**Thermal Physics, Autumn 2019 CMI**

Problem set 5

Due by the beginning of lecture, Tue, Oct 15, 2019

Entropy and its properties

1. ⟨**8**⟩ Suppose we choose the conjugate variables $T$ and $S$ as independent thermodynamic variables instead of $P$ and $V$. (a) Draw a diagram of a Carnot cycle on a $TS$ diagram ($T$ vertical, $S$ horizontal) indicating the axes, direction of process, adiabats, temperatures, isotherms. (b) Geometrically interpret the heats absorbed/expelled by the engine, net heat absorbed, the net work done and the efficiency of the engine.

2. ⟨**8**⟩ Show that the infinitesimal heat reversibly added to a gas (not necessarily ideal) can be expressed as (Hint: use results we have derived!)

$$TdS = c_V dT + \frac{\alpha T}{\kappa_T} dV. \tag{1}$$

3. ⟨**6**⟩ Calculate the adiabatic (isentropic) compressibility $\kappa_S$ of an ideal gas. Is it less or more than the isothermal compressibility?