$$2\,HCl + Na_2CO_3 \rightarrow CO_2 + H_2O + 2\,NaCl$$

If 48.90 mL of hydrochloric acid solution react with sodium carbonate to produce 125.0 mL of carbon dioxide gas at 0.950 atm and 290.2 K. What is the molar concentration of the acid?

We need to find M of HCl solution: $M_{HCl} = \frac{\text{mol HCl}}{\text{L solution}}$ ← 48.90 mL = 0.04890L

1 - Convert volume carbon dioxide to moles using ideal gas equation.
2 - Convert moles carbon dioxide to moles HCl using chemical equation
3 - Calculate molarity of HCl by dividing moles HCl and volume of HCl solution

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① $n = \frac{PV}{RT}$ | $P = 0.950\,atm$ $\quad R = 0.06206\,\frac{L\text{-}atm}{mol\cdot K}$ | $V = 125.0\,mL = 0.1250L$ $\quad T = 290.2\,K$

$$n_{CO_2} = \frac{(0.950\,atm)(0.1250L)}{\left(0.06206\,\frac{L\text{-}atm}{mol\cdot K}\right)(290.2\,K)} = 0.004986601\,9\,mol\,CO_2$$

$2\,mol\,HCl = mol\,CO_2$

$$0.004986601\,9\,mol\,CO_2 \times \frac{2\,mol\,HCl}{mol\,CO_2} = 0.009973203\,8\,mol\,HCl$$ ②

$$M_{HCl} = \frac{\text{mol HCl}}{\text{L solution}} = \frac{0.009973203\,8\,mol\,HCl}{0.04890L} = \boxed{0.204\,\underline{M}\,HCl}$$