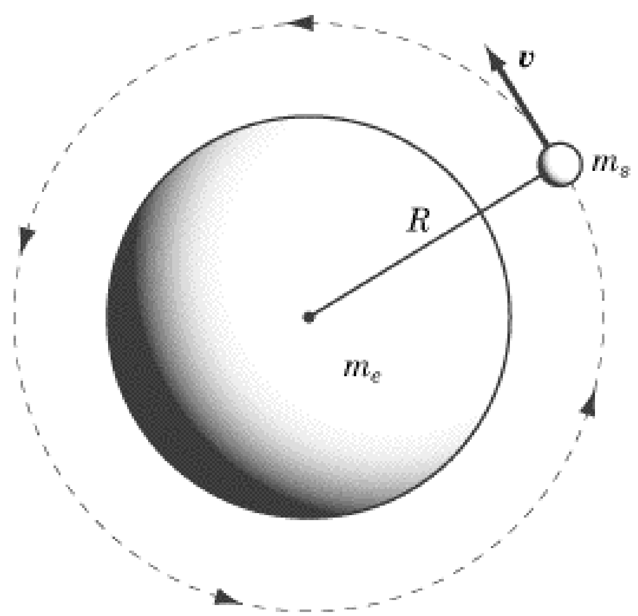
AP-1 Orbits



An object moves in an orbit around a more massive body if there is an ATTRACTIVE force between them (remember Newton's 3rd Law). The most common examples in physics are satellites orbiting planets or stars and electrons orbiting the nucleus of an atom.

FIRST PRINCIPLES

$$attractive\ force = centripetal\ force$$

$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$

Combining these equations, derive the empirically discovered Kepler's 3rd Law of Planetary Motion that $T^2 \propto r^3$

Basic circular motion relationships:

Speed of an object moving in a circle is simply based on distance/time:

$$v = \frac{2\pi r}{T}$$

The force required to change the direction of the object in order to move it in a circle:

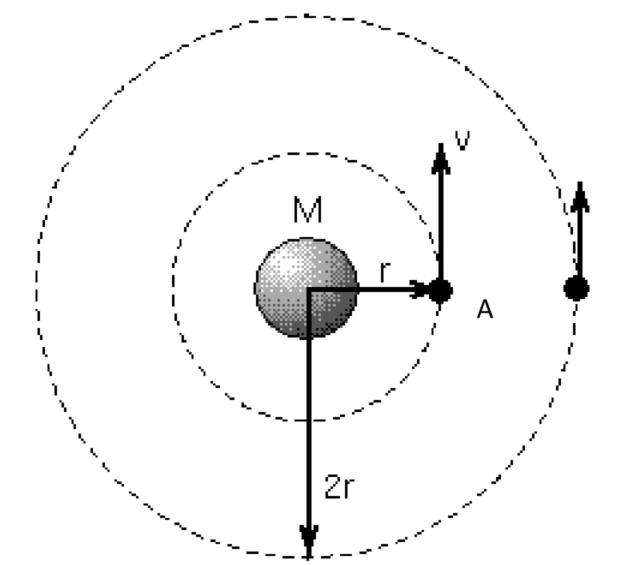
$$F = \frac{mv^2}{r}$$

Does the mass of the satellite affect the gravitational force holding it in orbit? If yes, why does it not change the nature of the orbit?

How does knowing the period and orbital radius of the Moon enable us to determine the mass of the Earth?

Common AP-1 problems like to compare two or more satellites in orbit around a planet.

The two satellites shown below have the same mass. The lower orbiting satellite has a speed *v* and an orbital radius *r*.



1. How does the gravitational force between satellite A and the planet compare with that of satellite B – be specific!

2. Which satellite has the higher speed and why?

3. How do the speeds of the satellites compare? Be specific!