

M04T.1—Equations of State

Problem

Experimentally, the equation of state (internal energy, U , and pressure, p) of a substance was found to be:

$$U = Vu(T), \quad p = \alpha u(T),$$

where V is the volume, T is the temperature, α is a constant and $u(T)$ is an unknown function.

- a) Determine the relation of T and V in an adiabatic process. If the process is instead isothermal, how much heat is exchanged with the heat bath?
- b) Sketch the p - V diagram for a Carnot cycle (2 adiabats, 2 isotherms) using this substance. Express the efficiency in terms of the function $u(T)$.
- c) Explain why the above efficiency should equal $1 - T_c/T_h$, where T_c and T_h are the temperatures of the low and high temperature isotherms in the Carnot cycle.
- d) What conclusions can you draw about the function $u(T)$, corresponding to the given value of α ?
- e) Give a physical system that shows this behavior.