Gas Mixture Percent by Mass

A mixture of oxygen and helium is 87.4% by mass oxygen with a total pressure of 675 Torr. What is the partial pressure of oxygen in this mixture?

1. 688 Torr

2. 590 Torr

3. 299 Torr

4. 314 Torr **correct**

5. 333 Torr

Explanation:

Assume you have 100 g of this mixture; calculate the number of moles:

$$\begin{aligned} n_{O_2} &= (87.4\text{ g } O_2)\,\frac{1\text{ mol } O_2}{31.9988\text{ g } O_2} \\ &= 2.73135\text{ mol } O_2\,. \end{aligned}$$

$$\begin{aligned} n_{He} &= (12.6\text{ g He})\frac{1\text{ mol He}}{4.0026\text{ g He}} \\ &= 3.14795\text{ mol He}\,. \end{aligned}$$

$$\begin{aligned} n_{tot} &= n_{O_2} + n_{He} \\ &= 2.73135\text{ mol } O_2 + 3.14795\text{ mol He} \\ &= 5.87931\text{ mol gas} \end{aligned}$$

Dalton's Law:

$$\begin{aligned} P_{O_2} &= P_{tot} \times \chi_{O_2} \\ &= P_{tot} \times \frac{n_{O_2}}{n_{tot}} \\ &= (687\text{ Torr})\frac{2.73135\text{ mol } O_2}{5.87931\text{ mol gas}} \\ &= 313.585\text{ Torr} \end{aligned}$$

KMT Calculation Modified

If the average speed of a CO_2 molecule is $411\ \text{m}\cdot\text{s}^{-1}$ at 25°C, what is the average speed of a molecule of CH_4 at the same temperature?

1. $247\ \text{m}\cdot\text{s}^{-1}$

2. $410\ \text{m}\cdot\text{s}^{-1}$

3. $681\ \text{m}\cdot\text{s}^{-1}$ **correct**

4. $1130\ \text{m}\cdot\text{s}^{-1}$

5. $1000\ \text{m}\cdot\text{s}^{-1}$

Explanation:

From kinetic molecular theory, the temperature is *directly* proportional to mean KE. $\text{KE}_{mean} = \frac{1}{2}(\text{MW})(\text{average molecular speed})^2$ and knowing T is constant,

$$\begin{aligned} \frac{v_{CH_4}}{v_{CO_2}} &= \sqrt{\frac{\text{MW}_{CO_2}}{\text{MW}_{CH_4}}} \\ v_{CH_4} &= v_{CO_2}\sqrt{\frac{\text{MW}_{CO_2}}{\text{MW}_{CH_4}}} \\ &= (411\text{ m/s})\sqrt{\frac{44.0098\text{ g/mol}}{16.0426\text{ g/mol}}} \\ &= 680.737 \end{aligned}$$