DAY 25 – Homework

1. In a "black hole" the gravitational field is so strong that any light coming out of the hole loses all its energy (frequency of zero). (a) For a sphere of mass M, use the gravitational red shift formula to derive a formula for the maximum radius the mass can have and still not allow light to escape with any energy. This is known as the *Schwarzschild Radius*. (b) Obtain a formula for the minimum density of matter in such a black hole.

2. Look at example #1 for today and problem #1 above. Discuss what happens to time at the Schwarzschild Radius of a black hole. You do not need to derive the Schwarzschild Radius formula to figure out this problem.

3. Calculate how far a beam of light will drop when crossing a room that measures 20 ft across.

4. A light pulse leaves a planet's surface with wavelength of 400 nm and arrives at a distant observer with wavelength of 500 nm at observer. How much time will observer see go by if one hour passes on the planets surface?

5. Calculate the Schwarzschild Radius for the mass of the Earth; for the mass of the Sun. These are the sizes to which the Earth & Sun would need to be compressed to become black holes. If the Earth were compressed to a black hole, what would happen to the orbit of the moon?

6. For a minute in deep space, calculate how much time passes at Earth's surface? At the Sun's surface?

7. If the Earth were compressed to a black hole, at what distance from the black hole's center of mass could light orbit the black hole in a circular orbit? For a minute in deep space, calculate how much time would pass at this orbit?