Homework 7 chapter 10

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Classical Physics - 1 (201)
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Homework-7 chapter 10 [6, 10, 19, 22, 26, 41, 44, 47, 48, 53, 63, 65]

Q6] $\Delta x = N_{rev}(\pi d) \rightarrow N = \frac{\Delta x}{\pi d} = \frac{7200m}{\pi(0.68m)} = \boxed{3400 rev}$

Q10] a] The earth makes one orbit around the sun in one year $\omega_{orbit} = \frac{\Delta\theta}{\Delta t} = \left(\frac{2\pi rad}{1 year}\right)\left(\frac{1 year}{3.16\times10^{7} s}\right)$

$= \boxed{1.99\times10^{-7} rad/s}$

b] One revolution about its axis

$\omega_{rotation} = \frac{\Delta\theta}{\Delta t} = \left(\frac{2\pi rad}{1 day}\right)\left(\frac{1 day}{86,400}\right) = \boxed{7.27\times10^{-5} \frac{rad}{s}}$

Q19] a] $\alpha = \frac{\omega^2-\omega_0^2}{2\theta} = \frac{0-(850 rev/min)^2}{2(1350 rev)}$

$= \left(-267.6 \frac{rev}{min^2}\right)\left(\frac{2\pi rad}{1 rev}\right)\left(\frac{1 min}{60 s}\right)^2$

$= -0.47 \frac{rad}{s^2}$

b] $\theta = \frac{1}{2}(\omega_0+\omega)t$

$t = \frac{2\theta}{\omega_0+\omega} = \frac{2(1350 rev)}{850 rev/min}\left(\frac{60 s}{1 min}\right) = \boxed{190 s}$

Q22] $\theta = 8.5t - 15.0t^2 + 1.6t^4$

a] $\omega = \frac{d\theta}{dt} = \boxed{8.5 - 30.0t + 6.4t^3}$, ω rad/sec and t in sec.

b] $\alpha = \frac{d\omega}{dt} = \boxed{-30.0 + 19.2t^2}$ where α in rad/sec^2 t in sec

c] $\omega(3.0) = 8.5 - 30.0(3.0) + 6.4(3.0)^3$

$= \boxed{91 \text{ rad/s}}$

$\alpha(3.0) = -30.0 + 19.2(3.0)^2 = \boxed{140 \text{ rad/s}^2}$

d] $\omega_{avg} = \frac{\Delta\theta}{\Delta t} = \frac{\theta(3.0) - \theta(2.0)}{3.0s - 2.0s}$

$= \frac{[8.5(3.0) - 15.0(3.0)^2 + 1.6(3.0)^4] - [8.5(2.0) - 15.0(2.0)^2 + 1.6(2.0)^4]}{1.0s}$

$= \boxed{38 \text{ rad/s}}$

e] $\alpha_{avg} = \frac{\Delta\omega}{\Delta t} = \frac{\omega(3.0) - \omega(2.0)}{3.0s - 2.0s}$

$= \frac{[8.5 - 30.0(3.0) + 6.4(3.0)^3] - [8.5 - 30.0(2.0) + 6.4(2.0)^3]}{1.0s}$

$= \boxed{92 \text{ rad/s}^2}$

26] Torque is calculated $T = rF\sin\theta$

a] For the first case $\theta = 90°$

$T = rF\sin\theta = (0.96m)(32N)\sin 90° = \boxed{31 \text{ m·N}}$

b] For the second case $\theta = 60.0°$

$T = rF\sin\theta = (0.96m)(32N)\sin 60° =$

$\boxed{27 \text{ m·N}}$

41] torque required is equal to the angular acceleration times the moment of inertia.

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

$\tau = I\alpha = \left(\frac{1}{2} m R_0^2\right)\left(\frac{\omega}{t}\right) = \frac{m R_0^2 \omega}{2t}$

$= \frac{(31000 kg)(7.0m)^2 (0.08 rad/s)}{2(24s)}$

$= \boxed{2.2 \times 10^4 m \cdot N}$

44] $\tau = I\alpha = (I_{wgr} + I_{children}) \frac{\Delta \omega}{\Delta t} = \left(\frac{1}{2} m_{mgr} R^2 + 2 m_{child} R^2\right) \frac{\omega - \omega_0}{t}$

$= \left[\frac{1}{2}(760 kg) + 2(25 kg)\right](2.5m)^2 \frac{(15 rev/min)(2\pi rad/rev)(1 min/60s)}{10.0s}$

$= \boxed{420 m \cdot N}$

So $\tau = F_\perp R \sin\theta \rightarrow F_\perp = \tau / R = 422.15 m \cdot N / 2.5m = \boxed{170N}$

47] a] moment of inertia $\frac{1}{3} mL^2$

$I_{total} = 3\left(\frac{1}{3} ml^2\right) = ml^2 = (135 kg)(3.75m)^2$

$= 1898 kg \cdot m^2$

$= \boxed{1.90 \times 10^2 kg \cdot m^2}$

b] $\tau = I_{total}\, \alpha = I_{total} \frac{\omega - \omega_0}{t} = \frac{(1898 kg \cdot m^2)(5.0 rad/sec)(2\pi rad/rev)}{8.0s} = \boxed{7500 m \cdot N}$

48] $\alpha = t/I$, so by substituting into the equation

$$\omega^2 = \omega_0^2 + 2\alpha\theta \rightarrow \theta = \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{0 - \omega_0^2}{2(t/I)}$$

$$= \frac{-\omega_0^2}{2(t/\frac{1}{2}mR^2)} = \frac{-mR^2\omega_0^2}{4t}$$

$$= \frac{-(3.80kg)(0.0710m)^2\left[(10{,}300\,\frac{rev}{min})(\frac{2\pi rad}{1rev})(\frac{1min}{60s})\right]^2}{4(-1.20N\cdot m)}$$

$$= 4643 rad\left(\frac{1rev}{2\pi rad}\right) = \boxed{739 rev}$$

time $\rightarrow \theta = \frac{1}{2}(\omega_0 + \omega)t$

$$t = \frac{2\theta}{\omega_0 + \omega} = \frac{2(739rev)}{10{,}300 rev/min}\left(\frac{60s}{1min}\right) = \boxed{8.61s}$$

53] a) Angular acceleration equation

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta \rightarrow \alpha = \frac{\omega^2 - \omega_0^2}{2\Delta\theta} = \frac{(v/r)^2 - 0}{2\Delta\theta}$$

$$= \frac{[(26.5m/s)/(1.20m)/(1.20m)]^2}{2(8\pi rad)} = 9.702\ rad/s^2$$

b) $a_{tan} = \alpha r = (9.702 rad/s^2)(1.20m)$

$= 11.64 m/s^2 \approx \boxed{11.6 m/s^2}$

c) $a_{rad} = v^2/r = (26.5m/s^2)/(1.20m)$

$= 585.2 m/s^2 = \boxed{585 m/s^2}$

d) $F_{net} = ma_{net} = m\sqrt{a^2_{tan} + a^2_{rad}}$

$= (7.30kg)\sqrt{(11.64m/s^2)^2 + (585.2m/s^2)^2} = \boxed{4270N}$

e] $\theta = \tan^{-1} \frac{a_{tan}}{a_{rad}} = \tan^{-1} \frac{11.66 m/s^2}{585.2 m/s^2} = \boxed{1.14°}$

63] The energy required to bring the rotor up to speed from rest is equal

$K_{rotor} = \frac{1}{2} I\omega^2 = \frac{1}{2} (4.25 \times 10^{-2} kg \cdot m^2)$

$\left[9750 \frac{rev}{min} \left(\frac{2\pi \, rad}{1 rev} \right) \left(\frac{1 min}{60 s} \right) \right]^2$

$= \boxed{2.22 \times 10^4 J}$

65] Work required is the change in rotational kinetic energy. The initial angular velocity is 0

$W = \Delta K_{rotor} = \frac{1}{2} I\omega_f^2 - \frac{1}{2} I\omega_i^2$

$= \frac{1}{2} \left(\frac{1}{2} mR^2 \right) \omega_f^2 = \frac{1}{4} (1640 kg)(7.50 m)^2$

$\left(\frac{2\pi \, rad}{8.00 s} \right)^2 = \boxed{1.42 \times 10^4 J}$

Homework 7 Chapter 11

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Homework-7 chapter 11 [10]

Q[10] Subscript 1 = before collision
Subscript 2 = after the collision.
rod has no initial angular momentum

$L_1 = L_2 \rightarrow I_1 \omega_1 = I_2 \omega_2 \rightarrow$

$$\omega_2 = \omega_1 \frac{I_1}{I_2} = \omega_1 \frac{I_{disk}}{I_{disk} + I_{rod}} = \omega_1 \left[\frac{\frac{1}{2} m R^2}{\frac{1}{2} m R^2 + \frac{1}{12} m (2R)^2} \right]$$

$$= (3.7\ \text{rev/s}) \left(\frac{3}{5} \right) = \boxed{2.2\ \text{rev/s}}$$