Serway + Vuille (8th Edition)
Chapter 7 Homework

2. $R = 4.1\,\text{m}$

$\theta_1 = 30^\circ\left(\frac{\pi\ \text{rad}}{\cancel{180^\circ}_{6}}\right)$

$S_1 = \theta_1 R = \left(\frac{\pi}{6}\right)4.1\,\text{m} = 2.1\,\text{m}$

$S_2 = \theta_2 R = (30\,\text{rad})(4.1\,\text{m}) = 123\,\text{m} \approx 120\,\text{m}$

$S_3 = \theta_3 R = (30\,\text{rev})\left(\frac{2\pi\ \text{rad}}{\text{rev}}\right)(4.1\,\text{m}) = 7.7\times10^2\,\text{m}$

4. $t = 30\,\text{s}$

$\omega_0 = 0$

$f_f = 1.00\,\text{rev}/\text{s}$

$1.00\,\frac{\text{rev}}{\text{s}}\left(\frac{2\pi\,\text{rad}}{\text{rev}}\right) = 6.28\,\text{rad}/\text{s} = \omega_f$

a) $\alpha = \frac{\omega_f - \omega_0}{t} = \frac{6.28\,\text{rad}/\text{s} - 0}{30\,\text{s}}$

$\therefore\ \alpha = .209\ \text{rad}/\text{s}^2$

b) $\omega_f = \alpha t$ (t is held constant)

Yes, ω_f is directly proportional to α

10. $\omega_0 = 0$

$\omega_f = \frac{5.0\,\text{rev}}{\text{s}}\left(\frac{2\pi\,\text{rad}}{\text{rev}}\right) = 31.4\,\text{rad}/\text{s}$

$t_1 = 8.0\,\text{s}$

$t_2 = 12.0\,\text{s}$

$\omega_{2_f} = 0$

$\omega_{2_0} = \omega_f = 31.4\,\text{rad}/\text{s}$

$\alpha_1 = \frac{\omega_f - \omega_0}{t_1} = \frac{31.4\,\text{rad}/\text{s}}{8.0\,\text{s}} = 3.93\,\frac{\text{rad}}{\text{s}^2}$

$\theta_1 = \frac{\omega_f^2 - \omega_0^2}{2\alpha_1} = \frac{(31.4\,\text{rad}/\text{s})^2 - 0}{2(3.93\,\text{rad}/\text{s}^2)} = 126\,\text{rad}$

or

$\theta_1 = \bar{\omega}_1 t_1 = \left(\frac{31.4\,\text{rad}/\text{s}}{2}\right)(8.0\,\text{s}) = 126\,\text{rad}$

$\therefore\ \theta_2 = \bar{\omega}_2 t_2$

$\theta_2 = \frac{(31.4\,\text{rad}/\text{s})}{2}(12.0\,\text{s}) = 188\,\text{rad}$

$\therefore\ \theta_{total} = \theta_1 + \theta_2 = 126\,\text{rad} + 188\,\text{rad}$

$= 314\,\text{rad}\left(\frac{\text{rev}}{2\pi\,\text{rad}}\right)$

$= 50\,\text{rev}$

17)

a) $78\ rpm = f$

$10.0\ in = d \therefore 25.4\ cm\left(\frac{1m}{100cm}\right) = .254m = d \Rightarrow r = d/2$

$= .127m$

$\omega_0 = 0$

$\omega_f = 78\frac{rev}{min}\left(\frac{1\ min}{60\ s}\right)\left(\frac{2\pi\ rad}{1\ rev}\right) = 8.16\ rad/s$

$$\alpha = \frac{\omega_f - \omega_0}{t} = \frac{8.16\ rad/s}{3.0\ s} = 2.72\ rad/s^2$$

a) $a_T = \alpha r = (2.72\ rad/s^2)(.127m) = .345\ m/s^2 \approx \boxed{.35\ m/s^2}$

b) $V_T = \omega r = (8.16\ rad/s)(.127m) = 1.04\ m/s \approx \boxed{1.0\ m/s}$

c) $t = 1.0s$

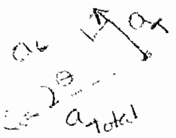
$a_T = .35\ m/s^2$

$\omega_f = \omega_0 + \alpha t = (2.72\ rad/s^2)(1.0s) = 2.72\ rad/s$

$a_c = \omega^2 r = (2.72\ rad/s)^2(.127m) = \boxed{.94\ m/s^2}$

$a_{total} = \sqrt{a_T^2 + a_c^2} = \boxed{1.0\ m/s^2}$

$\tan\theta = \frac{a_T}{a_c} = .37 \Rightarrow \theta = 20°$



23. $R_1 = 150m$ $\qquad \mu_s \eta = \mu_s \cancel{m} g = \frac{\cancel{m} v^2}{R}$

$V_{max_1} = 32.0 \, m/s$

$R_2 = 75.0 \, m$ $\qquad \mu_s = \frac{v^2}{Rg}$ (constant coef. of static friction)

$V_{max_2} = ?$

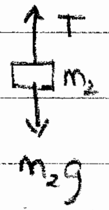
$$\therefore \frac{V_{1_{max}}^2}{R_1 \cancel{g}} = \frac{V_{2_{max}}^2}{R_2 \cancel{g}} \quad \therefore V_{2_{max}} = \sqrt{\frac{V_{1_{max}}^2 \; R_2}{R_1}}$$

$$\therefore V_{2_{max}} = \sqrt{\frac{(32.0 \, m/s)^2 \, (75.0m)}{(150m)}} = 22.6 \, m/s$$

27. $m_1 = 0.25kg$ $\quad$ a) m_2 is in equilibrium

$R = 1.0m$

$m_2 = 1.0 kg$



$\Sigma F_y = 0 \therefore T = m_2 g$

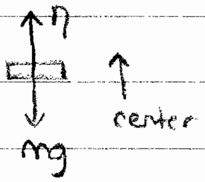
$T = (1.0kg)(9.8 \, m/s^2) = 9.8N$

b) The centripetal force is supplied by the tension.

$\therefore T = 9.8N =$ horizontal force acting on m_1

c) $\Sigma F = \frac{mv^2}{R}$ $\quad \therefore 9.8N = \frac{(.25kg) v^2}{1.0m} \Rightarrow v = 6.3 \, m/s$

32. $m = 500kg$ $\quad$ a)



$\Sigma F = ma_c$

$\eta - mg = \frac{mv^2}{r}$

$V_A = 20.0 \, m/s$

$r_A = 10m$

$r_B = 15m$ $\qquad \therefore \eta = \frac{mv^2}{r} + mg = m\left[\frac{v^2}{r} + g\right]$

$$\eta = (500kg)\left[\frac{(20.0 \, m/s)^2}{10m} + 9.8 \, m/s^2\right]$$

$$= 2.5 \times 10^4 N$$

32. continued:

b) V_{max} for gravity to hold it on the track

$\therefore \eta \rightarrow 0$ and solve for v:

$$mg = \frac{m v_B^2}{r_B} \quad \therefore \quad V_B = \sqrt{g\, r_B}$$

$$= \sqrt{(9.8\,m/s^2)(15m)}$$

$$= 12\,m/s$$

41. $V = 5000\,m/s$

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

$M_E = 5.98 \times 10^{24}\,kg$

a) $$\frac{G m M_E}{R^2} = \frac{m v^2}{R}$$

$$\frac{G M_E}{R} = V^2 \Rightarrow R = \frac{G M_E}{V^2}$$

$$R = \frac{(6.67 \times 10^{-11}\,Nm^2/kg^2)(5.98 \times 10^{24}\,kg)}{(5000\,m/s)^2}$$

$= 1.59 \times 10^7 m$ (from center of Earth)

$R' =$ Altitude $= R - R_E = 1.59 \times 10^7 m - 6.38 \times 10^6 m$

$= 9.58 \times 10^6 m$

b) $$T = \frac{2\pi(1.59 \times 10^7 m)}{(5{,}000\,m/s)}$$

$= 2.00 \times 10^4 s = 5.56h$

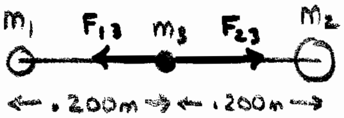
37. $m_1 = 200\,kg$

$m_2 = 500\,kg$

$R = .400m$

$m_3 = 50.0\,kg$

a)



$\vec{F}_3 = \vec{F}_{13} + \vec{F}_{23}$

both m_1 + m_2 located r' from m_3

$$|\vec{F}_3| = \frac{G m_3 (m_2 - m_1)}{r'^2}$$

$$|\vec{F}_3| = \left(6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}\right)(50.0\,kg)(500-200)\,kg \Big/ (.200\,m)^2$$

$= 2.50 \times 10^{-5} N$ to the right

b) Want vector sum of forces to = 0, let d = distance from m_3 to m_2

$$\therefore \quad \frac{G m_1 m_3}{(.400-d)^2} = \frac{G m_2 m_3}{d^2}$$

37. Continued:

$$\frac{200\text{ kg}}{.160 - .800d + d^2} = \frac{500\text{ kg}}{d^2}$$

Solve
Quadratic
Formula

$$2d^2 = 5\left[.160 - .800d + d^2\right]$$

$$2d^2 = .800 - 4.00d + 5d^2$$

$$0 = .800 - 4.00d + 3d^2$$

$$\frac{-(-4.00) \pm \sqrt{(-4.00)^2 - 4(3)(.800)}}{2(3)} = d$$

$\therefore$ $d = .245$ or 1.09 m $\therefore$ only $d = .245\text{m}$ is a point between m_1 & m_2

51. $m = 5.00\text{ Kg}$

$R = 0.800\text{m}$

$f = 0.500\text{ rev/s}$

$\therefore \omega = .500 \frac{\text{rev}}{\text{s}}\left(2\pi \frac{\text{rad}}{\text{rev}}\right)$

$= \pi \frac{\text{rad}}{\text{s}} = 3.14\text{ rad/s}$

a) $V_T = \omega R$

$= (3.14\text{ rad/s})(.800\text{m})$

$= 2.51\text{ m/s}$

b) $a_c = \frac{V^2}{R} = \frac{(2.51\text{ m/s})^2}{(.800\text{m})}$

$= 7.89\text{ m/s}^2$

or

$a_c = \omega^2 R = 7.89\text{ m/s}^2$

c) $T_{max} = 100\text{ N} = \frac{mv^2}{R}$

$100\text{ N} = \frac{(5.00\text{kg})\,v^2}{(.800\text{m})}$

$\therefore$ $v = 4.00\text{ m/s}$