Thermal Physics, Autumn 2019 CMI
Problem set 4
Due by the beginning of lecture on Tuesday, Sep 17, 2019
Carnot Cycle, Second Law of Thermodynamics, Efficiency of heat engines

1. $\langle 5 \rangle$ Suppose the working substance of a Carnot engine operating between gas thermometer temperatures $T_2 > T_1$ is an ideal gas. Show that the ratios of volumes V_B/V_A and V_C/V_D are equal. Here AB is the isothermal expansion at high temperature T_2 and CD the isothermal compression at T_1. BC and DA are the adiabatic expansion and compression respectively.

2. $\langle 6 \rangle$ Consider the above Carnot cycle ABCDA operating between the gas thermometer temperatures $T_2 > T_1$. Express the ratio of heats absorbed and expelled Q_2/Q_1 in terms of the temperatures T_1, T_2 and volumes of the ideal gas at A, B, C and D.

3. $\langle 4 \rangle$ Give a formula for the efficiency η_{rev} of a reversible heat engine that operates between a pair of reservoirs at absolute thermodynamic temperatures $\theta_2 > \theta_1$. For a reversible refrigerator find the ratio of work required to transfer (extract) a unit amount of heat from the interior. Express this in terms of the corresponding absolute thermodynamic temperatures of the interior (θ_1) and exterior (θ_2).