3

- What quantity of heat is released when 15.2 g of propane (C_3H_8) is burnt according to the following equation?

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + H_2O(l) \qquad \Delta H = -2221 \text{ kJ mol}^{-1}$$

The molar mass of C_3H_8 is (3×12.01 (C) + 8×1.008 (H)) g mol^{-1} = 44.094 g mol^{-1}. Hence, a mass of 15.2 g corresponds to:

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{15.2 \text{ g}}{44.094 \text{ g mol}^{-1}} = 0.345 \text{ mol}$$

As 2221 kJ of heat are generated by burning one mole, this quantity generates:

$$\text{heat} = (0.345 \text{ mol}) \times (2221 \text{ kJ mol}^{-1}) = 766 \text{ kJ}$$

2

- How much heat is evolved when 907 g of ammonia is produced according to the following equation? (Assume the reaction occurs at constant pressure.)

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) \qquad \Delta H = -91.8 \text{ kJ mol}^{-1}$$

The molar mass of ammonia, NH_3, is 14.01 (N) + 3 × 1.008 (H) = 17.034 g mol^{-1}.

Thus, the number of moles of ammonia is:

$$\text{number of moles} = \frac{\text{mass (in g)}}{\text{molar mass (in g mol}^{-1})} = \frac{907\text{ g}}{17.034\text{ g mol}^{-1}} = 53.2\text{ mol}$$

The chemical equation shows that when *two* moles are produced, ΔH = -91.8 kJ mol^{-1} and so half this value is evolved when *one* mole is produced.

Hence, 53.2 mol will produce:

$$\text{heat produced} = 91.8\text{ kJ mol}^{-1} \times 0.5 \times 53.2\text{ mol} = 2440\text{ kJ} = 2.44\text{ MJ}$$

Answer: **2440 kJ or 2.44 MJ**

Marks 3

- The balanced equation for the complete oxidation of glucose to carbon dioxide and water is given below.

$$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$$

Calculate the mass of carbon dioxide produced by the complete oxidation of 1.00 g of glucose.

The molar mass of glucose is:

$$(6 \times 12.01\ (C)) + (12 \times 1.008\ (H)) + (6 \times 16.00\ (O)) = 180.156$$

1.0 g of glucose corresponds to $\frac{\text{mass}}{\text{molar mass}} = \frac{1.00}{180.156} = 0.00555\ \text{mol}$

From the chemical equation, oxidation of 1 mol of glucose leads 6 mol of CO_2. Hence the number of moles of CO_2 produced is 6 × 0.00555 = 0.0333 mol.

The molar mass of CO_2 is (12.01 (C)) + (2 × 16.00 (O)) = 44.01

Therefore, the number of mass of CO_2 produced is:

mass = number of moles × molar mass = 0.0333 × 44.01 = 1.47 g

Answer: **1.47 g**

Calculate the volume of this mass of carbon dioxide at 0.50 atm pressure and 37 °C.

The ideal gas law gives PV = nRT, hence:

$$V = \frac{nRT}{P} = \frac{(0.0333)\times(0.08206)\times(273+37)}{(0.50)} = 1.69\ \text{L}$$

Answer: **1.69 L**