Homework 7 - Solutions

Note Title 1/4/2006

(C2) $G \sim 10^{-11} \frac{N m^2}{Kg^2}$ $M_1 M_2 \sim 10^2 Kg^2$ $r \sim 10$ meters

$$\frac{10^{-11} \cdot 10^2}{10} = 10^{-10} N.$$ NOT A WHOLE LOT.

(C5) YES! WHEN YOU PUT 20 INCH RIMS ON A GEO METRO, THE VEHICLE MOVES FURTHER WITH EACH WHEEL ROTATION. THE SPEEDOMETER DETERMINES THE VEHICLE SPEED FROM THE NUMBER OF ROTATIONS. THEREFORE, THE SPEEDOMETER ACTUALLY READS LOW.

(C11.) THE ROTATION OF SUCH A CYLINDER WOULD CAUSE A CENTRIPETAL FORCE EQUIVALENT TO GRAVITY ON THE SURFACE OF THE EARTH.

7.1 (a) $\theta = \frac{s}{r} = \frac{60\,000 \text{ mi}}{1.0 \text{ ft}}\left(\frac{5280 \text{ ft}}{1 \text{ mi}}\right) = \boxed{3.2\times10^8 \text{ rad}}$.

(b) $\theta = 3.2\times10^8 \text{ rad}\left(\frac{1 \text{ rev}}{2\pi \text{ rad}}\right) = \boxed{5.0\times10^7 \text{ rev}}$.

7.5 (a) $\alpha = \frac{(2.51\times10^4 \text{ rev/min}-0)}{3.20 \text{ s}}\left(\frac{2\pi \text{ rad}}{1 \text{ rev}}\right)\left(\frac{1 \text{ min}}{60.0 \text{ s}}\right) = \boxed{821 \text{ rad/s}^2}$

(b) $\theta = \omega_i t + \frac{1}{2}\alpha t^2 = 0 + \frac{1}{2}\left(821 \frac{\text{rad}}{\text{s}^2}\right)(3.20 \text{ s})^2 = \boxed{4.21\times10^3 \text{ rad}}$

7.10 We will break the motion into two stages: (1) an acceleration period and (2) a deceleration period.

The angular displacement during the acceleration period is

$$\theta_1 = \bar{\omega}t = \left(\frac{\omega_f + \omega_i}{2}\right)t = \left[\frac{(5.0 \text{ rev/s})(2\pi \text{ rad/1 rev}) + 0}{2}\right](8.0 \text{ s}) = 126 \text{ rad},$$

and while decelerating,

$$\theta_2 = \left(\frac{\omega_f + \omega_i}{2}\right)t = \left[\frac{0 + (5.0 \text{ rev/s})(2\pi \text{ rad/1 rev})}{2}\right](12 \text{ s}) = 188 \text{ rad}.$$

The total displacement is $\theta = \theta_1 + \theta_2 = [(126+188) \text{ rad}]\left(\frac{1 \text{ rev}}{2\pi \text{ rad}}\right) = \boxed{50 \text{ rev}}.$

$\boxed{11}$ $\Delta\theta = \omega t$ where $\omega = 1$ rad/s, $t = 30$ min $= 1800$ s

Thus, the rounds n of the tape runs should be

$$n = \frac{\Delta\theta}{2\pi} = \frac{\omega t}{2\pi}$$

Thus, the tape's thickness d times n is equal to radius R of the tape wheel, which gives $n \cdot d = R \Rightarrow d = \frac{2\pi R}{\omega t}$

where $R \approx 3$ cm. Thus,

$$d = \frac{2\pi\,(3\text{ cm})}{1 \text{ rad/s}\,(1800 \text{ s})} \sim \boxed{10^{-2} \text{ cm}}$$

12 $\because \quad \omega^2 = \omega_0^2 + 2\alpha\Delta\theta \quad \therefore \Delta\theta = \dfrac{\omega^2 - \omega_0^2}{2\alpha}$

where $\omega_0 = 18.0$ rad/s , $\omega = 0$, $\alpha = -1.90$ rad/s^2

And since there is no slipping ,

$\Delta x = \Delta\theta \cdot \dfrac{d}{2}$, where d is the diameter of the com .

$$\Delta x = \frac{d}{2} \cdot \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{2.40\text{ cm}}{2} \cdot \frac{0 - (18.0\text{ rad/s})^2}{2(-1.90\text{ rad/s}^2)}$$

$$= \boxed{102.3\text{ cm}}$$