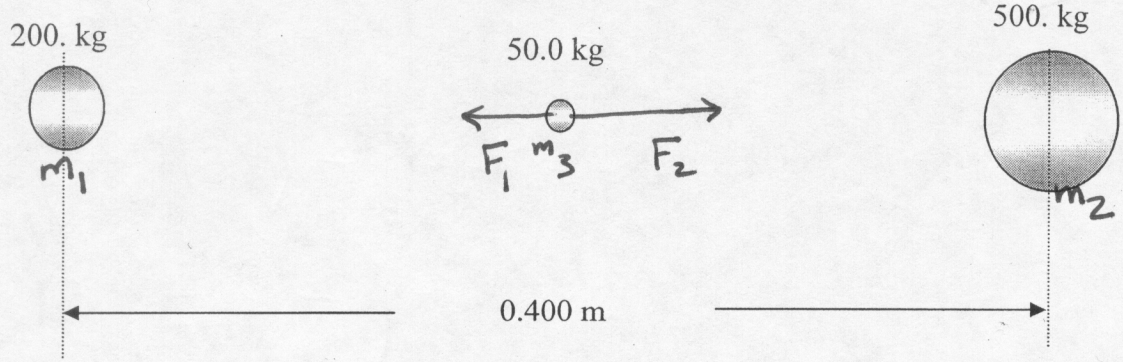
Name_____ SP211 Section 1123

Quiz 6 25 Feb 05

A 200. kg mass and a 500. kg mass are floating in outer space and currently separated by a distance of 0.400 m. A 50.0 kg mass is placed exactly midway between.



a. Draw the forces currently acting on the 50.0 kg mass (i.e a FBD). (2)

b. What is the net gravitational force (magnitude and direction) acting on this 50. kg mass due to the other two masses at their current position? (4)

$$F_1 = \frac{G m_1 m_3}{r^2} = \frac{(6.67\times10^{-11}\frac{N\text{-}m^2}{kg^2})(200\,kg)(50\,kg)}{(.2m)^2} = 1.67\times10^{-5}N$$

$$F_2 = \frac{G m_2 m_3}{r^2} = \frac{(6.67\times10^{-11}\frac{N\text{-}m^2}{kg^2})(500\,kg)(50\,kg)}{(.2m)^2} = 4.17\times10^{-5}N$$

$$\vec{F}_{NET} = \vec{F}_2 + \vec{F} = -1.67\times10^{-5}N\,\hat{i} + 4.17\times10^{-5}N\,\hat{i} = \boxed{2.5\times10^{-5}N\,\hat{i}}$$

c. At what position (other than infinitely remote ones) would the 50 kg mass experience a net force of zero Newtons? (4)

$$F_1 = F_2$$

$$\frac{\cancel{G} m_1 \cancel{m_3}}{r_1^2} = \frac{\cancel{G} m_2 \cancel{m_3}}{r_2^2}$$

$$\frac{r_2^2}{r_1^2} = \frac{m_2}{m_1} = \frac{5}{2} \Rightarrow r_2 = r_1\sqrt{\frac{5}{2}}$$

$$r_1 + r_2 = .4m$$

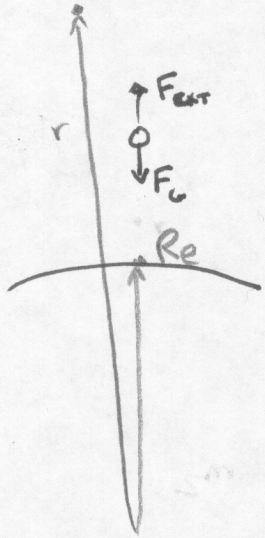
$$r_1 + \sqrt{\frac{5}{2}}\,r_1 = .4m$$

$$2.58r_1 = .4m$$

$$\boxed{r_1 = .155m}$$

E.C. (2)How much work would be done by an external force raising a ball of mass, m, from a resting position on the surface of the earth, $r = R_e$, to an instantaneous resting position some higher distance, r, from the center of the earth? Call the mass of the earth, M_e. (show work on back)

$$\vec{F}_{12} = -\frac{Gm_1m_2}{r_{21}^2}\hat{r}_{21} \qquad G = 6.67\text{x}10^{-11}\frac{N-m^2}{kg^2} \qquad W = \vec{F}\bullet\vec{d} \qquad W = \int_a^b \vec{F}\bullet d\vec{l}$$



$$W = \int_{R_e}^{r} \frac{GM_e m}{r^2}\, dr$$

$$GM_e m \int_{R_e}^{r} \frac{dr}{r^2} = GM_e m \left(-\frac{1}{r}\right)_{R_e}^{r}$$

$$= -\frac{GM_e m}{r} - \left(-\frac{GM_e m}{R_e}\right)$$

$$= GM_e m \left(\frac{1}{R_e} - \frac{1}{r}\right)$$