SL midterm review

1. Consider the following reaction

$N_2(g) + H_2O(g) \rightarrow NH_3(g) + O_2(g)$

a. Balance the reaction
b. Determine the Molar masses of each reagent and each product
c. If 13 g of N_2 reacts with 28.0g of H_2O, which is the limiting reagent?
d. Which is in excess?
e. If 14.5g of NH_3 is isolated, what's the % yield?

2. Calculate the mass of each compound
a. 0.0054 mol of aluminum carbonate
b. 9.45 moles of calcium oxide

3. If 13.5 g of NH_3 is isolated in a flask at a pressure of 2.25 bar, what will the density of the gas temperature of 20*C be?

4. 164.00 g of sodium hydroxide are dissolved in 350.0 mL of water. Find the molarity.

5. 280.0 mL of 3.00 M HCl react with 68.5 g of zinc in a single replacement reaction. Determine the percentage yield of this reaction if it produces 0.644 g of hydrogen gas.

6. Every year almost 80 million tonnes of ethanol (C_2H_5OH) is produced industrially.

A method to prepare ethanol is the bacterial fermentation of sugars such as glucose ($C_6H_{12}O_6$) according to the reaction below. The sugars are derived from plants grown for this purpose (eg. Sugar cane, beets, corn)

$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$

Ethanol is also synthesized from the chemical reaction of ethylene (C_2H_4) and water. The ethylene is prepared by heating components of natural gas and petroleum at very high temperatures and pressures.

$C_2H_4 + H_2O \rightarrow C_2H_5OH$

a. Calculate the molecular masses of each of the reagents and products in the two chemical equations presented

b. Calculate the OAE for each reaction taking C_2H_5OH as the desired product.
c. Calculate the E factor for both reactions

7. Name a principle of green chemistry and provide an example!

8. Which atom has the most neutrons?
a. ^{55}Mn
b. ^{58}Ni
c. ^{1}H
d. ^{59}Co

9. Copper has two naturally occurring isotopes. Cu-63 has an atomic mass of 62.9296 amu and an abundance of 69.15%. What is the atomic mass of the second isotope?

10. Answer the following mass spectrum problem given the following natural abundancies for antimony trifluoride, SbF_3. ^{121}Sb: 57%, ^{123}Sb: 43%, ^{19}F: 100%

a. How many signals appear in the mass spectrum of SbF_3?
b. What mass values do these signals appear at?
c. Sketch a mass spectrum labelling all axis's given your answers to part a and b. Sketch all necessary signals on the diagram with the correct qualitative relative intensities. Assume no fragmentation occurs (we are only considering the isotopes provided in the question)

11. A balloon filled with F_2 (F, Z=9) at temperature of 40*C has a volume of 1.9L. Under a constant external pressure of 105kPa, the balloon is cooled to -95*C.

a. What is the volume of F_2 gas in the balloon at the lower temperature?

b. Compared to F_2 molecules an equal number of Ne (Z=10) molecules at the same temperature.
   i. Exert less pressure because they have lower mass
   ii. Have the same kinetic energy because they move at the same speed
   iii. Occupy a smaller volume because they are smaller
   iv. Have a higher average speed because they have lower mass

c. The graph below represents the distribution of speeds of F_2 gas at 250*C. On the same graph qualitatively sketch the expected distribution of speeds for the same amount of Ne at the same temperature. No calculations required.