Thermochemical equations – and [PV = nRT]
Lesson 10

1) Propane gas is used as a fuel source.

a) What amount of energy, in MJ, is provided by the complete combustion of propane gas kept in a 2.00 Litre vessel at 137.0 °C and a pressure of 240.0 kPa.?

Step 1 – Using the ideal gas equation (PV=nRT) find the mol of propane gas present in the vessel.
=> $n = PV / RT$
=> $n = (240.0 \times 2.00) / (8.31 \times 4.10 \times 10^2)$
=> $n = 0.141$
Step 2 – Using the molar heat of combustion from the Data Book calculate the amount of energy in MJ released by this many mol of propane.
=> Energy (MJ) = 2220 kJ X 0.141 = 0.313 MJ

b) Write a thermochemical equation for the complete combustion of 2 mol of propane gas to produce carbon dioxide and liquid water.

$2C_3H_8(g) + 10O_2(g) \rightarrow 6CO_2(g) + 8H_2O(l)$ $\Delta H = -4440$ kJ/mol

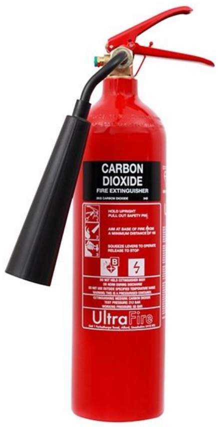
c) A mass of 33.56 grams of propane is ignited with a limited amount of oxygen in a 2.45 litre vessel. A total amount of 0.777 MJ of energy is released and all the CO_2 gas is removed from the chamber. Assume all the oxygen is used up to produce CO_2 and liquid water.

i. Using the equation in c) above calculate the pressure exerted on the walls of the container after the reaction is complete if the temperature of the vessel is kept at 60 °C ? (Propane MW = 44.1 g/mol)

The only gas present after the reaction is complete is the unreacted propane gas.
Step 1 Find the mol of propane gas added to the mixture
=> 33/56 / 44.1 = 0.761mol
Step 2 Find the mol of propane that actually reacted using the stoichiometric ratio from the equation in c)
=> 2/4440 = x 777 => (2/4440) X 777 = 0.350 mol
Step 3 Find the mol of excess propane
=> 0.761 – 0.350 = 0.411mol
Step 4 using the ideal gas equation calculate the amount the pressure exerted by the unreacted propane.
=> $P = (nRT)/V = (0.411 \times 8.31 \times 333) / 2.45 = 464$ kPa

ii. The CO_2 produced, in c) above, is placed in a 5.00 litre fire extinguisher at 25.0 °C. What pressure is exerted on the walls of the extinguisher?

Step 1 Using the stoichiometric ratio in b) find the mol of CO_2 produced.
=> since only 0.350 mol propane react the mol of CO_2 produced is given by the expression
mol of CO_2 = 0.350 X (6/2) = 1.05
Step 2 calculate the pressure using the ideal gas



equation.

P =(nRT)/V = (1.05 X 8.31 X 298) / 5.00 = 5.20 X10² kPa