2.4.4 Relationship between the volume and quantity of gas expressed in number of moles

31.

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\frac{70\ \text{L}}{4\ \text{mol}} = \frac{V_2}{6\ \text{mol}}$$

$$V_2 = \frac{70\ \text{L} \cdot 6\ \cancel{\text{mol}}}{4\ \cancel{\text{mol}}} = 105\ \text{L}$$

Answer: The volume of the container must be 1×10^2 L.

32. *1. Calculation of* n_2*:*

$$n_2 = 5.2\ \text{mol} + 2.2\ \text{mol} = 7.4\ \text{mol}$$

2. Calculation of the volume:

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\frac{6.7\ \text{L}}{5.2\ \text{mol}} = \frac{V_2}{7.4\ \text{mol}}$$

$$V_2 = \frac{6.7\ \text{L} \cdot 7.4\ \cancel{\text{mol}}}{5.2\ \cancel{\text{mol}}} = 9.5\ \text{L}$$

Answer: The volume of the balloon will be 9.5 L.

33 *1. Calculation of the number of moles:*

$$n = \frac{m}{M}$$

$$n_1 = \frac{16\ \text{g}}{4.003\ \text{g/mol}} = 3.997\ \text{mol}$$

$$n_2 = 3.997\ \text{mol} + \frac{16\ \cancel{\text{g}}}{31.998\ \cancel{\text{g}}/\text{mol}} = 4.497\ \text{mol}$$

2. Calculation of the volume:

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\frac{81\ \text{L}}{3.997\ \text{mol}} = \frac{V_2}{4.497\ \text{mol}}$$

$$V_2 = \frac{81\ \text{L} \cdot 4.497\ \cancel{\text{mol}}}{3.997\ \cancel{\text{mol}}} = 91\ \text{L}$$

Answer: The volume of the balloon will be 91 L.

34. *1. Calculation of the number of moles remaining in the tire:*

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\frac{35\ \text{L}}{3.3\ \text{mol}} = \frac{29\ \text{L}}{n_2}$$

$$n_2 = \frac{29\ \cancel{\text{L}} \cdot 3.3\ \text{mol}}{35\ \cancel{\text{L}}} = 2.734\ \text{mol}$$

2. Calculation of the number of moles that escaped:

$$n_{esc} = 3.3\ \text{mol} - 2.734\ \text{mol} = 0.57\ \text{mol}$$

Answer: 0.57 mol of air molecules escaped from the tire.

35. *1. Calculation of the total number of moles:*

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\frac{1.76\ \text{L}}{0.0784\ \text{mol}} = \frac{1.98\ \text{L}}{n_2}$$

$$n_2 = \frac{1.98\ \text{L} \cdot 0.0784\ \text{mol}}{1.76\ \text{L}} = 0.0882\ \text{mol}$$

2. Calculation of the number of moles that must be added:

$$n_{add} = 0.0882\ \text{mol} - 0.0784\ \text{mol} = 0.0098\ \text{mol}$$

Answer: 0.0098 mol of carbon dioxide (CO_2) must be added to the balloon. If the carbon dioxide were replaced by helium (He), the same number of moles would have to be added to the balloon, that is, 0.0098 mol of helium.

2.4.5 Molar volume of gases

37. $\frac{22.4\ \text{L}}{1\ \text{mol}} = \frac{?}{3.45\ \text{mol}}$

$? = \frac{22.4\ \text{L} \cdot 3.45\ \cancel{\text{mol}}}{1\ \cancel{\text{mol}}} = 77.3\ \text{L}$

Answer: The molar volume of argon (Ar) gas is 77.3 L.

38. *a)*

$\frac{24.5\ \text{L}}{1\ \text{mol}} = \frac{5.1\ \text{L}}{?}$

$? = \frac{1\ \text{mol} \cdot 5.1\ \cancel{\text{L}}}{24.5\ \cancel{\text{L}}} = 0.21\ \text{mol}$

b) 1. Conversion from mL into L:

$\frac{1\ \text{L}}{1000\ \text{mL}} = \frac{?}{20.7\ \cancel{\text{mL}}}$

$? = \frac{1\ \text{L} \cdot 20.7\ \cancel{\text{mL}}}{1000\ \text{mL}} = 0.0207\ \text{L}$

2. Calculation:

$\frac{22.4\ \text{L}}{1\ \text{mol}} = \frac{0.0207\ \text{L}}{?}$

$? = \frac{1\ \text{mol} \cdot 0.0207\ \cancel{\text{L}}}{22.4\ \cancel{\text{L}}} = 9.24 \cdot 10^{-4}\ \text{mol}$

c) 1. Conversion from mL into L:

$\frac{1\ \text{L}}{1000\ \text{mL}} = \frac{?}{90\ \text{mL}}$

$? = \frac{1\ \text{L} \cdot 90\ \cancel{\text{mL}}}{1000\ \cancel{\text{mL}}} = 0.090\ \text{L}$

2. Calculation:

$\frac{24.5\ \text{L}}{1\ \text{mol}} = \frac{0.090\ \text{L}}{?}$

$? = \frac{1\ \text{mol} \cdot 0.090\ \cancel{\text{L}}}{24.5\ \cancel{\text{L}}} = 3.7 \cdot 10^{-3}\ \text{mol or } 3.7\ \text{mmol}$

41. $\frac{22.4\ \text{L}}{1\ \text{mol}} = \frac{?}{2.25\ \text{mol}}$

$? = \frac{22.4\ \text{L} \cdot 2.25\ \cancel{\text{mol}}}{1\ \cancel{\text{mol}}} = 50.4\ \text{L}$

Answer: The neon (Ne) will occupy a volume of 50.4 L.

42. $\frac{24.5\ \text{L}}{1\ \text{mol}} = \frac{?}{500\ \text{mol}}$

$? = \frac{24.5\ \text{L} \cdot 500\ \cancel{\text{mol}}}{1\ \cancel{\text{mol}}} = 12\,250\ \text{L}$

Answer: Hydrogen (H_2) occupies a volume of 12 300 L.

43. $\frac{24.5\ \text{L}}{1\ \text{mol}} = \frac{?}{56\ \text{mol}}$

$? = \frac{24.5\ \text{L} \cdot 56\ \cancel{\text{mol}}}{1\ \cancel{\text{mol}}} = 1372\ \text{L}$

Answer: The volume occupied by the hydrogen sulphide (H_2S) is 1400 L.

44. *1. Calculation of the number of moles of H_2:*

$\frac{2.016\ \text{g}}{1\ \text{mol}} = \frac{2.02\ \text{g}}{?}$

$? = \frac{1\ \text{mol} \cdot 2.02\ \cancel{\text{g}}}{2.016\ \cancel{\text{g}}} = 1.001\,98\ \text{mol}$

2. Calculation of the volume:

$\frac{24.5\ \text{L}}{1\ \text{mol}} = \frac{?}{1.001\,98\ \text{mol}}$

$? = \frac{24.5\ \text{L} \cdot 1.001\,98\ \cancel{\text{mol}}}{1\ \cancel{\text{mol}}} = 24.5\ \text{L}$

Answer: The volume occupied by the hydrogen (H_2) is 24.5 L.

45. *a)*

$\frac{22.4\ \text{L}}{1\ \text{mol}} = \frac{2.00\ \text{L}}{?}$

$? = \frac{1\ \text{mol} \cdot 2.00\ \cancel{\text{L}}}{22.4\ \cancel{\text{L}}} = 8.93 \cdot 10^{-2}\ \text{mol}$

Answer: There are $8.93 \cdot 10^{-2}$ mol of helium (He).

b) 1. Calculation of the number of moles:

$\frac{22.4\ \text{L}}{1\ \text{mol}} = \frac{11.2\ \text{L}}{?}$

$? = \frac{1\ \text{mol} \cdot 11.2\ \cancel{\text{L}}}{22.4\ \cancel{\text{L}}} = 0.500\ \text{mol}$

2. Calculation of the number of molecules:

$\frac{6.02 \cdot 10^{23}\ \text{molecules}}{1\ \text{mol}} = \frac{?}{0.500\ \text{mol}}$

$? = \frac{0.500\ \text{mol} \cdot 6.02 \cdot 10^{23}\ \text{molecules}}{1\ \text{mol}}$

$= 3.01 \cdot 10^{23}\ \text{molecules}$

Answer: There are 3.01×10^{23} molecules of helium (He).