Fuels – Incomplete and complete combustion

1. A mass of 0.560 grams of CH_4 reacts completely, in the right stoichiometric ratio, with oxygen gas at SLC. The volume and mass of the product gas formed is measured.
   a. The volume of the product gas is 0.496 litres and weighs 0.560 grams. Identify the gas

   b. Give the balanced chemical equation for the combustion reaction of methane and oxygen gas under these conditions. States required.

   c. Is this a complete or incomplete combustion reaction? Justify your reasoning with reference to oxidation states.

2. An amount of 1.60 grams of pure methane gas burns in oxygen to raise the temperature of 2.00 litres of distilled water by 7.26 ^oC.
   a. If the water was originally at 25^oC, calculate the amount of energy produced, assuming all energy was absorbed by the water.

   b. Write the balanced chemical equation for the combustion of methane gas and oxygen under these conditions given that 1.60 grams of methane reacts with 4.80 grams of oxygen gas. States required.

   c. Write the balanced thermochemical equation for the reaction

3. Propane gas reacts with oxygen gas in a combustion reaction at SLC to produce 22.0 grams of a gaseous product. This gaseous product occupies a volume of 12.4 litres.
   a. Write a balanced thermochemical equation for the combustion of propane gas under these conditions.
   b.
   c. Propane gas is used to heat 200 litres of water in a hot water tank. The water, originally at 30.0 ^{o}C, is heated to 50.0^{o}C. A mass of 0.4000 kg of propane was used to heat the water.
      i. Calculate the amount, in kJ, of energy absorbed by the water. Assume water density 1.00 g /mL.

      ii. Calculate the theoretical amount of heat energy, in kJ, delivered by 0.400 kg of propane. Use the thermochemical equation given in question a. above.

      iii. Consider the energy efficiency formula of an appliance shown on the right, diagram 1.

$$\% \text{ Energy efficiency} = \frac{\text{Useable energy}}{\text{Total energy supplied}} \times 100$$

Diagram 1

      Calculate the energy efficiency of the hot water tank.

      iv. Under the conditions at which propane gas burns, in another hot water tank, energy efficiency is low at around 35%. During the combustion reaction in this tank a toxic, diatomic gas is given off as well as unburnt propane.
      Give the balanced chemical equation for this reaction and provide an explanation as to how this toxic gas can be avoided.