



The University of Zambia
School of Natural Sciences
Department of Physics

PHY2231: Properties of Matter and Thermodynamics

2022-2023 Academic year-Part I

Assignment 2

Hand in on Thursday 30th May

1. Two plates of equal dimensions and thermal conductivities K_1 and K_2 are welded together into a single plate of double thickness. Show that the equivalent thermal conductivity K is given by

$$K = \frac{2K_1K_2}{K_1 + K_2}.$$

2. A heat engine takes 0.350 mol of a diatomic ideal gas around the cycle shown in the PV-diagram in figure 1. Process 1 \rightarrow 2 is isochoric, process 2 \rightarrow 3 is adiabatic, and process 3 \rightarrow 1 is isobaric at 1.00 atm. The value of γ for this gas is 1.40.
 - (a) Find the pressure and volume at points 1, 2, and 3.
 - (b) Calculate Q , W , and ΔU for each of the three processes.
 - (c) Find the net work done by the gas in the cycle.
 - (d) Find the net heat flow into the engine in one cycle.
 - (e) What is the thermal efficiency of the engine?
 - (f) How does this compare to the efficiency of a Carnot-cycle engine operating between the same minimum and maximum temperatures T_1 and T_2 ?

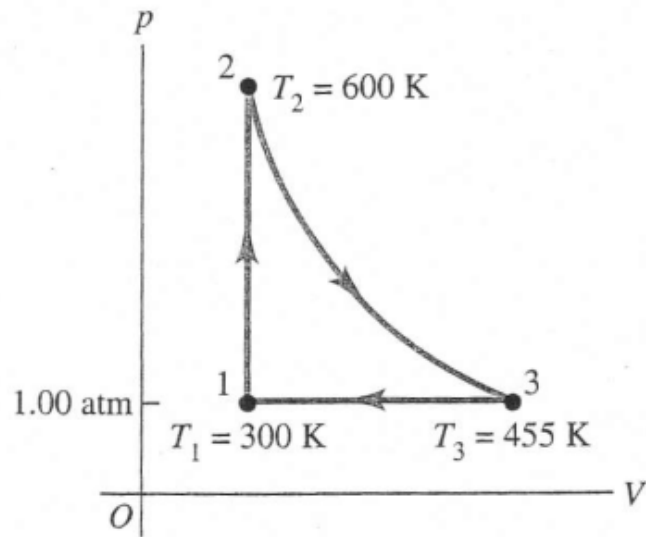


Figure 1: A thermodynamic cyclic process

3. Calculate the change in entropy when 1 g of gas expands five times its original volume.
4. 1 g of air ($\gamma = 1.4$) at 27°C and atmospheric pressure is suddenly compressed to half its original volume. Find the final
 - (a) Pressure, and
 - (b) Temperature.
5. Show that for the amount of heat $Q=100$ J, heat flow is allowed from a hot reservoir at $T_H = 373.16$ K to a cold one at $T_C = 303.16$ K but the reverse process is not allowed.