Answer on Question #66239 - Chemistry - General Chemistry

Question: Stoichiometric Relationships with Gases:

Part A: When heated, calcium carbonate decomposes to yield calcium oxide and carbon dioxide gas via the reaction $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$. What is the mass of calcium carbonate needed to produce 37.0 L of carbon dioxide at STP? Express your answer with the appropriate units.

Part B: Butane, C_4H_{10}, is a component of natural gas that is used as fuel for cigarette lighters. The balanced equation of the complete combustion of butane is

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

At 1.00 atm and 23°C, what is the volume of carbon dioxide formed by the combustion of 2.20 g of butane? Express your answer with the appropriate units.

Solution

Part A

1) We can find the mass of calcium carbonate from the balanced reaction equation:

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g).$$

The mass of $CaCO_3$ can be found from the equation (V_M at STP is equal to 22.4 L/mol):

$$m(CaCO_3) = \frac{V(CO_2) * M(CaCO_3)}{V_M} = \frac{37.0 * 100}{22.4} \approx 165.1786\ g.$$

Part B

1) Find the amount of substance of CO_2 according to the balanced reaction equation:

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

The amount of substance of CO_2 can be found from the equation:

$$n(CO_2) = \frac{m(C_4H_{10}) * 8}{2M(C_4H_{10})} = \frac{2.2\ g * 8}{2 * 58} \approx 0.1517\ mol.$$

2) We can use the Ideal Gas Law to calculate the volume of CO_2:

$$P * V = n * R * T.$$

In this equation, we express the pressure in kPa (1.00 atm = 101.325 kPa), R is the gas constant (8.314 J/mol*K), temperature in kelvins (23°C = 296.15 K):

$$V(CO_2) = \frac{n(CO_2) * R * T}{P} = \frac{0.1517 * 8.314 * 296.15}{101.325} \approx 3.6869\ L.$$

Answer: A) the mass of calcium carbonate is 165.1786 g; B) the volume of CO_2 is 3.6869 L.