FP6

For the following problem use on 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 $c = 3\,\text{x}10^8$ 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 $M_\odot = 2.0\,\text{x}10^{30}$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 $h = 2m$, 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 $h << R$ 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.