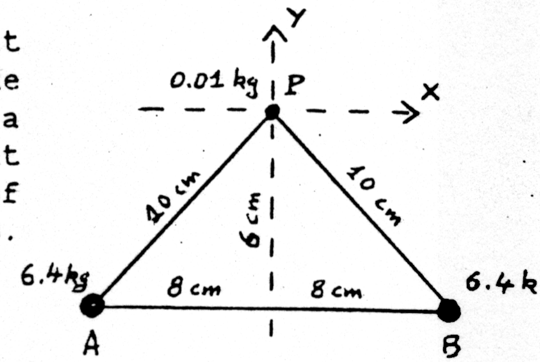
CHAPTER 14

Two spheres, each of mass 6.4 kg, are fixed at points A and B (see figure). Find the magnitude and direction of the initial acceleration of a sphere of mass 0.010 kg if released from rest at point P and acted only by forces of gravitational attraction of the spheres A and B.



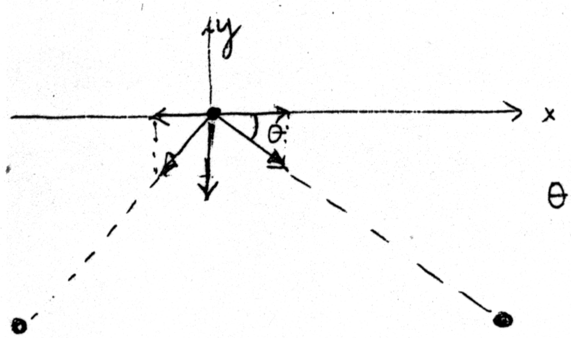
A. $0.51*10**(-7)$ m/s**2 $(-\vec{j})$

B. $0.32*10**(-7)$ m/s**2 $(-\vec{j})$

C. $0.11*10**(-6)$ m/s**2 $(-\vec{j})$

D. $0.41*10**(-6)$ m/s**2 $(\vec{i} - \vec{j})$

E. $0.23*10**(-5)$ m/s**2 $(\vec{i} + \vec{j})$



$\theta = \tan^{-1}\left(\frac{6}{8}\right) = 37°$

$F_x = 0$

$F_y = \frac{2 G m_1 m_2}{r^2} \sin 37° = 5.1 \times 10^{-10}$ N

$\vec{F} = 0\,\hat{i} - 5.1 \times 10^{-10}\text{ N}\,\hat{j}$

$\boxed{\vec{a} = \frac{\vec{F}}{m} = 0\,\hat{i} - 0.51 \times 10^{-7}\text{ m/s}^2\,\hat{j}}$

A rocket is fired vertically from the earth's surface and reaches a maximum altitude above the surface of the earth equal to four earth radii. What is the initial speed of the rocket ?

A. 3.8 km/s
B. 10 km/s
C. 7.6 km/s
D. 16 km/s
E. 12 km/s

$$K_i + U_i = K_f + U_f$$

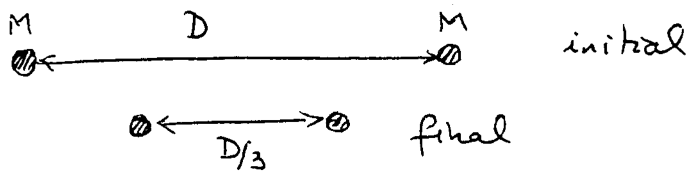
$$\frac{1}{2} m v_i^2 - \frac{GMm}{R_E} = \frac{1}{2} m v_f^2 - \frac{GMm}{5R_E}$$

$$v_i^2 = \cancel{v_f^2}^{\to 0} + \frac{8}{5}\frac{GM}{R_E}$$

$$v_i = \sqrt{\frac{8}{5}\frac{GM}{R_E}} = 10\,000 \text{ m/s} = \underline{\underline{10 \text{ km/s}}}$$

Two particles of mass M are initially separated by a distance D. They are released from rest and accelerate towards one another through gravitational attraction. What is the kinetic energy of each particle when their separation distance is D/3 ? (G = gravitational constant)

A. 3*G*(M**2)/D
B. G*(M**2)/D
C. G*M/(2*(D**2))
D. 4*G*(M**2)/D
E. G*(M**2)/(2*D)



$$\cancel{K_i}^{\to 0} + U_i = K_f + U_f$$

$$-\frac{GM^2}{D} = K_f - \frac{GM^2}{D/3} = K_f - \frac{3GM^2}{D}$$

$$\Rightarrow K_f = \frac{2GM^2}{D} \quad (\text{for both particles})$$

For one particle $\boxed{K_f = \frac{GM^2}{D}}$

A satellite is observed to orbit a large planet close to its surface with a period of 6.00 hours. Find the average mass density of the planet. Assume that the planet is spherical.

A. 2725 kg/(m**3)
B. 1.29 kg/(m**3)
C. 170 kg/(m**3)
D. 303 kg/(m**3)
E. 5522 kg/(m**3)

$$T^2 = \left(\frac{4\pi^2}{GM}\right) r^3$$

$$T^2 = \frac{4}{3}\pi r^3 \left(\frac{3\pi}{GM}\right) = \left(\frac{V}{M}\right)\frac{3\pi}{G} = \frac{1}{\rho}\ \frac{3\pi}{G}$$

$$\Rightarrow \quad \rho = \frac{3\pi}{G T^2} = 303 \text{ kg/m}^3$$

Change to seconds

At what altitude (in earth's radii) above the surface of the earth would the acceleration of gravity be 1/8 of that on the surface ? (Re = radius of the earth)

A. 0.65 * Re
B. 1.83 * Re
C. 2.51 * Re
D. 1.02 * Re
E. 0.44 * Re

$$a_g = \frac{GM}{(R_E + h)^2} = \frac{1}{8}\ \frac{GM}{R_E^2}$$

$$\Rightarrow \quad (R_E + h)^2 = 8 R_E^2$$

$$R_E + h = \sqrt{8}\, R_E \Rightarrow \boxed{h = 1.83 R_E}$$