Orbital Motion

- Angular velocity in terms of period of rotation:

$$\varpi = \frac{2\pi}{T}$$

- Connection between angular and linear velocity:

$$v = \varpi R$$

- Centripetal Acceleration:

$$a = \varpi^2 R = \frac{v^2}{R}$$

- Newton’s Gravity law:

$$F = G\frac{Mm}{r^2}$$

Homework

Problem 1

Many satellites used for communications use *geostationary* orbit: they stay above the same point on the Earth surface. In order to achieve that, the period of their rotation must be equal to T=24hrs. Find the radius of a geostationary orbit, R. Express the result in terms of gravitational acceleration on the Earth surface g, radius of earth R_E, and length of Earth day, T. Compute its value.

Note: the radius of such an orbit is significantly larger than radius of Earth, so the gravitational force is given by general Newton's formula rather than F=mg. For Earth gravity, you can rewrite it as:

$$F = G\frac{M_E m}{r^2} = mg\left(\frac{R_E}{r}\right)^2$$

Problem 2

Estimate the radius R of the Black Hole of mass M. The Black Hole should be able keep an object moving with speed of light c, on the orbit of radius R (in reality, it will "swallow" everything inside that radius).