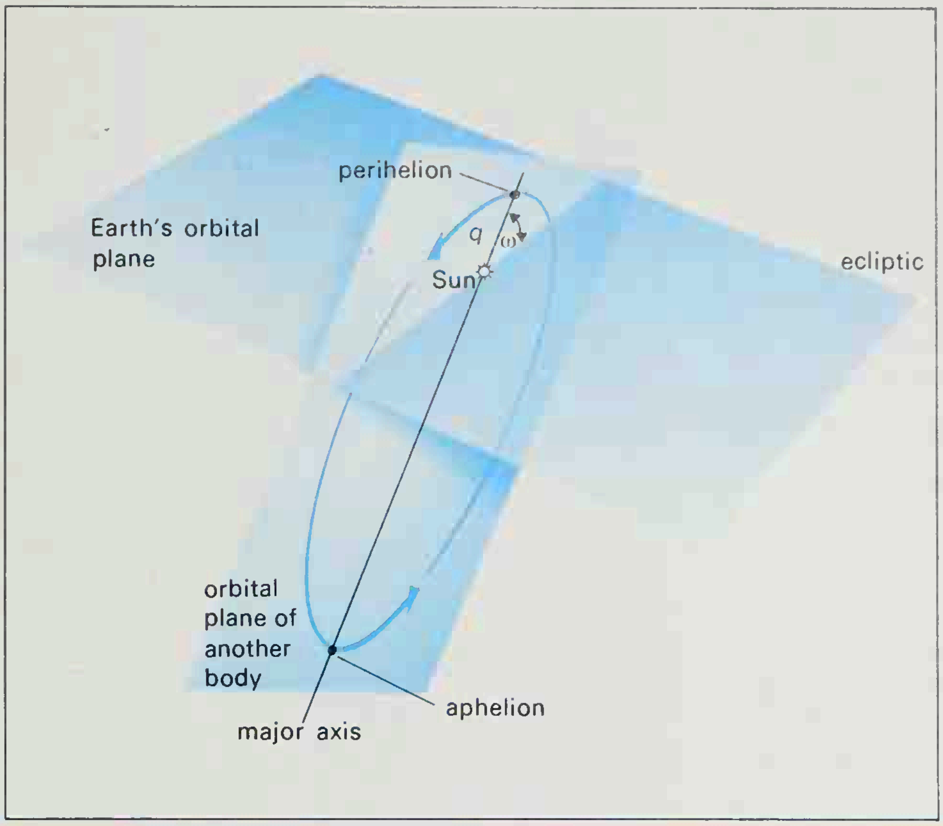
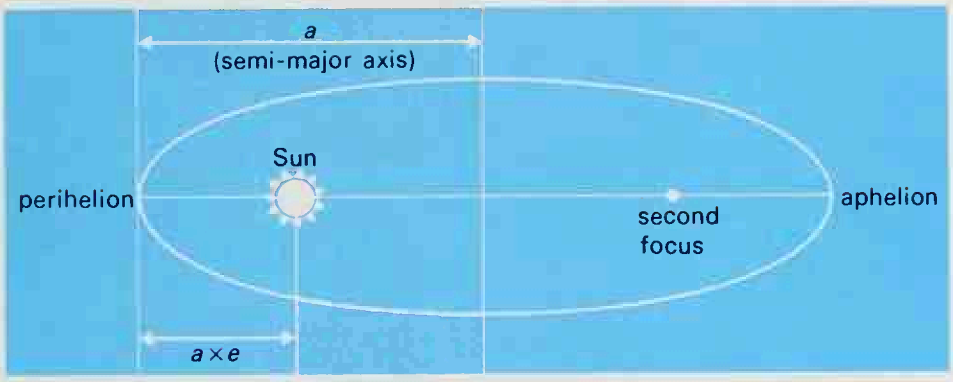
Mercury, which requires the further refinement offered by Einstein's general theory of relativity.

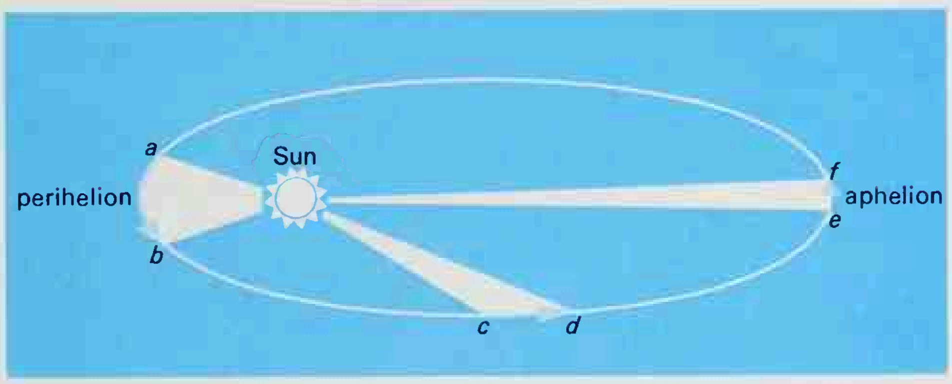
Once its orbit is known, the position of any body at any time may be established if the **longitude**, which is measured from the ascending node, at any given instant is available. Conversely, from several observations of the position of a body at known times, the orbit and period may be derived. Under certain circumstances, when one of the bodies has little mass, Keplerian methods may suffice, but usually the masses and consequent disturbing effects (PERTURBATIONS) of the planets must be taken into account. By means of electronic computers it is possible to include all the planetary perturbations, and positions of the planets have been calculated for periods of 500 000 years before and after the present, with such studies showing very long-term variations in the orbital eccentricities.

The **axial rotation periods** given in the various tables are **sidereal periods**, rotations measured with respect to the background of the 'fixed' stars. These differ from the **synodic periods** which bring the body into the same axial position relative to the Sun (Fig. 2·7). In the case of the Earth, the mean sidereal axial period is $23_h56_m4{\cdot}1_s$, and the mean solar day is $24_h3_m56{\cdot}6_s$. A similar relationship exists between a satellite's sidereal and synodic orbital periods, and for the Moon, these are approximately 27·322 days and 29·531 days respectively. In the case of a planet, one synodic period brings the Sun, Earth and planet back into the same relative positions (Fig. 2·8). Due to the differing orbital motions of the planets, the Earth may be overtaken by, or overtake, another planet, and at such times the planet appears to retrograde, or move from east to west against the background of stars, contrary to its usual motion. Terms for planetary positions relative to the Earth are illustrated in Fig. 2·10.

Details of the orbits of the planets are given in Table 2·1, while those of satellites, minor planets and comets are covered in their respective sections. The basic unit of distance within the Solar System is the **astronomical unit** (au) which is the average distance of the Earth from the Sun. From highly accurate radar measurements of various objects, such as the planet Venus and minor planets which closely approach the Earth, the latest value for this essential unit is







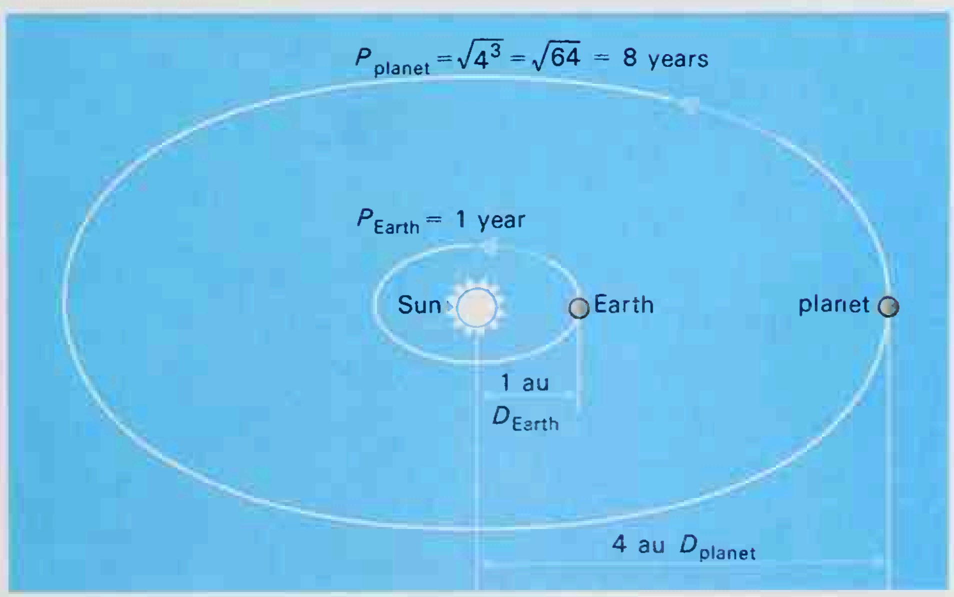


Fig. 2·3, top right: *The orientation of an object on its orbital plane is given by the angle of perihelion, ω, measured from the ascending node. The shape of the ellipse is given by the perihelion distance q, and the eccentricity (see Fig. 2·4).*

Fig. 2·4, centre top: *Kepler's First Law. The planets (and other bodies) move in ellipses, with the Sun at one focus. Mathematically, the perihelion distance q = a (semi-major axis) × e (eccentricity).*

Fig. 2·5, centre below: *Kepler's Second Law. The radius vector (line joining Sun and planet) sweeps out equal areas in equal times. When close to the Sun the body moves faster, so that distance a–b is greater than c–d, itself greater than e–f.*

Fig. 2·6, right: *Kepler's Third Law. The square of the periods is proportional to the cube of the distances. (Mathematically P^2/D^3 is the same for every orbit.) Counting the Earth's distance as 1, then for a planet at 4 times the Earth's distance from the Sun, $P^2 = D^3 = 4^3 = 64$, so the period $P = \sqrt{64}$ or 8 years. Certain minor planets actually have periods close to this.*