

# Universal Law of Gravitation

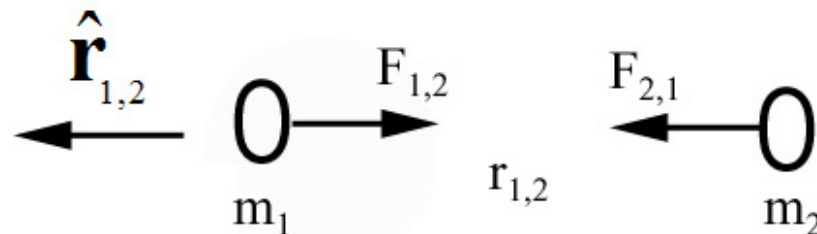
- The force on body 1 due to the gravitational interaction between two bodies of masses  $m_1$  and  $m_2$  is

$$\vec{\mathbf{F}}_{1,2} = -G \frac{m_1 m_2}{r_{1,2}^2} \hat{\mathbf{r}}_{1,2}$$

where

$$G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2 / \text{kg}$$

and  $\hat{\mathbf{r}}_{1,2}$  is the unit vector located at the position of body 1 and pointing from body 2 towards body 1.

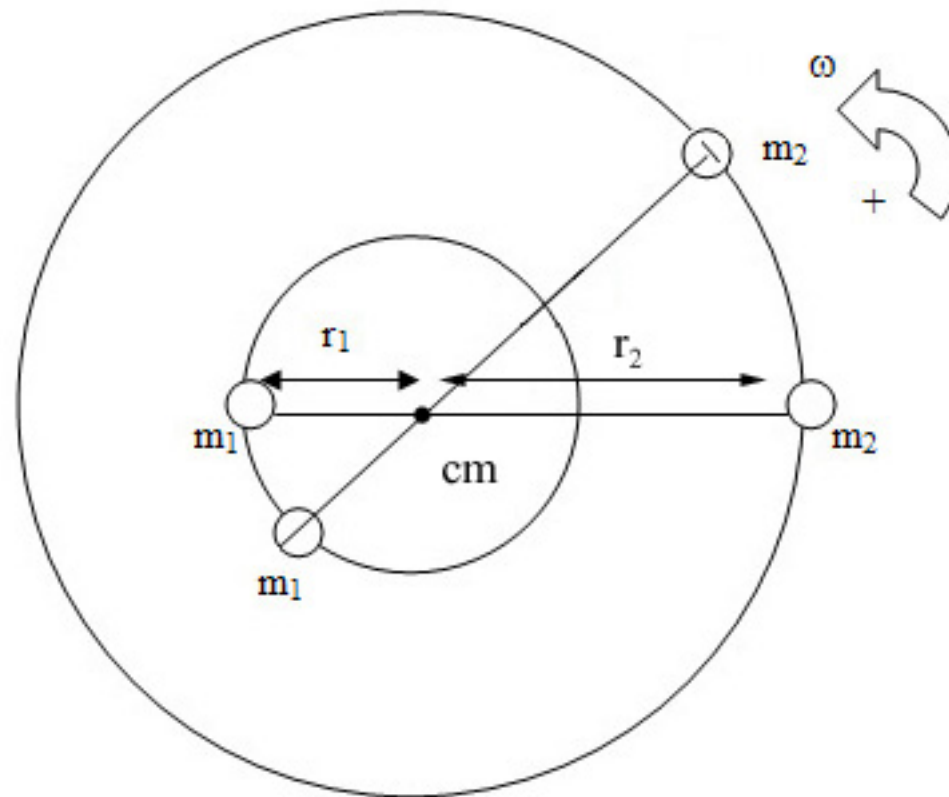


# Double Star System

- **Example 1: Double Star System**

Consider a double star system under the influence of gravitational force between the stars. Star 1 has mass  $m_1$ . Star 2 has mass  $m_2$ . Assume that each star undergoes uniform circular motion about the center of mass of the system. If the stars are always a fixed distance  $r$  apart, what is the period of the orbit?

# Class Problem 1 (con't)



# **The Gravitational Field of a Spherical Shell of Matter**

- The gravitational force on a mass placed outside a spherical shell of matter of uniform surface mass density is the same force that would arise if all the mass of the shell were placed at the center of the sphere.
- The gravitational force on a mass placed inside a spherical shell of matter is zero.

# The Gravitational Field of a Spherical Shell of Matter

$$\vec{\mathbf{F}}_{m,s}^{\square}(r) = \begin{cases} -G \frac{mm_s}{r^2} \hat{\mathbf{r}}, & r > R \\ \vec{\mathbf{0}}, & r < R \end{cases}$$

where  $\hat{\mathbf{r}}$  is the unit vector located at the position of mass and pointing radially away from the center of the shell.