Gas Generation Problem – Stoichiometry → Gas Law

$$1\,CaCO_{3(s)} \rightarrow 1\,CaO_{(s)} + 1\,CO_{2(g)}$$

25.3 g of $CaCO_3$ decomposes completely into its products. If we collect the CO_2 gas in a container at a temp of 45°C and 328 mm Hg pressure, what is the volume (ℓ)?

1. We use stoichiometry to convert g $CaCO_3$ → mole CO_2

$$mm\ CaCO_3 = 1(40.\,g) + 1(12\,g) + 3(16\,g) = \frac{100.\,g\ CaCO_3}{1\ mol\ CaCO_3}$$

$$(25.3\,g\ CaCO_3)\left(\frac{1\ mol\ CaCO_3}{100.\,g\ CaCO_3}\right)\left(\frac{1\ mol\ CO_2}{1\ mol\ CaCO_3}\right) = 0.2530\ mol\ CO_2$$

2. Using Gas Law (Ideal) to convert mole CO_2 → ℓ CO_2

$$PV = nRT \Rightarrow V = \frac{nRT}{P}$$

$R = 0.0821 \frac{\ell\text{-atm}}{mol\text{-}K}$

$n = 0.2530\ mol\ CO_2$

$T = 45°C + 273 = 318\,K$

$P = (328\ mm\ Hg)\left(\frac{1\ atm}{760.\ mm\ Hg}\right) = 0.4315\ atm$

$$V = \frac{(0.2530\ mol\ CO_2)\left(0.0821 \frac{\ell\text{-atm}}{mol\text{-}K}\right)(318\,K)}{(0.4315\ atm)}$$

$V = 15.30\ \ell$

$\boxed{V = 15.3\ \ell}$