1. Mass-Luminosity Relations

   a) Consider a chemically homogeneous star in which the equation of state is that of an ideal gas and in which heat is transferred only by radiative diffusion. Show that the luminosity $L$ of such a star scales approximately as
   \[ L \propto \frac{\mu^4 M^3}{\langle \kappa_R \rangle} \]
   where $\langle \kappa_R \rangle$ is a typical value of the Rosseland mean opacity in the stellar interior.

   b) Determine how $L$ scales as a function of $\mu$, $M$ and $R$ only, for
   (i) a star like the sun ($M \approx 1M_\odot$)
   (ii) a massive star ($M \approx 30M_\odot$)

   Hint: What is the dominant opacity source in each of these stars? Your answer for the $30M_\odot$ star will be inaccurate, since radiation pressure is not negligible within such a star.

2. Motion of a fluid element

   Consider a region inside a star which is stable against convection. A fluid element in such a region is displaced adiabatically from its equilibrium position by a small distance $\Delta r$ and remains in pressure equilibrium with its surroundings.

   a) Show that the element oscillates in simple harmonic motion about its equilibrium position.

   b) Find an expression for the frequency $\omega$ of oscillation.