Section 2.6
General gas law

textbook, p. 107

1. *1. Conversion of the temperature into kelvin:*

$T_1 = -200°C + 273 = 73\ K$

2. Calculation of the temperature:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Since $n_1 = n_2$: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$T_2 = P_2V_2 \cdot \frac{T_1}{P_1V_1}$$

$$T_2 = 100\ \text{kPa} \cdot 600\ \text{mL} \cdot \frac{73\ \text{K}}{110\ \text{kPa} \cdot 400\ \text{mL}} = 99.55\ \text{K}$$

3. Conversion of the temperature into degrees Celsius:

$T = 99.55\ K - 273 = -173.45°C$

Answer: The gas must be brought to a temperature of −173°C.

2. *1. Conversion of the temperature into kelvin:*

$T_1 = 50°C + 273 = 323\ K$

$T_2 = 17°C + 273 = 290\ K$

2. Calculation of the volume:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Since $n_1 = n_2$: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1}{T_1} \cdot \frac{T_2}{P_2}$$

$$= \frac{75\ \text{kPa} \cdot 100\ \text{L}}{323\ \text{K}} \cdot \frac{290\ \text{K}}{100\ \text{kPa}} = 67.34\ \text{L}$$

Answer: The volume of the gas would be 67 L.

3. *1. Conversion of the temperature into kelvin:*

$T_1 = 20°C + 273 = 293\ K$

$T_2 = 35°C + 273 = 308\ K$

2. Calculation of the volume:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Since $n_1 = n_2$: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1}{T_1} \cdot \frac{T_2}{P_2}$$

$$= \frac{100\ \text{kPa} \cdot 5.0\ \text{L}}{293\ \text{K}} \cdot \frac{308\ \text{K}}{90\ \text{kPa}} = 5.8\ \text{L}$$

Answer: The volume of the gas would 5.8 L.

4. *1. Conversion of the temperature into kelvin:*

$T_1 = 40°C + 273 = 313\ K$

2. Calculation of the temperature:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Since $n_1 = n_2$: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$T_2 = P_2V_2 \cdot \frac{T_1}{P_1V_1}$$

$$= 35\ \text{atm} \cdot 23\ \text{mL} \cdot \frac{313\ \text{K}}{1\ \text{atm} \cdot 500\ \text{mL}} = 503.93\ \text{K}$$

3. Conversion of the temperature into degrees Celsius:

$T = 503.93\ K - 273 = 230.93°C$

Answer: The final temperature of the gas in the cylinder will be 231°C.-

5. *1. Conversion of the temperature into kelvin:*

$T_1 = 25°C + 273 = 298\ K$

$T_2 = 20°C + 273 = 293\ K$

2. Calculation of the volume:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Since $n_1 = n_2$: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1}{T_1} \cdot \frac{T_2}{P_2}$$

$$= \frac{102.5\ \text{kPa} \cdot 1.0\ \text{L}}{298\ \text{K}} \cdot \frac{293\ \text{K}}{98.6\ \text{kPa}} = 1.022\ \text{L}$$

Answer: The new volume of the balloon is 1.0 L.

8. *1. Conversion of the temperature into kelvin:*

$T_1 = 25°C + 273 = 298\ K$

$T_2 = -20°C + 273 = 253\ K$

2. Calculation of P_2:

$P_2 = 4 \cdot 100\ kPa$

3. Calculation of the volume:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Since $n_1 = n_2$: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1}{T_1} \cdot \frac{T_2}{P_2}$$

$$= \frac{100\ \cancel{kPa} \cdot 600\ mL}{298\ \cancel{K}} \cdot \frac{253\ \cancel{K}}{400\ \cancel{kPa}}$$

$$= 127\ mL$$

Answer: The final volume of the methane (CH_4) gas sample is 127 mL.

10. *1. Conversion of the temperature into kelvin:*

$T_1 = 0°C + 273 = 273\ K$

2. Calculation of the temperature:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Since $n_1 = n_2$: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$T_2 = P_2V_2 \cdot \frac{T_1}{P_1V_1}$$

$$= 110\ \cancel{kPa} \cdot 24\ \cancel{mL} \cdot \frac{273\ K}{101.3\ \cancel{kPa} \cdot 48\ \cancel{mL}} = 148.22K$$

3. Conversion of the temperature into degrees Celsius:

$T = 148.22\ K - 273 = -124.78\ °C$

Answer: The new temperature of the gas is 1.5×10^2 K or -1.2×10^2 °C.

13. *1. Conversion of the temperature into kelvin:*

$T_1 = 205°C + 273 = 478\ K$

$T_2 = 25°C + 273 = 298K$

2. Calculation of the pressure:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Since $n_1 = n_2$: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$P_2 = \frac{P_1V_1}{T_1} \cdot \frac{T_2}{V_2}$$

$$P_2 = \frac{350\ kPa \cdot 5.0\ \cancel{L}}{478\ \cancel{K}} \cdot \frac{298\ \cancel{K}}{1.7\ \cancel{L}}$$

$$= 641.77\ kPa$$

Answer: A pressure of $\times 10^2$ kPa must be applied to the gas.