HW #4
SP211 Vanhoy

Due Mon 21 Sept

Seven Book problems

Serway Ch 6 Problems: 5, 11, 13, 14, 17, 26, 30

Zero multiple choice
Ch 6.5

a) friction is responsible for the circular motion.

\[ \sum \vec{F}'s \]

\[ m_{rad} = \sum F_{rad}'s \]

\[ m_{rad} = f_{static} \]

\[ m_{rad} = N - mg \]

max speed = static friction

\[ m_{rad} = \mu_s N \]

\[ \mu_s = \frac{0.65}{0.30} = \mu_s (9.8) \]

\[ \mu_s = 0.085 \]

Ch 6.1

\[ \cos \theta = \frac{1.5}{2.0} \]

\[ \theta = 41.4^\circ \]

\[ (1.5)^2 + (R)^2 = 2^2 \]

\[ R = 1.323 \text{ m} \]

\[ m = 4 \text{ kg} \quad \nu = 6 \text{ m/s} \]

Inward is positive radial direction.

radial & vertical

\[ \sum \vec{F}'s \]

\[ m_{rad} = \sum F_{rad}'s \]

\[ m_{z} = \sum F_{e}'s \]

\[ m_{rad} = T_1 \sin \theta + T_2 \sin \theta \]

\[ \frac{m \nu^2}{R} = T_1 \cos \theta - T_2 \cos \theta \]

\[ \frac{m \nu^2}{R^2} = T_1 \sin \theta + T_2 \sin \theta \]

\[ 0 = T_2 \cos \theta - T_1 \cos \theta - mg \]

\[ T_2 \cos \theta = T_1 \cos \theta + mg \]

\[ T_2 = \frac{1}{\cos \theta} \left[ T_1 \cos \theta + mg \right] \]

\[ \frac{m \nu^2}{R} = \left[ T_1 + \frac{mg}{\cos \theta} \right] \sin \theta \]

\[ T_2 = T_1 + \frac{mg}{\cos \theta} \]

\[ \frac{m \nu^2}{R} = \left[ 2T_1 + \frac{4(9.8)}{\cos 41.4^\circ} \right] \sin 41.4^\circ \]

\[ 164.59 = \left[ 2T_1 + 52.26 \right] \]

\[ T_1 = 56.2 \text{ Newtons} \]

\[ T_2 = 108.5 \text{ Newtons} \]
Anchor point of chairs is the "center" of rotation.

For radial direction:
\[ \mathbf{a} = \Sigma F_{\text{rad}} \]

We are only worried about radial forces in this problem.

\[ ma_{\text{rad}} = \Sigma F_{\text{rad}} \]
\[ ma_{\text{rad}} = T + T - mg \]
\[ m \frac{v^2}{R} = 2T - mg \]
\[ 40 \frac{v^2}{3} = 2(350) - 40(9.8) \]
\[ v = 4.81 \text{ m/s} \]

The upward force on the child (actually inward radial direction) is 700 Newtons.

\[ m = 500 \text{ kg} \]
\[ R = 10 \text{ m} \]
\[ v = 20 \text{ m/s} \]
\[ ma_{\text{rad}} = \Sigma F_{\text{rad}} \]
\[ m \frac{v^2}{R} = m \frac{v^2}{R} = mg - N \]

As the speed increases, \( N \) will decrease.
The smallest \( N \) can be is \( \approx \) zero.

\[ m \frac{v^2}{R} = mg - 0 \]
\[ 500 \frac{v^2}{15} = 500(9.8) - 0 \]
\[ v = 12.1 \text{ m/s} \]
Ch 6.17

\[ m = 80 \text{ kg} \]
\[ \text{terminal speed} = 50 \text{ m/s} \]

a) What is acceleration when speed 30 m/s?

So we'll need to make assumptions here.

Use the high-speed drag force \( \frac{1}{2} D p A v^2 \)

we aren't provided

the drag coeff D
nor the Area A

\[ m a = \frac{1}{2} D p A v^2 - mg \]

The terminal velocity is 50 m/s, at which the \( C_D = 0 \)

\[ 0 = \frac{1}{2} D p A (50)^2 - 80 (9.8) \]

\[ D p A = 0.627 \]

We'll use this product of quantities

a) at 30 m/s

\[ m a = \frac{1}{2} D p A v^2 - mg \]

80 \( a = \frac{1}{2} (0.627) 30^2 - 80 (9.8) \)

\[ a = -6.27 \text{ m/s}^2 \]

b) Drag force when 50 m/s?

Since this is the terminal speed \( \text{Drag} = mg \)

80(9.8) = 784 Newtons

- or use the other formula

c) Drag force when 30 m/s²

\[ \frac{1}{2} D p A v^2 = \frac{1}{2} (0.627) 30^2 = 282 \text{ Newtons} \]
Ch 6.30

\[ m = 1200 \text{ kg} \quad V = 100 \text{ km/h} = 27.8 \text{ m/s} \]

\[ D = 0.25 \]

\[ A = 2.20 \text{ m}^2 \]

*Ignore any other frictional forces*

\[ \frac{1}{2} D p A V^2 = \frac{1}{2} (0.25) \left[ 1.2 \text{ kg/m}^3 \right] (2.20) (27.8)^2 \]

\[ = 255 \text{ Newtons} \]

\[ \text{Drag} = -mg + F_x \]

\[ m a_x = \int F_x \text{ d}s \]

\[ m a_x = -\text{Drag} \]

\[ 1200 \quad a_x = -255 \]

\[ a_x = -0.21 \text{ m/s}^2 \]