On a one whole sheet of paper, solve the following problems. Show your complete solutions and final answers only.

Express your answers in correct number of significant figures, unit, and chemical formula. (5 points each)

1. Consider the combustion of butane (C_4H_{10}): $2C_4H_{10}$ (g) + $13O_2$ (g) → $8CO_2$ (g) + $10H_2O$ (l)
In a particular reaction, 6.5 moles of C_4H_{10} are reacted with an excess of O_2. Calculate the number of moles of CO_2 formed.

2. A laboratory method of preparing O_2(g) involves the decomposition of $KClO_3$(s).
$2KClO_3$ (s) → $2KCl$ (s) + $3O_2$ (g) (a) How
many moles of O_2 (g) can be produced by the decomposition of 34.6 g $KClO_3$?
(b) How many grams of $KClO_3$ must decompose to produce 45.5 g O_2?
(c) How many grams of KCl are formed, together with 27.5 g O_2, in the decomposition of $KClO_3$?

3. The reaction of calcium hydride with water can be used to prepare small quantities of hydrogen gas, as is done to fill weather-observation balloons: CaH_2 (s) + H_2O (l) → $Ca(OH)_2$ (s) + H_2 (g)
(a) How many grams of H_2(g) result from the reaction of 134 g CaH_2 with an excess of water?
(b) How many grams of water are consumed in the reaction of 58.3 g CaH_2?
(c) What mass of CaH_2(s), in g, must react with an excess of water to produce 4.15 x 1024 molecules of H_2?

4. Fermentation is a complex chemical process of wine making in which glucose ($C_6H_{12}O_6$) is converted into ethanol
($2C_2H_5OH$) and carbon dioxide: $C_6H_{12}O_6$ → $2C_2H_5OH$ + $2CO_2$
Starting with 512.5 g of glucose, what is the maximum amount of ethanol in grams and in liters that can be obtained by this process? (Density of ethanol = 0.789 g/mL)

5. When baking soda (sodium bicarbonate or sodium hydrogen carbonate, $NaHCO_3$) is heated, it releases carbon dioxide gas, which is responsible for the rising of cookies, donuts, and bread.
(a) Write a balanced equation for the decomposition of the compound (one of the products is Na_2CO_3).
(b) Calculate the mass of $NaHCO_3$ required to produce 22.2 g of CO_2.

6. When 1.50 mol of aluminum metal and 3.00 mol chlorine gas combine in
the reaction: $2 Al$(s)+ $3 Cl_2$(g)→ $2 AlCl_3$(s)
(a) Which is the limiting reactant?
(b) How many moles of aluminum chloride are formed?
(c) How many moles of the excess reactant remain at the end of the reaction?

7. A side reaction in the manufacture of rayon from wood pulp is
$3CS_2$ + $6NaOH$ → $2Na_2CS_3$ + Na_2CO_3 + $3H_2O$
How many grams of Na_2CS_3 are produced in the reaction of 93.2 mL of liquid CS_2 (d = 1.26g/mL) and 2.66 mol NaOH?

8. Consider the reaction MnO_2 + $4HCl$ → $MnCl_2$ + Cl_2 + $2H_2O$
(a) If 0.92 mole of manganese dioxide and 47.4 g of hydrochloric acid react, which reagent will be used up first?
(b) How many grams of Cl_2 will be produced?

9. Calculate the maximum numbers of moles and grams of iodic acid (HIO_3) that can form when 624 g of iodine trichloride (ICl_3) reacts with 120.5 g of water: ICl_3 + H_2O → ICl + HIO_3 + HCl (unbalanced)

10. When heated, lithium reacts with nitrogen to form lithium nitride: $6Li$(s) + N_2(g) →$2Li_3N$(s)
(a) What is the theoretical yield of lithium nitride in grams when 11.8 g of lithium metal are heated with 34.5 g nitrogen gas?
(b) If the actual yield of lithium nitride is 8.88 g, what is the percent yield of the reaction?