PH2202 Thermal Physics
Fall Semester - 2024
Indian Institute of Science Education and Research, Kolkata
Instructor: Koushik Dutta

Homework: 4 Submission Date: 06/2/2024

The hand written solutions must be submitted at the start of the tutorial.

1. Starting from the first law in general, show that for an ideal gas, it can be written as $dQ = C_p dT - V dp$, where C_p is the specific heat at constant pressure.

2. Consider a reversible heat engine consisting of two isotherms of temperatures T_1 and T_2 and two isobars with pressures p_1 and p_2. The working substance for the heat engine is an ideal gas. Find out the efficiency of the heat engine. Assume C_p and C_v constant throughout the process.

3. Two Carnot's engines A and B operate in series. A receives heat at 900 K and rejects to a reservoir at T K. B receives the heat rejected by A and in turn rejects to a reservoir at 400 K. Find the temperature T when (a) the work output of A and B are equal and (b) the efficiencies of A and B are equal.

4. An ideal monoatomic gas occupies 2 litre at 30 K and 5×10^{-3} Pa. The internal energy of the gas taken to be zero at this point. It undergoes the following changes (a) The temperature is raised to 300 K at constant volume. (b) The gas is then expanded adiabatically till it attains the initial temperature. (c) Finally, it is compressed isothermally. Draw the cycle in the $p - V$ digram, and calculate the efficiency of the cycle.

5. Two identical bodies of constant heat capacity at temperature T_1 and T_2 are used as the source and sink respectively of a heat engine. If the bodies remain at constant pressure and there is no change in phase, show that the maximum possible work by the heat engine is $C_p(\sqrt{T_1} - \sqrt{T_2})^2$.