2.4.3 Relationship between pressure and temperature

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

$T_1 = 30°C + 273 = 303\ K$

2. Calculation of the temperature:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{90\ kPa}{303\ K} = \frac{110\ kPa}{T_2}$$

$$T_2 = \frac{110\ \cancel{kPa} \cdot 303\ K}{90\ \cancel{kPa}} = 370\ K$$

3. Conversion of the temperature into degrees Celsius:

$T_2 = 370\ K - 273 = 97°C$

Answer: The thermometer will show a temperature of 97°C.

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

$T_1 = 25°C + 273 = 298\ K$

$T_2 = 50°C + 273 = 323\ K$

2. Calculation of the pressure:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{700\ mm\ Hg}{298\ K} = \frac{P_2}{323\ K}$$

$$P_2 = \frac{700\ mm\ Hg \cdot 323\ \cancel{K}}{298\ \cancel{K}} = 759\ mm\ Hg$$

Answer: The final pressure exerted by the gas will be 759 mm Hg.

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

$T_2 = 20°C + 273 = 293\ K$

2. Calculation of the pressure:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{101.3\ kPa}{273\ K} = \frac{P_2}{293\ K}$$

$$P_2 = \frac{101.3\ kPa \cdot 293\ \cancel{K}}{273\ \cancel{K}} = 109\ kPa$$

Answer: The manometer will show a pressure of 109 kPa.

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

$T_1 = 45°C + 273 = 318\ K$

2. Calculation of the temperature:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{110\ kPa}{318\ K} = \frac{89\ kPa}{T_2}$$

$$T_2 = \frac{89\ \cancel{kPa} \cdot 318\ K}{110\ \cancel{kPa}} = 257.3\ K$$

3. Conversion of the temperature into degrees Celsius:

$T_2 = 257.3\ K - 273 = -16°C$

Answer: The temperature inside the freezer is −16°C.

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

$T_1 = 20°C + 273 = 293\ K$

2. Calculation of P_2:

$P_2 = 2P_1$

3. Calculation of the temperature:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{P_1}{293\ K} = \frac{2P_1}{T_2}$$

$$T_2 = \frac{2\cancel{P_1} \cdot 293\ K}{\cancel{P_1}} = 586\ K$$

4. Conversion of the temperature into degrees Celsius:

$T_2 = 586\ K - 273 = 313°C$

Answer: The gas must be heated to a temperature of 313°C.

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

$T_1 = 35°C + 273 = 308\ K$

2. Calculation of the temperature:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{150\ kPa}{308\ K} = \frac{250\ kPa}{T_2}$$

$$T_2 = \frac{250\ \cancel{kPa} \cdot 308\ K}{150\ \cancel{kPa}} = 513.3\ K$$

3. Conversion of the temperature into degrees Celsius:

$T_2 = 513.3\ K - 273 = 240.3°C$

Answer: The valve will open when the butane (C_4H_{10}) reaches a temperature of 240°C.

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

$T_1 = 15°C + 273 = 288\ K$

2. Calculation of T_2:

$T_2 = 2 \cdot 288\ K = 576\ K$

3. Calculation of the pressure:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{135.5\ kPa}{288\ K} = \frac{P_2}{576\ K}$$

$$P_2 = \frac{135.5\ kPa \cdot 576\ \cancel{K}}{288\ \cancel{K}} = 271\ kPa$$

Answer: The gas will exert a pressure of 271 kPa.

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

$T_1 = 18°C + 273 = 291\ K$

$T_2 = 40°C + 273 = 313\ K$

2. Calculation of the pressure:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{17.5\ atm}{291\ K} = \frac{P_2}{313\ K}$$

$$P_2 = \frac{17.5\ atm \cdot 313\ \cancel{K}}{291\ \cancel{K}} = 18.8\ atm$$

Answer: The pressure exerted by the helium (He) will be 18.8 atm.