Answer on Question # 59790 – Chemistry – General Chemistry

You have a 10-L container filled with 0.5 mol of O_2 has at a temperature of 30 degrees C with a pressure of 945torr.

a. What will happen to the pressure if the container size is doubled while keeping the temperature and number of moles constant?

b. What will happen to the pressure when the temperature is doubled while keeping the size of the container and the number of moles constant?

c. What will happen to the pressure when the amount of O_2 has is cut in half while keeping the size of the container and the temperature constant?

Solution:

a) According to the Boyle's law:

$$\mathrm{pV} = \mathrm{const};$$

where $\mathrm{p}\left[\mathrm{Pa}\right]$ is the pressure, $\mathrm{V}\left[\mathrm{m}^3\right]$ is the volume of the container. Since torrs are proportional to pascals ($1\left[\mathrm{Torr}\right] = \frac{101325}{760}\left[\mathrm{Pa}\right]$), litres are proportional to meters ($1\left[\mathrm{l}\right] = \frac{1}{100}\left[\mathrm{m}^3\right]$), this law can be written as follows:

$$\mathrm{p_1V_1} = \mathrm{p_2V_2};$$

$$\mathrm{p_2} = \frac{\mathrm{p_1V_1}}{\mathrm{V_2}} = \frac{\mathrm{p_1V_1}}{(2\mathrm{V_1})} = \frac{\mathrm{p_1}}{2} = \frac{945}{2} = 472.5\left[\mathrm{Torr}\right].$$

If the volume of the container is doubled at a constant temperature and number of moles, the pressure will decrease twice.

b) According to the Charles's law:

$$\frac{\mathrm{p}}{\mathrm{T}} = \mathrm{const};$$

where $\mathrm{T}\left[\mathrm{K}\right]$ is the temperature. Since the temperature in the container is given in Celsium degrees, and $\mathrm{T}\left[\mathrm{C}^0\right] + 273.15 = \mathrm{T}\left[\mathrm{K}\right]$, this law can be written as follows:

$$\frac{\mathrm{p_1}}{(\mathrm{T_1} + 273.15)} = \frac{\mathrm{p_2}}{(\mathrm{T_2} + 273.15)};$$

$$\mathrm{p_2} = \frac{\mathrm{p_1T_2}}{\mathrm{T_1}} = \frac{\mathrm{p_1}(2\mathrm{T_1} + 273.15)}{\mathrm{T_1} + 273.15} = \mathrm{p_1}\frac{(2\cdot 30 + 273.15)}{30 + 273.15} = 1{,}1\mathrm{p_1} = 1{,}1\cdot 945 = 1039.5\left[\mathrm{Torr}\right].$$

If the temperature in the container is doubled at a constant volume and number of moles, the pressure will increase to $1{,}1\mathrm{p_1}$.

c) According to the ideal gas law:

$$\mathrm{pV} = \mathrm{nRT};$$

where n is the number of moles in the container, R $\left[\frac{\mathrm{J}}{\mathrm{mol}\cdot\mathrm{K}}\right]$ is the gas constant.

If the size and the temperature in the container are constant:

$$\frac{p_1}{n_1} = \frac{p_2}{n_2};$$

$$p_2 = \frac{p_1 n_2}{n_1} = \frac{p_1 (0.5 n_1)}{n_1} = 0.5 p_1 = 0.5 \cdot 945 = 472.5 \left[\text{Torr} \right].$$

Answer: a) the pressure will decrease twice: $p_2 = \frac{p_1}{2} = 472.5 \left[\text{Torr} \right]$;

b) the pressure will increase to $p_2 = 1,1 p_1 = 1039.5 \left[\text{Torr} \right]$;

c) the pressure will decrease twice: $p_2 = 0.5 p_1 = 472.5 \left[\text{Torr} \right]$.