Ch 10

3. $\omega_{ave} = \frac{2\pi \times \text{revolutions}}{\text{time}} = \frac{2\pi \times 2.5}{t} = \frac{5\pi}{1.42} = 11 \text{ rad/s}$

t to fall 10m — kinematics $\Rightarrow$ $y - y_0 = \frac{1}{2} g t^2$

$\Rightarrow t = \sqrt{\frac{2(y-y_0)}{g}} = \sqrt{\frac{2 \times 10}{9.8}} = 1.42\text{s}$

4. $\omega = \frac{d\theta}{dt} = \frac{d}{dt}\left(4.0t - 3.0t^2 + t^3\right) = 4.0 - 6.0t + 3t^2$

$\alpha = \frac{d\omega}{dt} = \frac{d}{dt}\left(4.0 - 6.0t + 3t^2\right) = -6.0 + 6t$

(a) $\omega(t=2) = 4.0 - 6 \times 2 + 3 \times 2^2 = 4.0 \text{ rad/s}$

(b) $\omega(t=4) = 4.0 - 6 \times 4 + 3 \times 4^2 = 4.0 - 24 + 48 = 28.0 \text{ rad/s}$

(c) $\alpha_{avg} = \frac{\omega(t=4) - \omega(t=2)}{\Delta t} = \frac{28.0 - 4.0}{2} = 12.0 \text{ rad/s}^2$

(d) $\alpha(t=2) = -6.0 + 6 \times 2 = 6 \text{ rad/s}^2$

(e) $\alpha(t=4) = -6.0 + 6 \times 4 = 18 \text{ rad/s}^2$

9. Rotational kinematics. $\omega_0 = 120 \text{ rad/s}$ $\omega = 0$

$\alpha = -4.0 \text{ rad/s}^2$ $\theta_0 = 0$ $\theta = ?$ $t = ?$

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

$t = \frac{\omega - \omega_0}{\alpha} = \frac{0 - 120 \frac{\text{rad}}{\text{s}}}{-4.0 \text{ rad/s}^2} = 30\text{s}.$

(b) $\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$

$= 120 \times 30 + \frac{1}{2}(-4.0) \times 30^2$

$= 1800$ radians

16. $\omega_0 = 2\pi 10 \text{ rad/s}$ $\omega = 2\pi 15 \text{ rad/s}$

$\theta_0 - \theta = 60 \times 2\pi$ radians $\alpha = ?$ $t = ?$

$\omega^2 - \omega_0^2 = 2\alpha(\theta - \theta_0)$

$\alpha = \frac{\omega^2 - \omega_0^2}{2(\theta - \theta_0)} = \frac{(30\pi)^2 - (20\pi)^2}{\ldots} = 6.5 \frac{\text{rad}}{\text{s}^2}$

(6) We now know α — start with $\omega_0 = 0$ at $t = 0$
$\omega = 10 \times 2\pi$ rad/s $\quad \alpha = 6.5$ rad/s^2 $\quad t = ?$ $\quad \theta_0 = 0$ $\quad \theta = ?$

$$\omega = \omega_0 + \alpha t$$
$$t = (\omega - \omega_0)/\alpha = 20\pi/6.5 = \boxed{9.6\text{s.}}$$

(b) Time for 60 rev. use kinematic paramerts from (a).

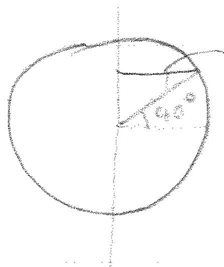
$$\omega = \omega_0 + \alpha t$$
$$t = \omega - \omega_0/\alpha = (30\pi - 20\pi)/6.5 = \boxed{4.8\text{s.}}$$

(d) Using kinematic parameters from (c)

$$\theta - \theta_0 = \omega_0 t + \tfrac{1}{2}\alpha t^2$$
$$= 0 + \tfrac{1}{2}\, 6.5 \times 9.6^2 = 300 \text{ radians}$$

$$\text{revolutions} = \frac{300 \text{ radians}}{2\pi} = \boxed{47.6 \text{ revs}}$$

29.



$R_e = 6.37 \times 10^6$ m.

$r = R_e \cos 40^\circ \qquad$ (a) $\omega = \dfrac{2\pi}{1\text{day}} = \boxed{7.2\times 10^{-5}}$

(b) $\quad V = \omega r = 7.2\times10^{-5} \times 6.37\times10^6 \times \cos 40$
$= \boxed{355\text{m/s.}}$

(c) $\omega = 7.2\times10^{-5}$ rad/s
(d) $V = \omega R_e = 7.2\times10^{-5} \times 6.37\times10^6 = \boxed{463 \text{ m/s}}$

30. If c has a rotation rate of 100 rev/min the speed of the edge will be V_c. V_A must match V_c if the belt does not slip.

$$V_c = \frac{2\pi r_c}{(1\text{min}/100\text{rev})} = \frac{2\pi r_c \times 100}{60\text{s}} = 2.62 \text{ m/s}$$

$V_A = 2.62\,m/s \Rightarrow \omega_A = \frac{V_A}{r_A} = \frac{2.62}{0.1} = 26.2$ ~~m~~ rad/s

Rotational kinematics to find when ω_A gets to 26.2 rad/s.

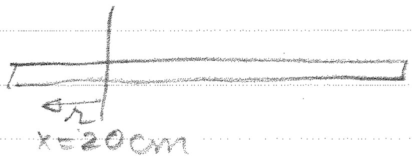
$\omega_0 = 0 \quad \omega = 26.2\,rad/s \quad \alpha = 1.6\,rad/s^2 \quad t = ?$

$\theta - \theta_0 = ?$

$$\omega = \omega_0 + \alpha t$$

$$t = \frac{\omega - \omega_0}{\alpha} = \frac{2.62 - 0}{1.6} = \boxed{1.64\,s}$$

35. $I = \int r^2\,dm$



$dm = \frac{M}{L}\,dx$

M is the total mass (0.56 kg) and L is the length (m

$$I = \int_0^1 (x - 0.2)^2 \frac{M}{\cancel{L}}\,dx$$

$$= M \int_0^1 (x^2 - 0.4x + 0.04)\,dx$$

$$= M \left[\frac{x^3}{3} - 0.4\frac{x^2}{2} + 0.04x\right]_0^1$$

$$= M\left(\frac{1}{3} - 0.2 + 0.04\right) = 0.097\,kg\,m^2$$

39. (a) $I = md^2 + m(2d)^2 + \underbrace{\frac{1}{12}(2M)(2d)^2 + 2Md^2}_{\text{By parallel axis theorem}}$

$= 0.85 (0.056)^2 + 0.85 \times 4 \times (0.056)^2 + \frac{1}{12}(2 \times 1.2)(2 \times 0.056)^2 + 2 \times 1.2 \times 0.056^2$

$= 2.66 \times 10^{-3} + 10.66 \times 10^{-3} + 2.51 \times 10^{-3} + 7.53 \times 10^{-3}$

$= 0.023\,kg\,m^2$

(b) $K.E = \frac{1}{2} I \omega^2 = \frac{1}{2} \times 0.023 \times 0.3^2 = 1.1 \times 10^{-3}\,J$