**CHE1031 Lecture 3 HW**

Problems must be solved, or written out, in their entirety with all work shown on engineering graph paper. You must label each set in the upper left hand corner with your name, the date and the chapter. Problems must be identified by number and all work must be shown with answers boxed. Be sure your handwriting is legible. An example is posted in the ‘course basics’ section of our Moodle page.

**3.1: Moles, molar mass, and simple conversions**

1. Calculate the molar mass of caffeine, C8H10N4O2.

2. What is the molar mass of diazepam (Valium) if 0.05570 moles has a mass of 15.86 g?

3. How many moles of ammonium ions are there in 6.955 g of ammonium carbonate?

4. What is the mass (g) of 1.5x1021 molecules of aspirin, C9H8O4?

5. A sample of the male sex hormone, testosterone (C19H28O2) contains 3.88x1021 hydrogen atoms.

a. How many atoms of carbon does the sample contain?

b. How many moles of testosterone does the sample contain?

c. How many molecules of testosterone does the sample contain?

d. What is the mass (g) of the sample?

**3:2 Molar conversions: percent composition, empirical & molecular formulae**

6. Calculate the percentage by mass of:

a. carbon in acetylene, C2H2

b. hydrogen in ascorbic acid, HC6H7O6 (aka vitamin C)

c. hydrogen in ammonium sulfate, (NH4)2SO4, a nitrogen fertilizer

7. Calculate the percentage by mass of:

a. platinum in PtCl2(NH3)2, a chemotherapy drug called cisplatin

b. oxygen in the female sex hormone, estradiol, C18H24O2

c. carbon in capsaicin, C18H27NO3, the heat in chili peppers

8. Determine the empirical *and* molecular formulas of Ibuprofen, a headache remedy that contains 75.69% C, 8.80% H and 15.51% O by mass and has a MW of 206 g/mol.

9. Determine the empirical *and* molecular formulas of cadaverine, the foul-smelling molecule of decomposing flesh that contains 58.55% C, 13.81% H and 27.40% N by mass and has a MW of 102.2 g/mol.

10. Determine the empirical *and* molecular formulas of epinephrine (adrenaline), a hormone secreted into the bloodstream in times of danger and stress, containing 59.0% C, 7.1% H 26.2% O, and 7.7% N by mass and has a MW of 180 g/mol.

**3.3: Stoichiometry: balancing chemical equations**

11. Balance this equation:

Li(s) + N2(g) 🡪 Li3N(s)

12. Balance this equation:

TiCl4(l) + H2O(l) 🡪 TiO2(s) + HCl(aq)

13. Write a balanced chemical equation representing this: solid potassium chlorate is heated and decomposes to form solid potassium chloride and oxygen gas.

14. Write a balanced chemical equation representing this: solid zinc metal reacts with sulfuric acid to form hydrogen gas and an aqueous solution of zinc sulfate.

15. Write a balanced chemical equation representing this: liquid phosphorous trichloride is added to water and reacts to form aqueous phosphorous acid (H3(PO3)) and aqueous hydrochloric acid.

16. Write a balanced chemical equation representing this: hydrogen sulfide gas is passed over solid hot iron (III) hydroxide and the reaction produces solid iron (III) sulfide and water as a gas.

**3.4: Patterns of chemical reactivity**

17. Write a balanced chemical equation for the reaction that occurs when copper (II) hydroxide decomposes into copper (II) oxide and water when heated.

18. Write a balanced chemical equation for the combustion of heptane (C7H16) in air.

19. Write a balanced chemical equation for the combustion of tert-butyl ether, C5H12O in air.

**3.5: Stoichiometry & conversions**

20. An iron ore sample contains Fe2O3 together with other substances. Reaction of the ore with CO produces iron metal:

Fe2O3(s) + CO(g) 🡪 Fe(s) + CO2(g)

1. Balance this equation.
2. Calculate the number of grams of CO that can react with 0.350 kg of Fe2O3.
3. Calculate the number of grams of Fe and CO2 produced when 0.350 kg of Fe2O3 reacts.
4. Show that your calculations are consistent with the law of conservation of mass.

21. The complete combustion of octane, C8H18, the main component of gasoline, proceeds as follows:

2 C8H18(l) + 25 O2(g) 🡪 16 CO2(g) + 18 H2O(g)

1. How many moles of O2 are needed to burn 1.5o moles of C8H18?
2. How many grams of O2 are needed to burn 10.0 g of C8H18?
3. Octane has a density of 0.692 g/mL at 20°C. How many grams of O2 are required to burn 15.0 gallons of C8H18?

22. One of the steps in the commercial process used to convert ammonia to nitric acid is the conversion of NH3 to NO:

4 NH3 (g) + 5 O2 (g) 🡪 4 NO (g) + 6 H2O (g)

2.00 g of NH3 are reacted with 2.50 g of O2.

a. Which reactant is limiting?

b. How many grams of NO and H2O form?

c. How many grams of excess reactant remain?

d. Prove that your results are consistent with the law of conservation of mass.

23. Solutions of sulfuric acid and lead (II) acetate react to form solid lead (II) sulfate and a solution of acetic acid. If 5.00 g of sulfuric acid and 5.00 g of lead (II) acetate are mixed, calculate the number of grams of each reactant and product that exist when the reaction is complete.