1 Sun vs. Jupiter

Gain experience with the relative sizes of objects and distances in the Solar System. Gain experience with realistic reduced masses.

Calculate the following quantities:

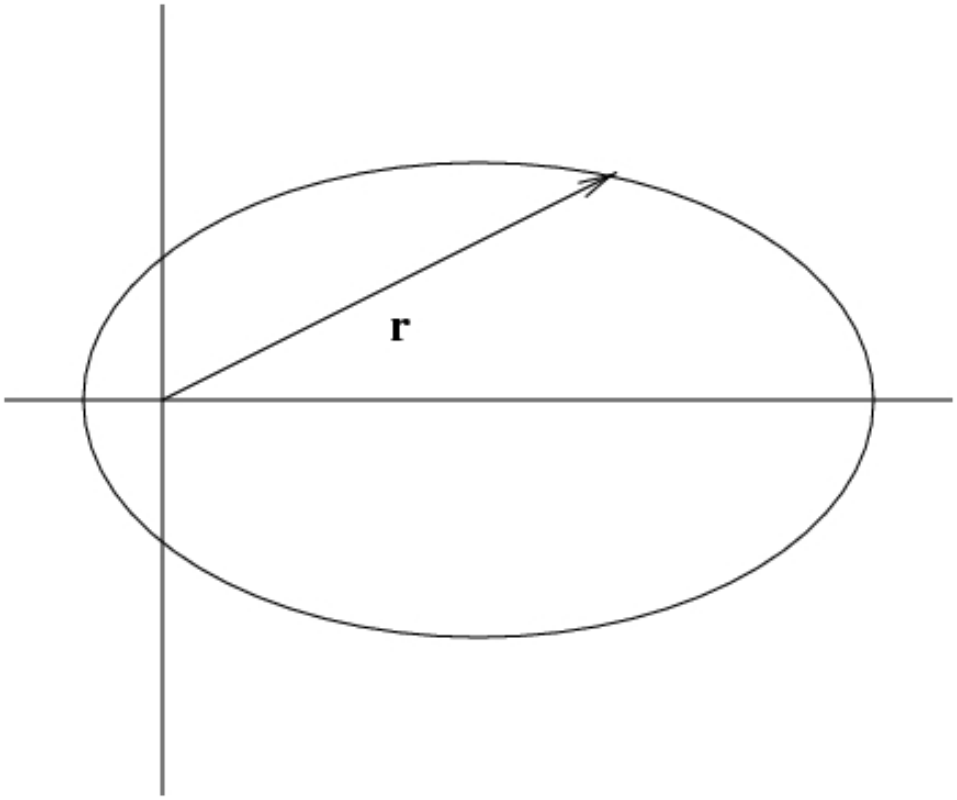
(a) Find $|\vec{r}_{\text{sun}} - \vec{r}_{\text{cm}}|$ and μ for the Sun-Earth system. Compare $|\vec{r}_{\text{sun}} - \vec{r}_{\text{cm}}|$ to the radius of the Sun and to the distance from the Sun to the Earth. Compare μ to the mass of the Sun and the mass of the Earth.

(b) Repeat the calculation for the Sun-Jupiter system.

2 Undo Formulas for Center of Mass (Geometry)

(Sketch limiting cases) Purpose: For two central force systems that share the same reduced mass system, discover how the motions of the original systems are the same and different.

The figure below shows the position vector $\vec{r}$ and the orbit of a "fictitious" reduced mass μ.



(a) Suppose $m_1 = m_2$, Sketch the position vectors and orbits for m_1 and m_2 corresponding to $\vec{r}$. Describe a common physics example of central force motion for which $m_1 = m_2$.

(b) Repeat, for $m_2 > m_1$.

3 Angular Momentum and Kinetic Energy in the Center of Mass

(Messy algebra) Convince yourself that the expressions for kinetic energy in original and center of mass coordinates are equivalent. The same for angular momentum.

Consider a system of two particles of mass m_1 and m_2.

(a) Show that the total kinetic energy of the system is the same as that of two "fictitious" particles: one of mass $M = m_1 + m_2$ moving with the velocity of the center of mass and one of mass μ (the reduced mass) moving with the velocity of the relative position.

(b) Show that the total angular momentum of the system can similarly be decomposed into the angular momenta of these two fictitious particles.