Fermi

4.2. $pV^{1.2} = 10^9 T^{1.1}$ is the equation of state for a system. At $V = 100$ liters, the thermal capacity is a constant of 0.1 cal/degree. Express its energy and the entropy of the system as a function of T and V.

Thermal capacity being constant $\Rightarrow$ Energy $= C_V T$.

$$\boxed{E = 0.1\, T \text{ cal.}}$$

For the entropy, we apply

$$S = \int \frac{dQ}{T} \qquad dQ = dU + P\,dV,$$
$$= C_V dT + \frac{10^9 T^{1.1}}{V^{1.2}} dV.$$

$\Rightarrow$

$$S = \int_{\text{initial state}}^{\text{final state}} \frac{C_V}{T} dT + \frac{10^9 T^{0.1}}{V^{1.2}} dV$$

$\Rightarrow$ setting the initial state to have $S = 0$,

$$\boxed{S = C_V \ln T + 10^9 T^{0.1} \frac{1}{0.2} V^{0.2}.}$$