## The Virial theorem

## Derivation of the virial theorem that connects kinetic and potential average energies.



## 1 Problem

In section 3.4 of Goldstein's book, an important theorem is derived – the *Virial theorem*. It says how averages of the kinetic and potential energies can be linked to one another. It is especially important for statistical mechanics, where it can be utilized to derive the 'ideal gas law'.

You should derive the theorem step-by-step, and also how, with the help of the equipartition theorem, the ideal gas law follows. Furthermore, derive the relations

$$\bar{T} = \frac{n}{n+2}E, \qquad \bar{V} = \frac{2}{n+2}E,$$

where we assume that the Hamiltonian is conservative and a homogeneous function of order n. Here, T and V are the standard kinetic and potential energies respectively, and E the total energy.