Assignment 2

1 Entropy change in the isobaric-isochoric cycle of an ideal gas

Show that the entropy change in the cyclic process of an ideal gas, that is represented by a rectangle in the (P, V) diagram, is zero.

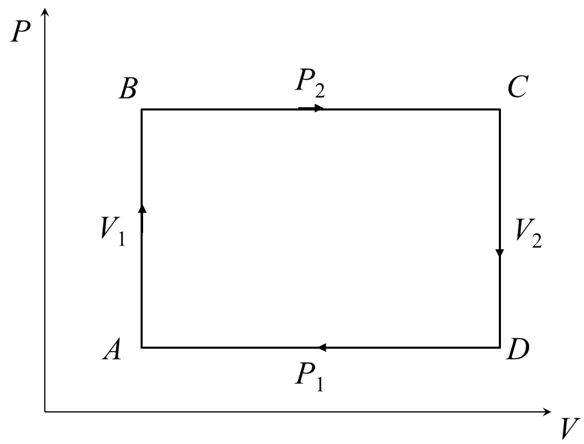

Figure 1: Isobar-isochore cycle.

2 Entropy change in the isobaric-isochoric-isothermic cycle of an ideal gas

Show that the entropy change in the cyclic process of an ideal gas that include an isobar, an isochor, and an isotherm is zero.

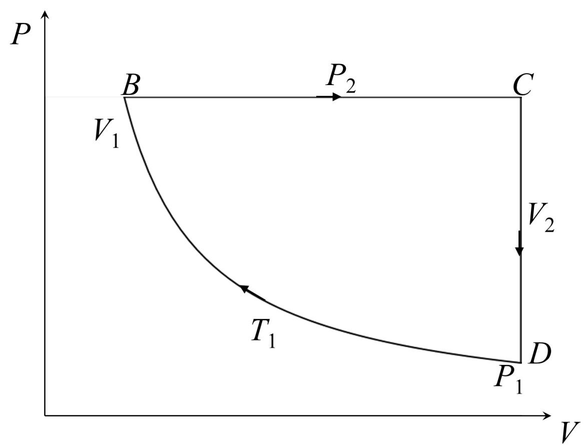

Figure 2: Isobar-isochor-isotherm cycle.

3 Entropy of a perfect gas

Calculate the entropy of a perfect gas as a function of (V, T) by integration using $S = \int \delta Q/T$.

4 Internal energy of a perfect gas in natural variables

Express the energy of a perfect gas in the natural variables, $U = U(S, V)$, and check relations

$$T = \left(\frac{\partial U}{\partial S}\right)_V, \qquad -P = \left(\frac{\partial U}{\partial V}\right)_S, \qquad \left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V.$$

5 Thermodynamic potentials F and G of the perfect gas

Express thermodynamic potentials F and G of the perfect gas in terms of their natural variables and check relations similar to those in the preceding problem.

6 Thermodynamics from F

The Helmholtz free energy of a certain gas has the form

$$F = -\frac{\nu^2 a}{V} - \nu RT \ln\left(V - \nu b\right) + J(T).$$

Find the equation of state of this gas, as well as its internal energy, entropy, heat capacities C_P and C_V and, in particular, their difference $C_P - C_V$.