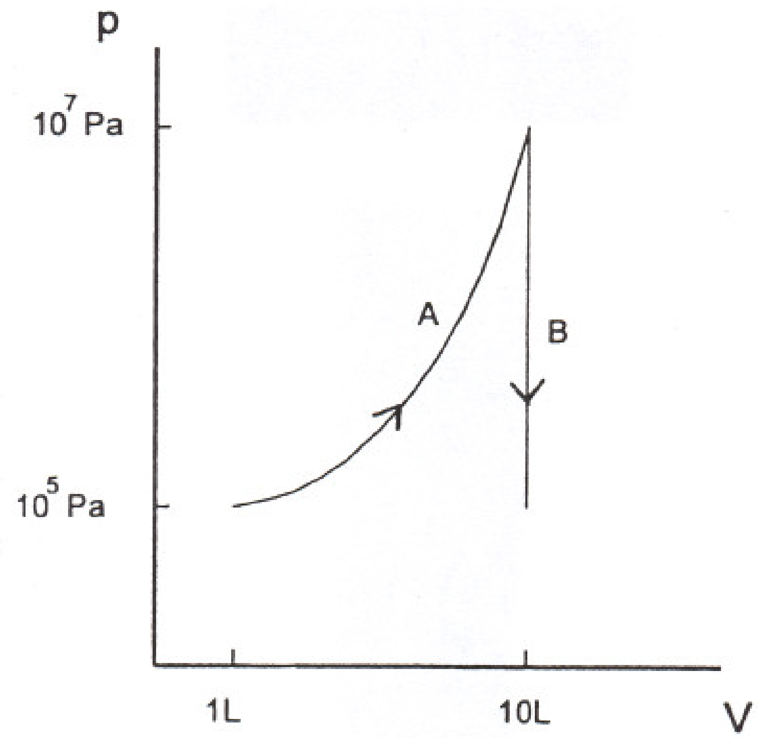
Candidacy Exam Fall 2000

Thermodynamics

[30] 1. Consider the following monatomic ideal gas process described by a reversible path in the p-V plane. There are 5 moles of gas.



The path marked A is a parabola $\left(P = \frac{10^5 \text{ Pa}}{L^2} V^2 \right)$. How much work must be done on the gas to traverse this path? What is the change in the entropy of the gas?

[20] 2. What is the *maximum* amount of work that can be extracted from a tank containing 100kg of water initially at 100°C if a giant reservoir of water at 20°C is available?

[30] 3. Prove that $\frac{C_p}{C_v} = \frac{\kappa_T}{\kappa_s}$ where κ_s is the adiabatic compressibility, $-\frac{1}{v}\left(\frac{\partial v}{\partial P}\right)_s$.

[20] 4. The equipartition theorem says that ideal gases have a molar specific constant volume heat capacity of $R/2$ for each degree of freedom. Explain qualitatively why diatomic gases have a c_v of $3R$ at high temperatures, $5R/2$ at intermediate temperatures and $3R/2$ at low temperatures?