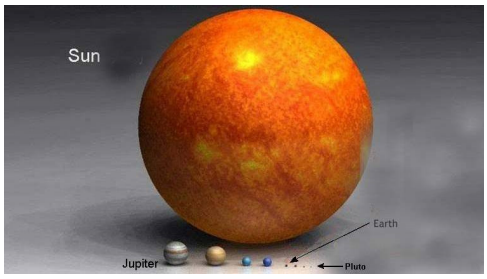
Sun – part 6 - size and mass

'The Sun plus some debris'. This description of the solar system accurately recognises the physical dominance of the Sun. Although just a medium-sized star among hundreds of billions of stars in the Milky Way galaxy, the Sun is, by far, the largest object in the solar system.



Sun-planets size comparison

An almost perfect sphere, the equatorial and polar diameters of this gaseous object differ by only approximately 10 km.

Solar size vital statistics
Diameter 1,392 km (109x Earth's diameter)
Mean radius 696,000 km
Circumference Around 4,366,813,km
Total volume 1.4 x 1027 m³ (about 1.3 million Earths could fit inside the Sun).

Solar mass vital statistics
The Sun contains 99.8% of the total mass of the solar system.

Because Earth follows an elliptical orbit around Sun, the solar mass can be computed from the equation for the orbital period of a small body orbiting a central mass. Based on the length of the year, the equation includes the Earth-Sun distance (AU) and the gravitational constant. Early calculations, however, were inherently inaccurate as this calculation of solar mass was used before either the AU or G, the gravitational constant, had themselves been precisely calculated.

Isaac Newton was the first to estimate the solar mass. In his *Principia* (1684) he estimated that the ratio of Earth's mass to that of the Sun was about 1/28,700. Later, he realised that the calculation was based on a faulty value for the solar parallax which he had used to calculate AU. In the 3rd edition of Principia, he corrected the estimated ratio to 1/169,282. Although more accurate, solar parallax was only correctly calculated a century late after transits of Venus in 1761 and 1769. The current value for solar parallax is even smaller: 1/332,960.

The modern calculation of solar mass identifies a value of 1.989 x 1,030 kg (about 333,000 times Earth's mass or 1,048 times Jupiter's mass).
Solar mass is used as a standard unit to indicate the masses of other stars, as well as clusters, nebulae and galaxies.

The mass of the Sun has decreased since the time the star was formed. This due to two processes acting in almost equal amounts:

- the Sun's core hydrogen is converted into helium by nuclear fusion. The primary reaction process (proton-proton chain) converts some mass into energy in form of gamma ray photons, most of which eventually radiates away from the Sun.

- High-energy protons and electrons in the solar atmosphere are ejected directly into outer space as the solar wind.

The original mass of the Sun when it reached the main sequence (when it began to shine by converting hydrogen to helium) is uncertain. The early Sun had much higher mass-loss rates than at present, so it might have lost anywhere from 1-7% of its initial mass over the course of its main sequence lifetime, so far. The Sun does gain a very small mass through asteroid and comet impacts, but these cannot offset the mass lost to radiation and ejection.

Sources: Ridpath, I (Ed) 2012 Oxford dictionary of astronomy 2nd ed rev, Astronomy (Dorling Kindersley – Eyewitness companions, www.en.wikipedia.org, www.space.com,