An Example of Heterogeneous Stoichiometric Calculations Involving the Gas Laws

6-48

A method of removing CO_2(g) from a spacecraft is to allow the CO_2 to react with LiOH. How many liters of CO_2(g) at 25.9°C and 751 torr can be removed per kilogram of LiOH consumed?

$$2\ \mathrm{LiOH(s)}\ +\ \mathrm{CO_2(g)}\ \rightarrow\ \mathrm{Li_2CO_3(s)}\ +\ \mathrm{H_2O(l)}$$

This is a stoichiometry problem involving a solid and a gas.

First, get constants and "knowns" properly defined...

$$T = 25.9\text{°C} + 273.2\ \text{K} = 299.1\ \text{K}$$

$$P = \frac{751\ \text{torr}}{760\ \frac{\text{torr}}{\text{atm}}} = 0.9882\ \text{atm}$$

Now, calculate the molar quantity of CO_2 consumed per kg of LiOH:

$$n_{CO_2} = 1000\ \text{g LiOH} \times \frac{1\ \text{mol LiOH}}{24.02\ \text{g LiOH}} \times \frac{1\ \text{mol CO}_2}{2\ \text{mol LiOH}} = 20.815\ \text{mol CO}_2$$

Finally, calculate the volume of CO_2 consumed per kg LiOH:

$$\frac{PV}{nT} = R \quad \text{so.....} \quad V = \frac{nTR}{P} = \frac{(20.815\ \text{mol})(299.1\ \text{K})(0.08206\ \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})}{0.9882\ \text{atm})} = 517\ \text{L}$$

6-32

A sample of N_2(g) occupies a volume of 42.0 mL under the existing barometric pressure. Increasing the pressure by 85 mm Hg reduces the volume to 37.7 mL. What is the prevailing barometric pressure, in millimeters of mercury?

V_1 = 42.0 mL
P_1 = unknown

V_2 = 37.7 mL
P_2 = P_1 + 85 mmHg

$$P_1(42.0\text{ mL}) = (P_1 + 85\text{ mmHg})(37.7\text{ mL})$$
$$1.114P_1 = P_1 + 85\text{ mmHg}$$
$$0.114P_1 = 85\text{ mmHg}$$
$$P_1 = P_{\text{barometric}} = 745\text{ mmHg}$$