Chapter 8

8-3

(a) Spin $T = 24\text{ hrs}$

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{(24\times 60\times 60)\text{s}}$$

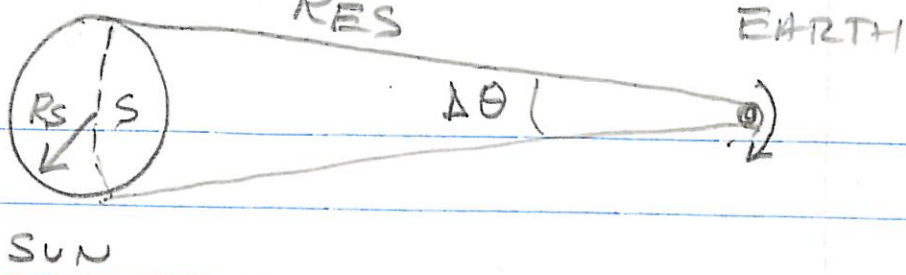
$$= 7.27\times 10^{-5}\ \text{r/s}$$

(b) Rotation about sun $T = 365\frac{1}{2}$ days

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{(365.5\times 24\times 3600)\text{s}}$$

$$\omega = 1.99\times 10^{-7}\ \text{r/s}$$

8-11



$\Delta\theta = 9.28 \times 10^{-3}$ rad

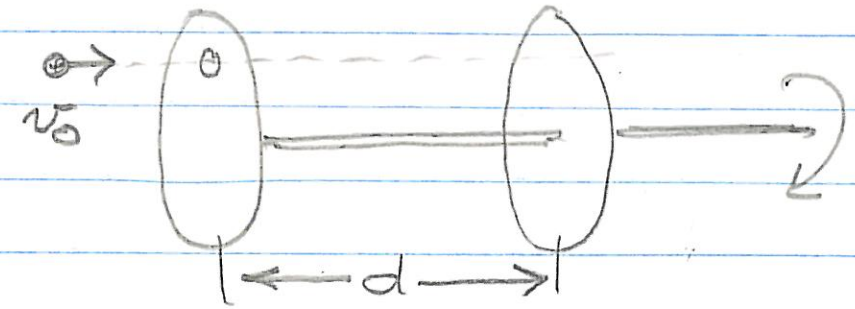
$S \approx 2R_S = 2 \times 6.96 \times 10^{8}$ m

EARTH $\omega = \dfrac{2\pi}{24 \times 3600} = 7.27 \times 10^{-5}$ r/s

$\Delta\theta = \omega \Delta t$

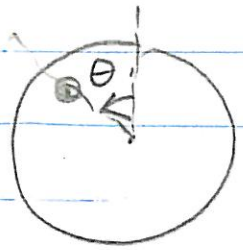
$\Delta t = \dfrac{9.28 \times 10^{-3} \text{ rad}}{7.27 \times 10^{-5} \text{ rad/s}} = 128 \text{ s}$

8-16



$d = 0.850\ m$

$\omega = 95\ r/s$



$\theta = 0.24\ rad$

Assume that the bullet maintains its speed after passing through the first disk, then it takes the bullet $t = d/v_0$ sec. to travel from the first to the second disk. During this time the disks move

$$\theta = \omega t = \omega \frac{d}{v_0}$$

or $$v_0 = \frac{\omega d}{\theta} = \frac{95 \times 0.85}{0.24}$$

$$\boxed{v_0 = 336.5\ m/s}$$

8-21

$\alpha = 2.5\ r/s^2$

$\omega_0 = 5\ r/s$

(a) $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$\theta(4s) = 5.4 + \frac{1}{2}(2.5)(4)^2$

$= 20 + 20 = 40\ rad$

(b) $\omega = \omega_0 + \alpha t$

$= 5 + 2.5 \cdot 4$

$= 5 + 10 = 15\ rad/s$

8-25

$15.92\ rev = 15.92 \times 2\pi\ rad$

$\simeq 100\ rad$

(a) $\bar{\omega} = \frac{\Delta\theta}{\Delta t}$

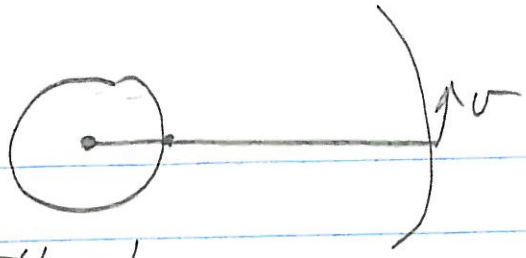
$\bar{\omega} = \frac{20+0}{2} = 10\ r/s$

$\Delta t = \Delta\theta/\bar{\omega} = \frac{100\ rad}{10\ r/s} = 10\ s$

(b) $\alpha = \frac{\Delta\omega}{\Delta t} = \frac{0-20}{10}$

$= -2\ r/s^2$

8-37



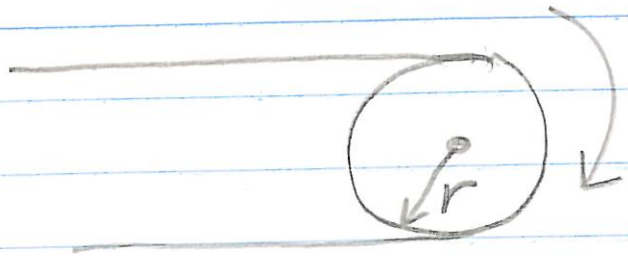
$v = 54\ m/s$

$\omega = 47\ rev/s = 47 \times 2\pi\ r/s$

$v = \omega L \rightarrow L = \frac{v}{\omega} = \frac{54}{47 \times 2\pi}$

$= 0.18\ m = \underline{18\ cm}$

8-39



$r = 4 \times 10^{-2}\ m$

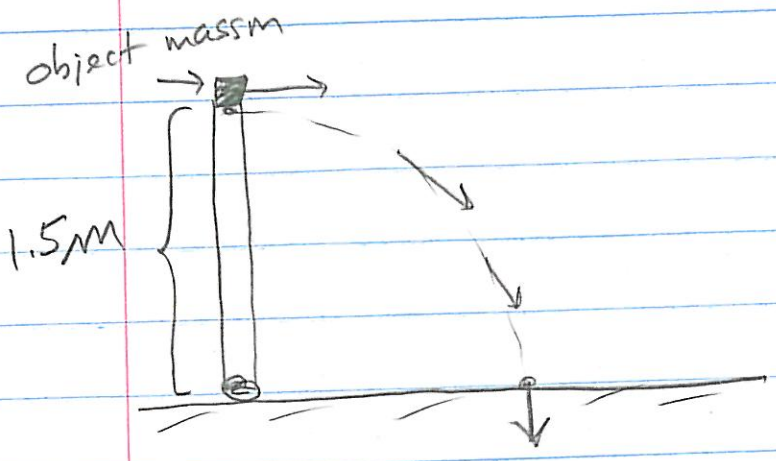
$v = 5.6\ m/s$

$\omega = \frac{v}{r} = \frac{5.6\ m/s}{4 \times 10^{-2}\ m}$

$= 140\ RAD/s$

$140\ RAD/s \times \frac{1\ Rev}{2\pi\ rad} \simeq \underline{22\ rev/s}$

8-43



(a) mass m falls 1.5m

$$mgh = \frac{1}{2}mv^2$$

$$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 1.5}$$

$$= 5.4 \text{ m/s}, \quad \omega = v/r = \frac{5.4}{1.5}$$

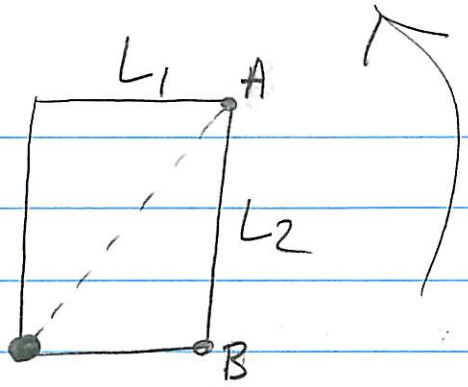
$$= \underline{3.6 \text{ RAD/s}}$$

(b) Just before it hits the ground, the mass m is moving downward with acceleration g

$$a = g = \alpha r$$

$$\alpha = \frac{9.8}{1.5} = \underline{6.5 \text{ RAD/s}^2}$$

8-49



$a_{c,A} = n\, a_{c,B}$, $n = 2$

$$a_c = \frac{v^2}{r} = \frac{(\omega r)^2}{r} = \omega^2 r$$

Both points A & B have same ω

$$a_{c,A} = \omega^2 r_A \qquad a_{c,B} = \omega^2 r_B$$

$$\frac{a_{c,A}}{a_{c,B}} = 2 = \frac{r_A}{r_B} = \frac{\sqrt{L_1^2 + L_2^2}}{L_1}$$

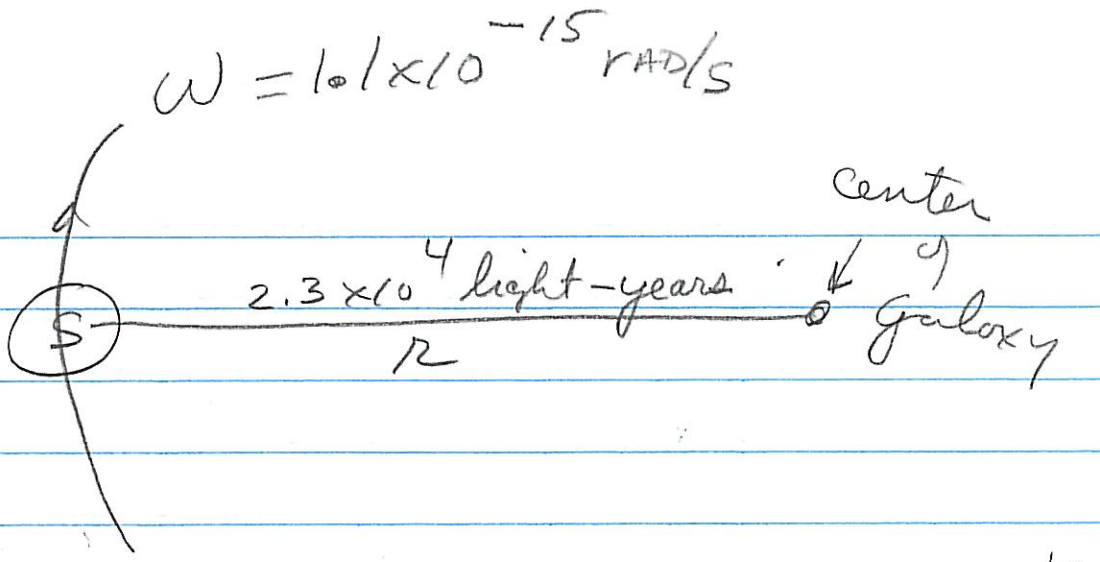
OR, squaring both sides $\quad 4 = \dfrac{L_1^2 + L_2^2}{L_1^2}$

$$4L_1^2 = L_1^2 + L_2^2$$

$$3L_1^2 = L_2^2$$

$$\left(\frac{L_1}{L_2}\right)^2 = \frac{1}{3} \Rightarrow L_1/L_2 = \frac{1}{\sqrt{3}} = \underline{\underline{0.58}}$$

8-51



$$r = 2.3 \times 10^4 \text{ light years} \times 9.5 \times 10^{15} \text{ m/ly} \; *$$

$$= 2.2 \times 10^{20} \text{ m}$$

(a)

$$v_T = \omega r = 1.1 \times 10^{-15} \text{ rad/sec} \times 2.2 \times 10^{20}$$

$$= \underline{2.4 \times 10^5 \text{ m/s}}$$

(b) $$F = m\frac{v^2}{r} = \frac{2 \times 10^{30} \text{ kg} (2.4 \times 10^5)^2}{2.2 \times 10^{20}}$$

$$\cong \underline{5 \times 10^{20} \text{ N}}$$

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* a light year is the distance travelled by light in one year. Light travels at 3×10^8 m/s, so

$$1 \text{ ly} = 3 \times 10^8 \text{ m/s} \times \underbrace{(365 \times 24 \times 3600)}_{\text{sec}} \simeq 9.5 \times 10^{15} \text{ m}$$