Solutions

PHYS-205A-001 (Midterm Exam 2) (Fall 2017)

Prob. 1

$\Delta x = 36.0\,m$

$\Delta t =$

$V_{ix} = 21.0 \cos 48 = 14.1 \frac{m}{s}$

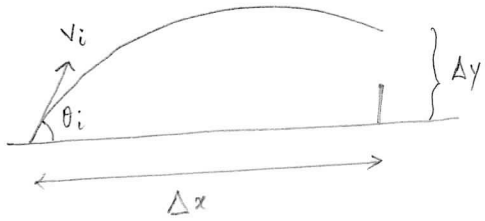
$\Delta y = ?$

$\Delta t =$

$V_{iy} = 21.0 \sin 48 = 15.6 \frac{m}{s}$

$a = -9.8 \frac{m}{s^2}$

$V_{fy} =$



$$\Delta t = \frac{\Delta x}{V_{ix}} = \frac{36.0}{14.1} = 2.55 \text{ seconds}$$

$$\Delta y = V_{iy}\Delta t + \frac{1}{2} a \Delta t^2$$

$$= (15.6)(2.55) + \frac{1}{2}(-9.8)(2.55)^2$$

$$= 39.78 - 31.9$$

$$= 7.92\,m$$

The football clears the crossbar by $7.92 - 3.05 = 4.87\,m$

Problem 2

downstream

$$v = 20 + 5 = 25 \frac{m}{s}$$

$$t = \frac{x}{v} = \frac{3000}{25} = 120\,s$$

upstream

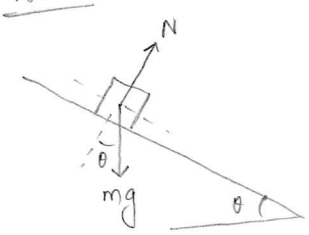
$$v = 20 - 5 = 15 \frac{m}{s}$$

$$t = \frac{x}{v} = \frac{3000}{15} = 200\,s$$

Total time $= 120 + 200 = 320$ seconds

$= 5.3$ minutes.

Prob. 3



$m\vec{g} + \vec{N} = m\vec{a}$

x: $mg\sin\theta = ma \Rightarrow a = g\sin\theta$

y: $-mg\cos\theta + N = 0 \Rightarrow N = mg\cos\theta$

(a) $a = g\sin\theta = 9.8 \sin 20 = 3.35 \frac{m}{s^2}$

(b) $v_i = 0$ $\quad \Delta x = 3.00\,m$

$v_f =$ $\quad \Delta t =$

$a = 3.35 \frac{m}{s^2}$.

$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$

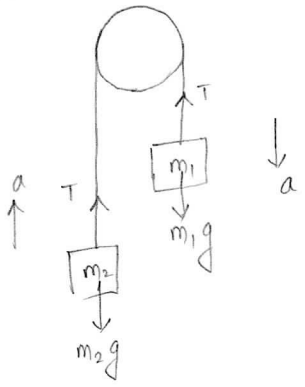
$3.00 = \frac{1}{2} 3.35 \Delta t^2$

$\Delta t = \sqrt{\frac{(3.00)\,2}{3.35}} = 1.34$ seconds

Prob 4

$m_1 = 32.0\,kg$

$m_2 = 28.0\,kg$



m_1: $-m_1 g + T = -m_1 a$

m_2: $-m_2 g + T = m_2 a$ $\quad \ominus$

$-m_1 g + m_2 g = -m_1 a - m_2 a$

$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$

(a) $a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g = \left(\frac{32.0 - 28.0}{32.0 + 28.0}\right) 9.8 = 0.653 \frac{m}{s^2}$.

(b) $\Delta y = -3.0\,m$ $\quad v_i = 0$ $\quad a = -0.653 \frac{m}{s^2}$.

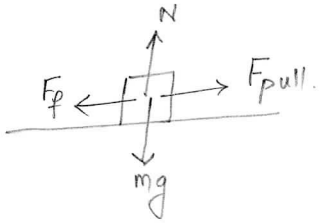
$\Delta t =$ $\quad v_f =$

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$

$-3.0 = 0 + \frac{1}{2}(-0.653) \Delta t^2$.

$\Delta t = \sqrt{\frac{(3.0)\,2}{0.653}} = 3.03$ seconds

Prob. 5



$N = mg$

$F_{pull} - F_f = ma$

$a = 0$

$F_f \leq \mu_s N = \mu_s mg$

$F_{pull} = \mu_s mg \Rightarrow \mu_s = \frac{F_{pull}}{mg} = \frac{75.0\ N}{(25.0)(9.8)} = 0.306$

Prob. 6

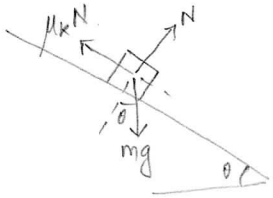
$-mg + N = -m\frac{v^2}{R}$

$N = 0$ for greatest speed

$v^2 = gR$

$v = \sqrt{gR} = \sqrt{(9.8)(250)} = 49.5\ \frac{m}{s}$

Prob. 7



downward

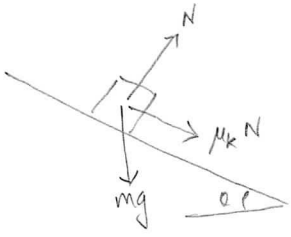
$y: \quad N = mg\cos\theta$

$x: \quad mg\sin\theta - \mu_k N = ma.$

Given $a = 0$. $\Rightarrow \quad mg\sin\theta = \mu_k mg\cos\theta$

$\Rightarrow \quad \mu_k = \tan\theta$

downward



upward

$y: \quad N = mg\cos\theta$

$x: \quad mg\sin\theta + \mu_k N = -ma.$

$mg\sin\theta + \mu_k mg\cos\theta = -ma$

$a = -g\sin\theta - \mu_k g\cos\theta$

$= -g\sin\theta - (\tan\theta)\, g\cos\theta$

$= -g\sin\theta - \sin\theta\, g$

$= -2g\sin\theta.$