 mL (from the table below).

   Therefore, if the measured mass difference is: 12.4235-10.4521 = 1.9714 g, then the actual volume dispensed is:

$$1.9714\ \text{g } H_2O \times \frac{1.0029\ \text{mL } H_2O}{1\ \text{g } H_2O} = 1.9771\ \text{mL}$$

   Since the tolerance of a 2 mL pipet is +/- 0.002 mL, the value is not within the tolerance of the pipet. Note that since the 1.0029 ml/g value is already buoyancy corrected, we do not need to correct for buoyancy in the original masses.

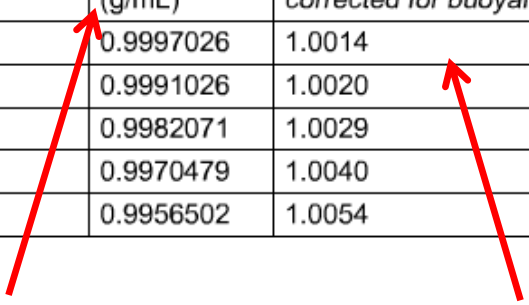
5. An empty 10-mL volumetric flask weighs 10.257 g. After filling to the mark with distilled water at 20°C, the mass is 20.221 g. What is the true volume of the flask at 20°C? (Be sure to correct for buoyancy.)

   At 20°C, the buoyancy corrected volume of 1 g of water is 1.0029 mL (from the table below).

   Therefore, if the measured mass difference is: 20.221g-10.257g = 9.964 g, then the actual volume of the flask is:

$$9.964 \text{ g } \cancel{H_2O} \times \frac{1.0029 \text{ mL } H_2O}{1 \text{ } \cancel{\text{g } H_2O}} = 9.993 \text{ mL}$$

Temperature (°C)	Density (g/mL)	Volume of 1 g of water (mL) *corrected for buoyancy*
10	0.9997026	1.0014
15	0.9991026	1.0020
20	0.9982071	1.0029
25	0.9970479	1.0040
30	0.9956502	1.0054



This value is not corrected for buoyancy, but this one is.