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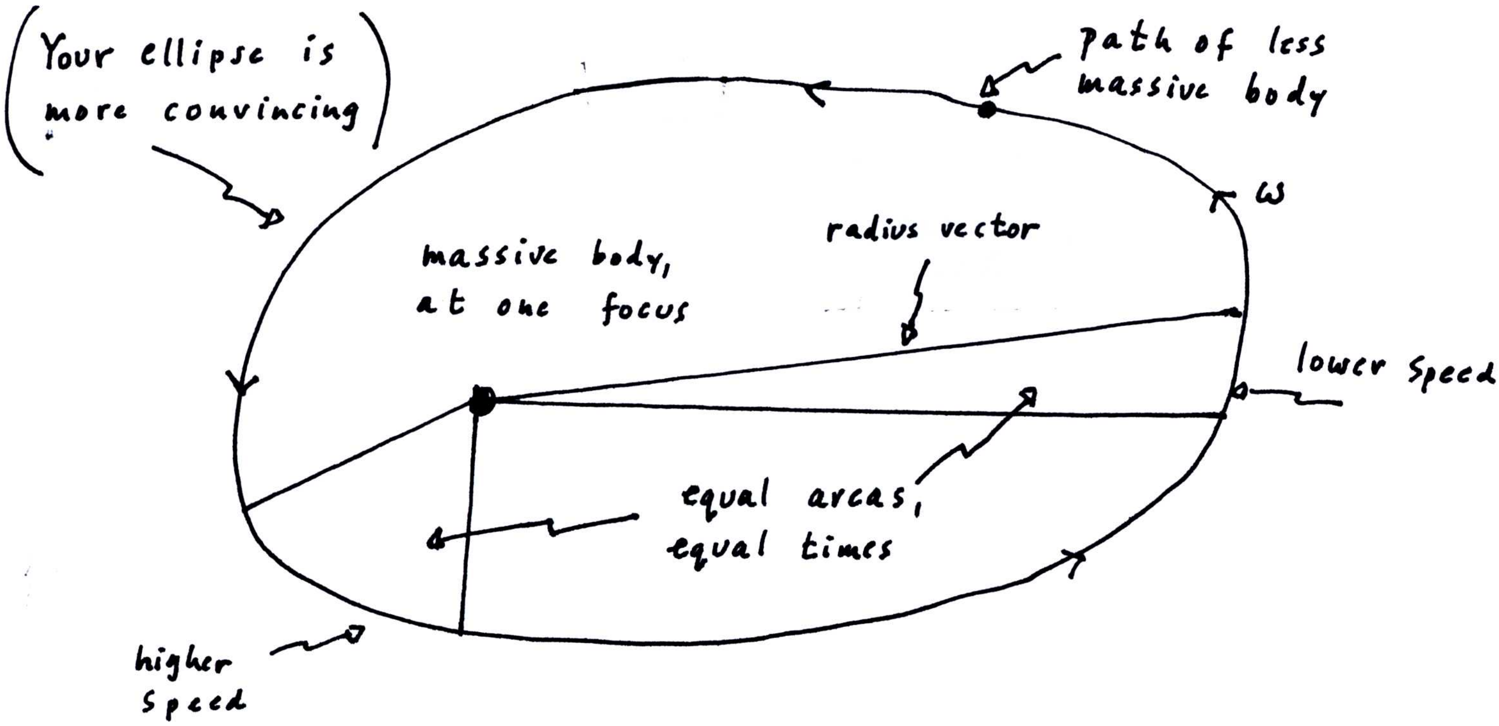
Johannes Kepler's Laws (published between 1609 and 1619)

Suppose we consider a small body, moving under a gravitational force near a much more massive body.



Law I: The Law of Orbits. The path of the less massive body is a conic section, having the more massive body as one focus. The particular section is determined by the speed of the body at a given instant.

Note: For the permanent members of the Solar System, the orbits are elliptical, of different eccentricities.

Law II: The Law of Areas. The radius vector sweeps out equal areas, during equal time intervals.

Note: This is a consequence of the gravitational force acting on the less massive body being entirely radial; there is no transverse component, so its angular momentum is conserved.

Law III: The Law of Periods. The square of the Sidereal Period is proportional to the cube of the mean distance of the secondary body from the primary.

That is,

$$\frac{T^2}{d^3} = \text{constant}$$

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Note: This is a consequence of the gravitational force obeying an inverse-square law.

Examples

The Primary body	The Secondary body / bodies
Our Sun	The planets, comets and asteroids
Jupiter	The Jovian moons
Saturn	Individual particles comprising the complex system of rings
The Earth	Artificial Earth Satellites Also, the Moon (but see below)

Most introductory Astronomy problems involving Kepler's Laws are based on the Law of Periods, for G.C.S.E. work. More advanced studies could involve Kepler's Law of Orbits. It will then be necessary for you to understand (*) aphelion, perihelion, eccentricity and semi-major axis. Please refer to the special sheets accompanying the ellipse, which you constructed.

For even more advanced work, the centre-of-mass of a Primary / Secondary system must be considered. For the Sun / Earth system, $M_{\odot} = 300\,000\, M_E$, so the centre-of-mass is practically at the centre of the Sun.

In the case of the Earth / Moon system, $M_E = 81\, M_{Moon}$. Here, the centre-of-mass lies about two-thirds of the distance from the centre of the Earth to its surface.

Therefore, it would be more accurate to say that the Earth and Moon revolve around their (common) centre-of-mass.

(*) The so-called Ellipse "parameters"