[tex176] Ideal gas atoms escaping from a container II

A large vessel of volume V initially contains N_0 atoms of a classical ideal gas in thermal equilibrium at temperature T. The rate at which the number N of atoms decreases due to particles escaping into the vacuum through a tiny hole of area A in a wall and the rate at which the escaping particles export energy is worked out in [tex62]:

$$\frac{dN}{dt} = -An\sqrt{\frac{1}{2\pi m}}(k_BT)^{1/2}, \quad \frac{dE}{dt} = An\sqrt{\frac{2}{\pi m}}(k_BT)^{3/2}.$$

(a) Find the density $n(t)$ of particles remaining in the vessel if the initial value is $n_0 = N_0/V$ and under the asumption that the gas is kept at constant temperature T.
(b) Find the energy $E(t)$ exported in the process.
(c) Compare the total energy $E(\infty)$ exported with the initial internal energy U_0 of the gas. Explain the source of the difference.

Solution: