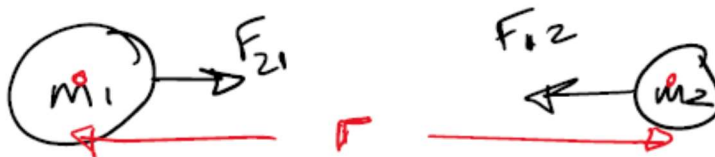


Ch 3.2 Universal Gravitation

Newton + the apple



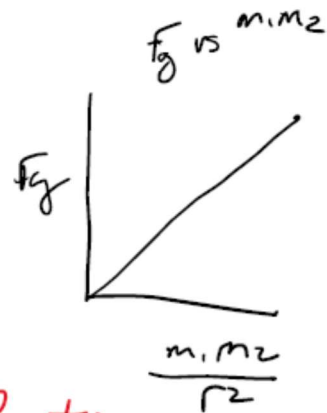
all massive object
exert an attractive
force on each other.



$$F_{12} = -F_{21}$$

magnitude = F_g

$$F_g \propto \frac{m_1 m_2}{r^2}$$



is directly proportional to

Newton's Law
of Universal
Gravitation

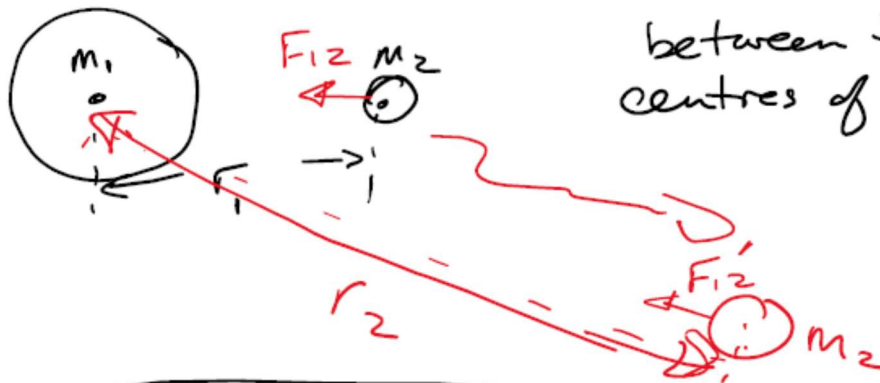
$$y = mx + b$$
$$F_g = \frac{G m_1 m_2}{r^2}$$

G = universal gravitation constant

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

$$F_g = \frac{G m_1 m_2}{r^2}$$

r = distance between the centres of mass



$$F_{12} = \frac{G m_1 m_2}{r_1^2}$$

$$F_{12}' = \frac{G m_1 m_2}{r_2^2}$$

if $r_2 = \underline{\underline{3 \times r_1}}$

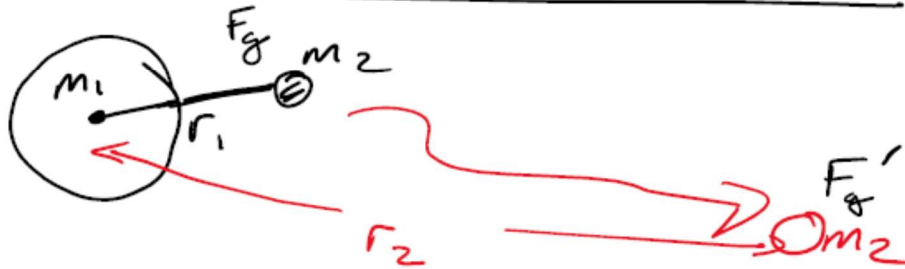
then

$$F_{12} = \frac{Gm_1 m_2}{r_1^2} \quad F_{12}' = \frac{Gm_1 m_2}{(3r_1)^2}$$

$$F_{12}' = \frac{Gm_1 m_2}{9r_1^2}$$

F_{12} VS F_{12}'

$$F_{12}' = \frac{1}{9} \left(\frac{Gm_1 m_2}{r_1^2} \right) = \frac{1}{9} F_{12}$$



$$\frac{F_g}{F_g'} = \frac{\frac{Gm_1 m_2}{r_1^2}}{\frac{Gm_1 m_2}{r_2^2}}$$

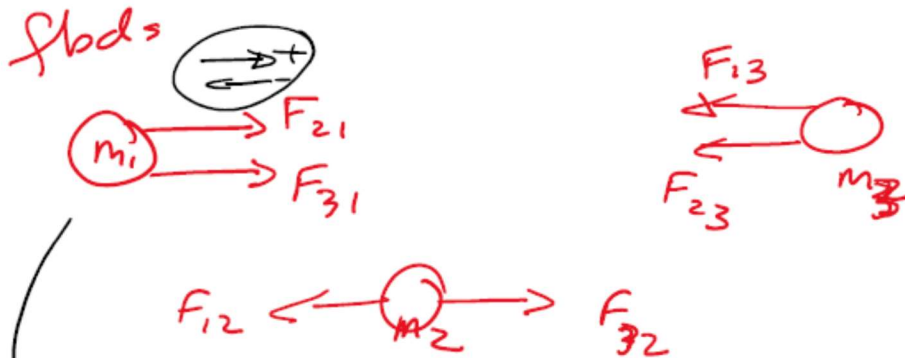
$$\frac{F_g}{F_g'} = \left(\frac{Gm_1 m_2}{r_1^2} \right) \times \left(\frac{r_2^2}{Gm_1 m_2} \right) = \frac{r_2^2}{r_1^2}$$

$$\frac{F_g}{F_g'} = \left(\frac{r_2}{r_1}\right)^2$$

$$F_g = F_g' \left(\frac{r_2}{r_1}\right)^2$$

$$F_g' = F_g \left(\frac{r_1}{r_2}\right)^2$$

F_g is a vector and adds as a vector if there are multiple masses



$$\sum \vec{F}_1 = m_1 \vec{a} = \frac{G m_1 m_2}{d_1^2} + \frac{G m_1 m_3}{(d_1 + d_2)^2} = ?$$

$$\Sigma F_2 = m_2 a = \frac{G m_2 m_3}{d_2^2} - \frac{G m_1 m_2}{d_1^2}$$

Gravitational Field Strength.
 $= g$

