Marks 4

- The complete combustion of butane, C_4H_{10}, in air gives water and carbon dioxide as the products. Write a balanced equation for this reaction.

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

$C_4H_{10}(g) + {}^{13}/_2O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$

What mass of oxygen is required for the complete combustion of 454 g of butane and what masses of carbon dioxide and water are produced?

The molar mass of butane is (4 × 12.01 (C)) + (10 × 1.008 (H)) = 58.12. Therefore, the amount of butane in 454 g is:

$$\text{number of moles of } C_4H_{10} = \frac{\text{mass}}{\text{molar mass}} = \frac{454}{58.12} = 7.81\,\text{mol}$$

From the chemical equation, each mole of C_4H_{10} requires ${}^{13}/_2$ moles of O_2 and produces 4 moles of CO_2 and 5 moles of H_2O.

Therefore:

number of moles of O_2 = ${}^{13}/_2 \times 7.81 = 50.8$ mol
number of moles of CO_2 = $4 \times 7.81 = 31.2$ mol
number of moles of O_2 = $5 \times 7.81 = 39.1$ mol

The molar masses of O_2, CO_2 and H_2O are:

molar mass of O_2 = 2 × 16.00 = 32.00
molar mass of CO_2 = 12.01 (C) + (2 × 16.00) = 44.01
molar mass of H_2O = (2 × 1.008 (H)) + 16.00 (O)= 18.016

Therefore:

mass of O_2 = number of moles × molar mass = 50.8 × 32.00 = 1620 g = 1.62 kg
mass of CO_2 = 31.2 × 44.01 = 1380 g = 1.38 kg
mass of H_2O = 39.1 × 18.016 = 704 g = 0.704 kg