

CHEM 150: Ch. 10 Ideal Gas Law

- How many moles of gas (air) are in the lungs of an adult with a lung capacity of 3.9 L? Assume that the lungs are at 1.00 atm pressure and at a body temperature of 40 °C.
(Hint: V, P, and T are given. Use the equation $PV = nRT$ where $R = 0.082058 \frac{L \cdot atm}{K \cdot mol}$)
- Calculate the volume occupied by 0.921 moles of nitrogen gas (N₂) at a pressure of 1.38 atm and a temperature of 316 K.
- A sample of gas has a mass of 0.312 g. Its volume is 0.255 L at a temperature of 55 °C and a pressure of 888 mmHg (1 atm = 760 mmHg). Find its molar mass $\frac{Mass (m)}{Moles (n)}$
(Hint: use $PV = nRT$)
- A piece of dry ice (solid carbon dioxide) with a mass of 30.0 g sublimates (solid to gas) into a large balloon. Assuming that all of the carbon dioxide ends up in the balloon, what is the volume of the balloon at a temperature of 22 °C and a pressure of 742 mmHg?
(Hint: 1 atm = 760 mmHg)

5. What is the volume occupied by 0.212 mol of helium gas at a pressure of 0.95 atm and a temperature of 325 K?
6. A cylinder contains 32.4 L of oxygen gas at a pressure of 2.3 atm and a temperature of 298 K. How much gas (in moles) is in the cylinder?
7. A sample of gas has a mass of 0.501 g. Its volume is 0.425 L at a temperature of 110 °C and a pressure of 1120 mmHg. Find its molar mass.

Solutions

1. How many moles of gas (air) are in the lungs of an adult with a lung capacity of 3.9 L? Assume that the lungs are at 1.00 atm pressure and at a body temperature of 40 °C.

(Hint: V, P, and T are given. Use the equation $PV = nRT$ where $R = 0.082058 \frac{L \cdot atm}{K \cdot mol}$)

$$K = 40 \text{ }^\circ\text{C} + 273.15 = 313.15 \text{ K}$$

$$n = \frac{PV}{RT} = \frac{(1.00 \text{ atm})(3.9 \text{ L})}{(0.082058 \frac{L \cdot atm}{K \cdot mol})(313.15 \text{ K})} = 0.15 \text{ mol}$$

2. Calculate the volume occupied by 0.921 moles of nitrogen gas (N₂) at a pressure of 1.38 atm and a temperature of 316 K.

$$V = \frac{nRT}{P} = \frac{(0.921 \text{ mol})(0.082058 \frac{L \cdot atm}{K \cdot mol})(316 \text{ K})}{(1.38 \text{ atm})} = 17.3 \text{ L}$$

3. A sample of gas has a mass of 0.312 g. Its volume is 0.255 L at a temperature of 55 °C and a pressure of 888 mmHg. Find its molar mass $\frac{\text{Mass (m)}}{\text{Moles (n)}}$

$$K = 55 \text{ }^\circ\text{C} + 273.15 = 328.15 \text{ K}$$

$$P = 888 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = 1.1684 \text{ atm}$$

$$n = \frac{PV}{RT} = \frac{(1.1684 \text{ atm})(0.255 \text{ L})}{(0.082058 \frac{L \cdot atm}{K \cdot mol})(328.15 \text{ K})} = 0.01106 \text{ mol}$$

$$\text{molar mass} = \frac{\text{Mass (m)}}{\text{Moles (n)}} = \frac{0.312 \text{ g}}{0.01106 \text{ mol}} = 28.2 \text{ g/mol}$$

is the molar mass of this gas.

4. A piece of dry ice (solid carbon dioxide) with a mass of 30.0 g sublimates (solid to gas) into a large balloon. Assuming that all of the carbon dioxide ends up in the balloon, what is the volume of the balloon at a temperature of 22 °C and a pressure of 745 mmHg?

$$30.0 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} = 0.68166 \text{ mol CO}_2 ; K = 22 \text{ }^\circ\text{C} + 273.15 = 295.15 \text{ K}$$

$$745 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = 0.980 \text{ atm}$$

$$PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{(0.68166 \text{ mol CO}_2)(0.082058 \frac{L \cdot atm}{K \cdot mol})(295.15 \text{ K})}{(0.980 \text{ atm})} = 16.8 \text{ L}$$

5. What is the volume occupied by 0.212 mol of helium gas at a pressure of 0.95 atm and a temperature of 325 K?

$$PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{(0.212 \text{ mol})(0.082058 \frac{\text{L} \cdot \text{atm}}{\text{K} \cdot \text{mol}})(325 \text{ K})}{(0.95 \text{ atm})} = 6.0 \text{ L}$$

6. A cylinder contains 32.4 L of oxygen gas at a pressure of 2.3 atm and a temperature of 298 K. How much gas (in moles) is in the cylinder?

$$PV = nRT \rightarrow n = \frac{PV}{RT} = \frac{(2.3 \text{ atm})(32.4 \text{ L})}{(0.082058 \frac{\text{L} \cdot \text{atm}}{\text{K} \cdot \text{mol}})(298 \text{ K})} = 3.0 \text{ mol}$$

7. A sample of gas has a mass of 0.501 g. Its volume is 0.425 L at a temperature of 110 °C and a pressure of 1120 mmHg. Find its molar mass.

$$K = 110 \text{ }^\circ\text{C} + 273.15 = 383 \text{ K}$$

$$P = 1120 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = 1.47 \text{ atm}$$

$$n = \frac{PV}{RT} = \frac{(1.47 \text{ atm})(0.425 \text{ L})}{(0.082058 \frac{\text{L} \cdot \text{atm}}{\text{K} \cdot \text{mol}})(383 \text{ K})} = 0.0198786 \text{ mol}$$

$$\text{molar mass} = \frac{\text{Mass (m)}}{\text{Moles (n)}} = \frac{0.501 \text{ g}}{0.0198786 \text{ mol}} = 25.2 \text{ g/mol is the molar mass of this gas.}$$