

PHY202: Thermodynamics and Statistical Physics

Assignment 4

1. What is the maximum possible efficiency of an engine operating between two thermal reservoirs, one at 100 °C and the other at 0 °C?
2. Show that the efficiency of the standard Otto cycle (2 adiabats and 2 isochores) is $1 - r^{1-\gamma}$, where $r = V_1/V_2$ is the compression ratio.
3. A mug of tea has been left to cool from 90°C to 18 °C. If there is 0.2 kg of tea in the mug, and the tea has specific heat capacity 4200 J/K.kg, estimate the entropy change of the tea. Comment on the sign of this result.
4. Consider n moles of an ideal gas, initially confined within a volume V and held at temperature T . The gas is expanded to a total volume αV , where α is a constant, by (a) a reversible isothermal expansion and (b) removing a partition and allowing a free "Joule" expansion into vacuum. Derive expressions for the change in entropy of the gas in both the above cases.
5. Calculate the change of entropy
 - (a) of a bath containing water, initially at 20 °C, when it is placed in thermal contact with a very large heat reservoir at 80 °C,
 - (b) of the reservoir when process (a) occurs,
 - (c) of the bath and of the reservoir if the bath is brought to 80 °C through the operation of a Carnot engine between them.The bath and its contents have total heat capacity 10^4 J/K.