\[ PV = nRT \]
\[ \Delta S_{\text{univ}} > 0 \]

\[ \Delta S_{\text{gas}} = \int \frac{dQ}{T} \]
\[ \Delta S_{\text{gas}} = nC_v \ln 2 + nR \ln 2 = \frac{5}{2} nR \ln 2 \]

\[ \Delta S_{\text{env}} = -\frac{Q}{2T} \]

\[ Q = nC_v T + nRT \ln 2 = \frac{3}{2} nRT + nRT \ln 2 \]

\[ \Delta S_{\text{env}} = -\frac{3}{4} nR - \frac{nR}{2} \ln 2 ; \Delta S_{\text{env}} = 2nR \ln 2 - \frac{3}{4} nR \]
Correction on previous slide

\[ dQ = dE_{\text{int}} + dW \]
\[ dQ = nC_v dT + \frac{nRT dV}{V} \]
\[ Q = nC_v T + nRT \ln 2 \]

2\text{nd} term in the Q expression above is wrong, this is not a isothermal process

It is a process at constant P, where V and T are changing. So the work is:

\[ W = P \Delta V, \quad P = \frac{nRT}{V}, \quad \Delta V = (2V - V) \implies W = nRT \]

\[ \Delta S_{\text{env}} = -\frac{3}{4} nR - \frac{1}{2} nR = -\frac{5}{4} nR \]
\[ \Delta S_{\text{univ}} = \frac{5}{2} nR \ln 2 - \frac{5}{4} nR = \frac{5}{4} nR(2 \ln 2 - 1) = 0.48nR \]
initially: \( PV = nRT \). then, \( P' = P/2 \)

Work done by gas: \( W = \frac{P}{2} \Delta V = nRT/2 \)

Heat absorbed: \( \Delta E_{\text{int}} = Q - W = 0 \Rightarrow Q = W \)

So \( \Delta S_{\text{env}} = -\frac{Q}{T} = -\frac{nRT}{2T} = -\frac{nR}{2} \)

\( \Delta S_{\text{gas}} = nR \ln \frac{V_f}{V_i} = nR \ln 2 \)

\( \Delta S_{\text{univ}} = nR (\ln 2 - \frac{1}{2}) = 0.19nR \)
A statistical view of entropy

Learning Objectives

- **20.21** Explain what is meant by the configurations of a system of molecules.
- **20.22** Calculate the multiplicity of a given configuration.
- **20.23** Identify that all microstates are equally probable but the configurations with more microstates are more probable than the other configurations.
- **20.24** Apply Boltzmann’s entropy equation to calculate the entropy associated with a multiplicity.