Answer on Question #50649 – Physics – Molecular Physics | Thermodynamics

Question.

A certain mass of a gas at 273 K temperature and one atmospheric pressure is expanded to 3 times its original volume under adiabatic conditions. Calculate the resulting temperature and pressure. (Take the value of γ= 1.4)

Given:

$T_1 = 273\ K$

$P_1 = 1\ atm$

$V_2 = 3V_1$

$\gamma = 1.4$

Find:

$T_2 = ?$

$P_2 = ?$

Solution.

Adiabatic process is described by the following equation:

$$PV^{\gamma} = const$$

Therefore,

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

$$P_2 = P_1 \left(\frac{V_1}{V_2}\right)^{\gamma}$$

From other hand, the adiabatic equation is:

$$TV^{\gamma-1} = const$$

Therefore,

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

Calculate:

$$P_2 = P_1 \left(\frac{V_1}{V_2}\right)^{\gamma} = 1\ atm \cdot \left(\frac{1}{3}\right)^{1.4} = 1\ atm \cdot 0.215 = 0.215\ atm$$

$$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{\gamma-1} = 273 \cdot \left(\frac{1}{3}\right)^{0.4} = 273 \cdot 0.644 = 175.8\ K$$

Answer.

$$P_2 = P_1\left(\frac{V_1}{V_2}\right)^{\gamma} = 0.215\ atm$$

$$T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1} = 175.8\ K$$