# PHYS 2311 Ch. 10 HW

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**Problem 1.**

**(a)** 0.785 rad, $\frac{\pi}{4}$ rad

**(b)** 1.0471 rad, $\frac{\pi}{3}$ rad

**(c)** 1.571 rad, $\frac{\pi}{2}$ rad

**(d)** 6.283 rad, $2\pi$ rad

**(e)** 7.7667 rad, $\frac{89\pi}{36}$ rad

**Problem 4.**

$$8500\text{rpm} \cdot \frac{1\,\text{min}}{60\,\text{s}} \cdot \frac{2\,\pi\text{rad}}{1\,\text{rev}} = 890.12\,\text{rad/s} = \omega$$

$$t = 4.0$$

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{890.12}{4.0} = \frac{890.12 - 0}{4.0} = \boxed{223\,\text{rad/s}^2}$$

**Problem 5.**

**(a)**

$$7200\text{rpm} \cdot \frac{1\,\text{min}}{60\,\text{s}} \cdot \frac{2\,\pi\text{rad}}{1\,\text{rev}} = \boxed{240\pi\,\text{rad/s}}$$

**(b)**

$$r = 3.00\,\text{cm} = 0.03\,\text{m}$$

$$v = r\omega = (0.03)(240\pi) = \boxed{22.62\,\text{m/s}}$$

**(c)**

$$22.62 \cdot \frac{1\,\text{b}}{0.5\,\mu\text{m}} = \boxed{45.24 \times 10^6\,\text{bps}}$$

**Problem 6.**

$$C = \frac{\text{distance}}{\text{revolutions}} = \frac{3.1}{12.0} = 0.258\,\text{m}$$

$$C = \pi \cdot d = \frac{0.258\,\text{m}}{\pi} = d = 0.822\,\text{m} = \boxed{8.2\,\text{cm}}$$

**Problem 19.**

$$15000\text{rpm} \cdot \frac{1\,\text{min}}{60\,\text{s}} \cdot \frac{2\,\pi\text{rad}}{1\,\text{rev}} = 1.57\,\text{rad/s}$$

$$\alpha = \frac{\omega_f - \omega_0}{t}$$

$$\alpha = \frac{1570.8\,\text{rad/s} - 0}{220\,\text{s}} = 7.14\,\text{rad/s}^2$$

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

$$\theta = \frac{1}{2} \times 7.14\,\text{rad/s}^2 \times (220\,\text{s})^2 = 172,960\,\text{rad}$$

$$\text{rev} = \frac{172,960\,\text{rad}}{2\pi\,\text{rad/rev}} = \boxed{27\,855\,\text{rev}}$$

**Problem 20.**

**(a)**

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

$$\text{rev} = 26 \cdot 2\pi = 52\pi\,\text{rev}$$

$$52\pi = \frac{1}{2}\alpha(60)^2$$

$$\alpha = \frac{(52\pi)(2)}{60^2} = \boxed{0.0909\,\text{rad/s}^2}$$

**(b)**

$$\omega_f = \omega_0 + \alpha t$$

$$\omega_f = 0 + (0.0909\,\text{rad/s}^2)(60\,\text{s})$$

$$\omega_f = 5.454\,\text{rad/s}$$

$$\omega_f = 5.454\,\text{rad/s} \times \frac{60\,\text{s}}{2\pi\,\text{rad}}$$

$$\omega_f \approx \boxed{52.0\,\text{rpm}}$$

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**Problem 21.**

**(a)**

$$\omega_0 = 780\,\text{rev/min} \times \frac{2\pi\,\text{rad}}{60\,\text{s}} = 81.68\,\text{rad/s}$$

$$\theta = 1250\,\text{rev} \times 2\pi\,\text{rad/rev} = 2500\pi\,\text{rad}$$

$$\omega_f^2 = \omega_0^2 + 2\alpha\theta$$

$$0 = (81.68\,\text{rad/s})^2 + 2\alpha(2500\pi\,\text{rad})$$

$$2\alpha(2500\pi) = -(81.68)^2$$

$$\alpha = \frac{-(81.68)^2}{2 \times 2500\pi}$$

$$\alpha \approx \boxed{-0.42\,\text{rad/s}^2}$$

**(b)**

$$\omega_f = \omega_0 + \alpha t$$

$$0 = 81.68\,\text{rad/s} + (-0.42\,\text{rad/s}^2)t$$

$$t = \frac{81.68\,\text{rad/s}}{0.42\,\text{rad/s}^2}$$

$$t \approx \boxed{192.3\,\text{s}}$$

**Problem 25.**

**(a)**

$$\theta = 9.5t - 13.0t^2 + 1.6t^4$$

$$\omega = 9.5 - 26.0t + 6.4t^3$$

**(b)**

$$\alpha = -26.0 + 19.2t^2$$

**(c)**

$$\omega(3.0) = 9.5 - 26.0(3.0) + 6.4(3.0)^3 = \boxed{104.3\,\text{rad/s}}$$

$$\alpha(3.0) = -26.0 + 19.2(3.0)^2 = \boxed{146.8\,\text{rad/s}^2}$$

**(d)**

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

$$= \frac{(9.5(3.0) - 13.0(3.0)^2 + 1.6(3.0)^4) - (9.5(2.0) - 13.0(2.0)^2 + 1.6(2.0)^4)}{1.0} = \boxed{48.5\,\text{rad/s}}$$

**(e)**

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

$$= \frac{(9.5 - 26.0(3.0) + 6.4(3.0)^3) - (9.5 - 26.0(2.0) + 6.4(2.0)^3)}{1.0} = \boxed{95.6\,\text{rad/s}^2}$$

**Problem 28.**

$$\tau_1 = mg\ell_1, \quad \tau_2 = mg\ell_2$$

$$\tau_{net} = \tau_1 + \tau_2 = mg\ell_1 + mg\ell_2 = mg(\ell_1 + \ell_2)$$

The direction of the net torque is clockwise.

**Problem 29.**

**(a)**

$$\tau = Fd = (37)(0.96) = \boxed{35.52\,\text{Nm}}$$

**(b)**

$$\tau = Fd\sin\theta = (37)(0.96)\sin(60) = \boxed{30.66\,\text{Nm}}$$

**Problem 30.**

$$\tau_1 = r_1 F_1 \sin\theta$$

$$\tau_1 = (0.12)(35)\sin(135^\circ)$$

$$\sin(135^\circ) = \sin(45^\circ) = \frac{\sqrt{2}}{2}$$

$$\tau_1 = (0.12)(35)(\frac{\sqrt{2}}{2})$$

$$\tau_1 = 2.97\,\text{Nm (counterclockwise)}$$

$$\tau_2 = r_2 F_2 \sin 90^\circ$$
$$\tau_2 = (0.24)(28)$$
$$\tau_2 = 6.72\,\text{Nm (counterclockwise)}$$

$$\tau_3 = r_2 F_3 \sin 90^\circ$$
$$\tau_3 = (0.24)(18)$$
$$\tau_3 = 4.32\,\text{Nm (clockwise)}$$

$$\tau_{\text{net}} = \tau_1 + \tau_2 - \tau_3 - \tau_{\text{friction}}$$
$$\tau_{\text{net}} = 2.97 + 6.72 - 4.32 - 0.60$$
$$\tau_{\text{net}} = \boxed{4.77\,\text{Nm (counterclockwise)}}$$

**Problem 34.**

The radius near the hub of the bicycle is effectively zero, as it is so small that it's considered negligible.

$$R = \frac{D}{2} = \frac{0.67}{2} = 0.335\,\text{m}$$

$$I = mR^2 = (1.1)(0.335)^2 = \boxed{0.123\,\text{kg}\cdot\text{m}^2}$$

**Problem 35.**

$$\alpha = \frac{0.72}{34} = 0.0212\,\text{rad/s}^2$$

$$\tau = m\frac{1}{2}R^2\alpha = (31000)\frac{1}{2}(7.0)^2(0.0212) = \boxed{16\,100\,\text{Nm}}$$

**Problem 37.**

**(a)**

$$I = \frac{1}{2}mR^2 = \frac{1}{2}(0.380)(0.0850)^2 = \boxed{1.37\times10^{-3}\,\text{kg}\cdot\text{m}^2}$$

**(b)**

$$\tau$$

**Problem 53.**

**Problem 54.**

**Problem 55.**

**Problem 64.**

**Problem 67.**

**Problem 69.**