## Answer on Question #57122, Physics / Molecular Physics | Thermodynamics

10/ Calculate the change in entropy of gases in the following cases:

a) A 3.0 mol sample of an ideal gas expands reversibly and isothermally at 350 K until its volume doubled.

b) The temperature of 1.0 mol of an ideal monatomic gas is raised reversibly from 200 K to 300 K, with its volume kept constant.

**Solution:**

a) For the expansion (or compression) of an ideal gas from an initial volume $V_0$ to a final volume V at any constant temperature, the change in entropy is given by:

$$\Delta S = nR\ln\left(\frac{V}{V_0}\right)$$

Here n is the number of moles of gas and R is the ideal gas constant.

$$\Delta S = 3.0 \cdot 8.31 \cdot \ln(2) = 17.28\ \frac{J}{K}$$

b) For heating or cooling of any system (gas, liquid or solid) at constant volume from an initial temperature $T_0$ to a final temperature T, the entropy change is

$$\Delta S = nC_V\ln\left(\frac{T}{T_0}\right)$$

where the constant-volume heat capacity $C_v$ is constant and there is no phase change.

In the case of a monatomic gas

$$C_V = \frac{3}{2}R$$

where R is the ideal gas constant

Thus,

$$\Delta S = \frac{3}{2}nR\ln\left(\frac{T}{T_0}\right) = \frac{3}{2}\cdot 1.0 \cdot 8.31 \cdot \ln\left(\frac{300}{200}\right) = 5.05\ \frac{\text{J}}{\text{K}}$$

**Answer:** a) $17.28\ \frac{J}{K}$; b) $5.05\ \frac{\text{J}}{\text{K}}$