Tutorial Nov 6

Problem 5.48

By what factor is the force of gravity smaller when you are in a geosynchronous orbit than when you are on the Earth's surface?

$$F_{grav} = \frac{G m M_E}{r^2}$$

class: (Kepler's 3rd law)

$$r_{GO} = \left[\frac{G M_E T^2}{4\pi^2}\right]^{1/3}$$

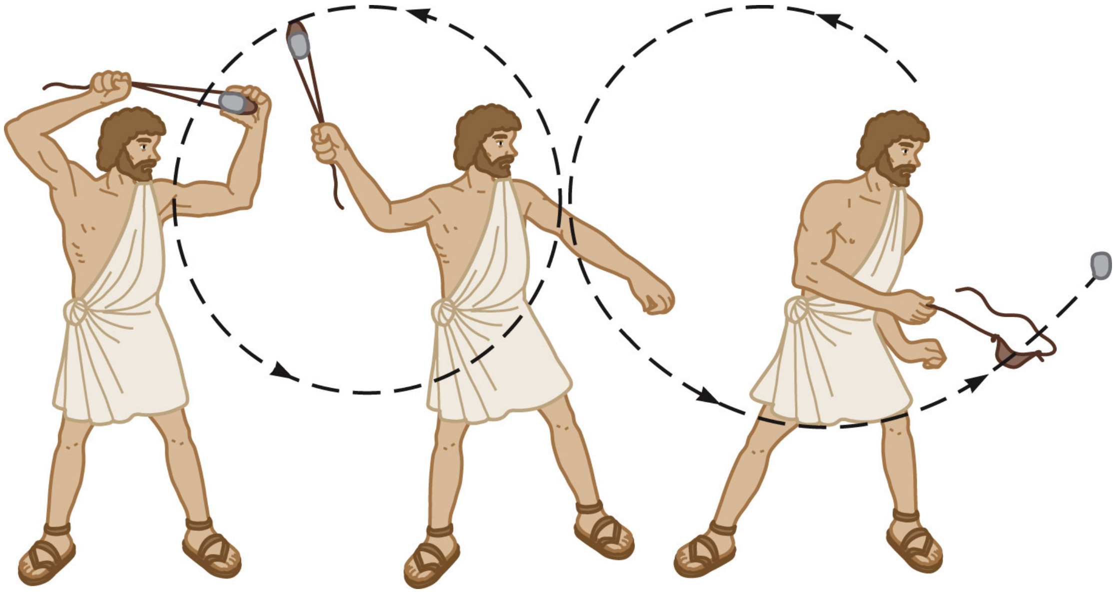
T = 1 day

$$= 4.2 \times 10^7 \text{ m}$$

$$= 6.6\, r_E$$

$$R = \frac{F_{GO}}{F_{grav}^{Earth}} = \frac{r_E^2}{r_{GO}^2} = \frac{1}{(6.6)^2} = 0.023$$

Problem 5.64



given

$f = 7.5 \frac{1}{s}$

(a) max. range (w/o air drag)

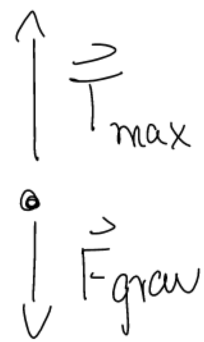
projectile motion : $\Delta x = \frac{v_0^2 \sin 2\theta}{g} \overset{\theta=45^\circ}{=} \frac{v_0^2}{g}$

need $v_0 = \omega r = 2\pi f r = 47\ m/s$ ($r \approx 1\ m$)

$\Rightarrow \Delta x = \frac{v_0^2}{g} = 230\ m$

(b) max tension in cords:

FBD (rock at bottom)



$$F_{net} = T_{max} - mg = ma_c = m\frac{V_0^2}{r}$$

$$\Leftrightarrow \quad T_{max} = m\left(g + \frac{V_0^2}{r}\right) = 220\,N$$

($m = 0.1\,kg$)

sling has two cords: $T_1 = T_2 = \frac{T_{max}}{2} = 110\,N$

Problem 5.68

Planet Tungsten:

(a) gravitational acceleration

(b) period of rotation

(a) $g_T = \frac{GM_T}{r_T^2} = \frac{GM_T}{(2r_E)^2}$ $\left(g_E = \frac{GM_E}{r_E^2} = 9.8\ m/s^2 \right)$

given. $r_T = 2r_E$, $\rho_T = 2\rho_E$

$\left(M = \frac{4\pi}{3} r^3 \rho \right)$ $M_T = \frac{4\pi}{3} r_T^3 \rho_T = \left(\frac{4\pi}{3} r_E^3 \rho_E \right) \times 16 = 16 M_E$

$\Leftarrow \quad g_T = \frac{16\, GM_E}{4\, r_E^2} = 4\, g_E = 39 \text{ m/s}^2$

(b) Questions says: N (equator of Tungsten) $= mg_E$

$\Leftarrow \quad F_{net} = mg_T - N = m(g_T - g_E) = 3 m g_E$

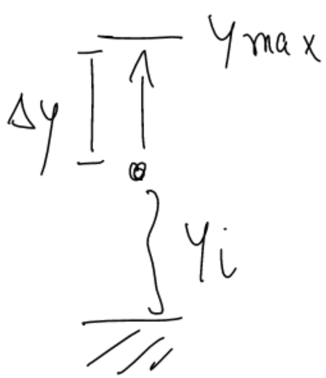
$= m a_c = m \frac{v_T^2}{r_T} = m \omega_T^2 r_T = \frac{4\pi^2 m\, 2 r_E}{T^2}$

$\omega_T^2 = \left(\frac{2\pi}{T}\right)^2$

$\Longleftrightarrow \quad T = 2\pi \sqrt{\frac{2 r_E}{3 g_E}} = 4140 \text{ s} \approx 69 \text{ min}$

Problem 6.18

- Rock thrown upward



$v_i = 25\ m/s$

$m = 0.05\ kg$

find $W_{grav} = F_{grav}\,\Delta y$ (not given!)

use work-energy theorem instead:

$$W_{grav} = \Delta KE = \frac{m}{2}v_f^2 - \frac{m}{2}v_i^2 = -\frac{m}{2}v_i^2$$

$v_f = 0$

$$= -16\ J$$

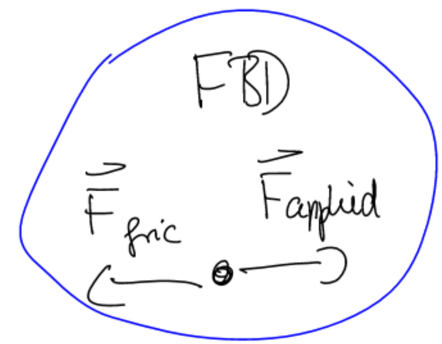
Problem 6.20

- Pushing a refrigerator across kitchen floor

(such that speed is constant)

$|F_{applied}| = 300\,N$

$= |F_{fric}|$



(a) total work $W = \Delta KE = 0$

(b) work done by friction

$\Delta X = 3.0\,m$

$W_{fric} = F_{fric}\,\Delta X = -F_{applied}\,\Delta X$

$= -900\,J$

Problem 6.22

- Average force exerted on baseball by pitcher

$v_f = 50 \text{ m/s}$

$m = 0.14 \text{ kg}$

$\Delta KE = W = F_{ave} \underbrace{\Delta x}_{= 2\text{ m}}$

$\Delta KE = \frac{m}{2} v_f^2 \quad (v_i = 0)$

$F_{ave} = \frac{m}{2\Delta x} v_f^2 = 88 \text{ N}$