Answer on Question #43050-Physics-Molecular Physics-Thermodynamics

If the temperature of a diatomic ideal gas initially at T and cooled to 1/4T calculate

1-the ratio of root mean square velocities and ratio of mean kinetic energies in two states

2-Cp,Cv and gamma constant of the gas

Solution

1. The root mean square velocity is

$$v_{rms} = \sqrt{\frac{3kT}{m}}.$$

The ratio of root mean square velocities in two states is

$$\frac{v_{2rms}}{v_{1rms}} = \frac{\sqrt{\frac{3kT_2}{m}}}{\sqrt{\frac{3kT_1}{m}}} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{\frac{1}{4}T}{T}} = \frac{1}{2}.$$

The mean kinetic energy of molecule is $\frac{3}{2}kT$.

The ratio of mean kinetic energies in two states

$$\frac{\frac{3}{2}kT_2}{\frac{3}{2}kT_1} = \frac{T_2}{T_1} = \frac{\frac{1}{4}T}{T} = \frac{1}{4}.$$

2. We have a diatomic ideal gas. Its molar heat capacities at constant volume is

$$c_V = \frac{5}{2}R = 20.8\frac{J}{molK}.$$

Its molar heat capacities at constant pressure is

$$c_p = c_V + R = \frac{7}{2}R = 29.1\frac{J}{molK}.$$

Its gamma constant is

$$\gamma = \frac{c_p}{c_V} = \frac{\frac{7}{2}R}{\frac{5}{2}R} = \frac{7}{5} = 1.4.$$