Worksheet on excess and limiting reactants/reagents.

When dealing with questions where the mol of more than one reactant is known, students must determine which reactant is in excess. There are two possibilities, the reactants are in the right stoichiometric ratio or that one of them is in excess. If the latter is the case then the limiting reagent/reactant is the one used to perform stoichiometric calculations.

Eg Methane undergoes complete combustion, at SLC, in atmospheric oxygen to produce carbon dioxide and water. The balanced chemical equation is given below.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

If 97.6 litres of methane was mixed with 150 litres of oxygen gas and ignited what mass, in grams, of CO_2 is formed at the completion of the combustion reaction.

Step 1 find the limiting reactant.

Reactant	mol	Limiting quotient Mol/coefficient
CH_4	97.6 / 24.8 = 3.94	3.94/1 = 3.94
O_2	150/24.8 = 6.05	6.05/2 = 3.02

=> Identify the reactant with the lowest limiting quotient as being the limiting reactant, in this case it is O_2.

Step 2 Using the limiting reactant find the mol of CO_2 produced.

=> 6.05 X ½ = 3.03 mol

Step 3 Find the mass of CO_2

=> 3.03 X 44.0 = 133 grams

1. 50.00 mL of a 0.200 M barium hydroxide solution is mixed with 50.00 mL of a 0.300 M nitric acid solution and allowed to react
   a. Give the overall balanced chemical equation for the reaction, states included.

   b. Identify the excess reactant and calculate the amount, in grams, by which it is in excess. Show all working out and give the answer to the right number of significant figures.

2. Methane is reacted with oxygen gas at SLC to provide heat to increase the temperature of 5.00 kilograms of pure water.
   a. Give the balanced chemical equation for the combustion of methane gas. Include states

   b. A mixture of 20.50 litres of methane and 40.0 litres of oxygen gas was ignited.
      i. Calculate the total volume of gas produced if the temperature and pressure remained at SLC.

      ii. What is the total volume, in litres, of gas remaining after the reaction is complete at SLC.

   c. Calculate the final temperature of the 5.00 kg of water assuming that all the energy produced during the combustion reaction was absorbed by the water?

3. An amount of 2.50 grams of calcium carbonate ($CaCO_3$) pellets was placed in a beaker containing 500 mL of a 0.100 M HCl solution.
   a. Give the balanced chemical equation for the reaction between $CaCl_2$ and HCl, states included, where products are either in aqueous, liquid or gaseous states.

   b. This reaction was conducted at SLC. Find the mass, in grams, of gaseous product that is formed?

4. Vapourised bioethanol is used as a fuel to propel a new hybrid-vehicle. The engine consumes 3.00 litres of gaseous ethanol and mixes it with 50.0 litres of air, which is composed of 20.0% oxygen gas. The mixture is ignited at SLC.

   a. Write a balanced chemical equation for the complete combustion of ethanol at SLC. States included.

   b. Identify the reactant in excess, show all working out.

   c. Calculate the amount of heat energy, in kJ, produced during the complete combustion of 3.00 litres of gaseous bioethanol with 50.0 litres of air at SLC.

d. Bioethanol is relatively expensive to produce and transport.
    i. Suggest a way that car manufacturers can guarantee that the amount of ethanol pumped into the engine is totally burnt to release the maximum possible heat energy.

    ii. Give one advantage of using bioethanol as a fuel. Provide at least one chemical reaction to support your answer.

5. Butane gas undergoes complete combustion when mixed with oxygen.
    a. Write the balanced chemical equation for the complete combustion of butane gas in the presence of atmospheric oxygen at SLC. States included.

    b. A mixture made up of 20.0 litres of butane gas and 100 litres of pure oxygen gas is ignited.
        i. Calculate the total volume, in litres, of product gas.

        ii. What is the total volume, in litres, of gas left over after the combustion reaction is complete.

6. In another experiment 5.80 grams of butane was mixed with 16.0 grams of oxygen gas in a sealed 5.00 litre vessel and ignited. The balanced chemical equation for the reaction is shown below.

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2 + 10H_2O(l)$$

Calculate the pressure, in kPa, exerted on the walls of the container if the temperature of the gaseous mixture is allowed to reach 70.0 ^{o}C.