Student name: AST221H
Student #: **Assignment 3** Due: Oct. 29, 2020

You may work together with other students to solve these problem sets, but all solutions must be written and submitted independently. Submit your assignment as a single .pdf file following the instructions on Quercus. ***Part marks only will be given for solutions with no explanation. Show your work, including intermediate steps and diagrams if necessary!*** *Check the syllabus for reading recommendations. Careful with units!*

Problem 1: Eddington Luminosity

Consider a proton and electron (i.e. an ionized hydrogen atom) located at some distance d from star that has mass M, radius R, luminosity L and temperature T. For purposes of this problem, assume $d >> R$.

1. Consider two forces acting on the ion: radiation pressure and gravity. Write down an expression for the net force, F, on the ion as a function of the variables described above. You may have to "invent" an expression for the force due to radiation on the electron, but remember that force is the change in momentum per unit time. Recall that the cross section for photons scattering via Thomson scattering on electrons is σ_T.
2. Solve the equation determined in the previous part for L in the $F = 0$ case. Describe what the solution means physically.
3. The luminosity that you have just determined is called the Eddington Luminosity. Evaluate the Eddington Luminosity, L_{Edd}, for the Sun.
4. Finally, for stars on the main sequence, the observed mass-luminosity relationship gives $L \propto M^4$. What mass of stars are at the Eddington luminosity? What would happen to stars more massive than this?

(Why all this junk about an "ion"? The ion must exist because one of the forces (you have two to pick from) acts primarily on the electron and one acts primarily on the proton. Invoking that we're examining an "ion" means that we're considering these two particles to be bound to each other by the (extremely strong compared to gravity) electrostatic force and acting as one unit, even though they're ionized.)