CHEM 150: Ch. 10 Ideal Gas Law

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 $\frac{L \cdot atm}{K \cdot mol}$)

2. Calculate the volume occupied by 0.921 moles of nitrogen gas (N_2) at a pressure of 1.38 atm and a temperature of 316 K.

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 (1 atm = 760 mmHg). Find its molar mass $\frac{Mass\ (m)}{Moles\ (n)}$

   (Hint: use PV = nRT)

4. A piece of dry ice (solid carbon dioxide) with a mass of 30.0 g sublimes (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 oC 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 ^{o}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 °C + 273.15 = 313.15 K

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

2. Calculate the volume occupied by 0.921 moles of nitrogen gas (N_2) at a pressure of 1.38 atm and a temperature of 316 K.

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

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 $\frac{Mass\ (m)}{Moles\ (n)}$

   K = 55 °C + 273.15 = 328.15 K

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

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

   $$\text{molar mass} = \frac{Mass\ (m)}{Moles\ (n)} = \frac{0.312\ g}{0.01106\ mol} = 28.2 \text{ g/mol}$$ is the molar mass of this gas.

4. A piece of dry ice (solid carbon dioxide) with a mass of 30.0 g sublimes (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?

   $$30.0 \text{ g } CO_2 \times \frac{1\ mol\ CO2}{44.01\ g\ CO2} = 0.68166 \text{ mol } CO_2$$; K = 22 °C + 273.15 = 295.15 K

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

   $$PV = nRT \rightarrow V = \frac{nRT}{P} = \frac{(0.68166\ mol\ CO2)(0.082058\ \frac{L \cdot atm}{K \cdot mol})(295.15\ K)}{(0.980\ atm)} = 16.8 \text{ L}$$

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?

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

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?

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

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 °C + 273.15 = 383 K

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

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

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