FP 6

Problem 1

For the following problem use only physics from this term and imagine that light is composed of particles called photons. A black hole is an object whose gravity is so strong that even light cannot escape. The radius, or "event horizon", of a black hole can be defined by the innermost distance from which light can escape. Recall that light propagates with velocity $c = 3 \times 10^8$ m/s. Hint: Note that the escape velocity of a particle, including a photon is independent of its mass.

(a) (4 points) Find an expression for the radius of a black hole of mass M. What is this radius for a black hole with the mass of our sun, $M_\odot = 2.0 \times 10^{30}$ kg.

(b) (3 points) If you find yourself standing at the event horizon of a black hole, the force of gravity at your feet is stronger than at your head. Assuming that your height $h = 2$ m, what is the difference in the acceleration due to gravity between your head and your feet for a solar mass black hole? (You may assume that $h \ll R$ if it is convenient.)

(c) (3 points) Considering your answer to part (b), would you be better off standing at the event horizon of a solar mass black hole or a much larger supermassive black hole ($M_{SM} = 10^7 M_\odot$) like those found in the center of most galaxies? Explain.