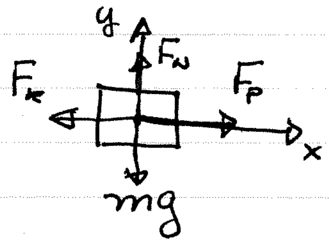
Ch 6 Homework

3.



$$\sum F_y = 0 \Rightarrow F_N - mg = 0$$

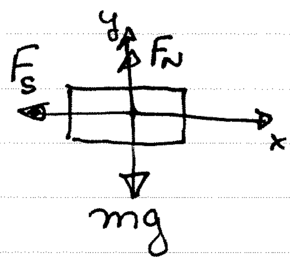
$$F_N = mg$$

$$F_k = \mu_k F_N = \mu_k mg$$
$$= \boxed{189N} \quad (a)$$

(b) $\sum F_x = ma_x$

$$F_p - F_k = ma_x \Rightarrow a_x = \frac{F_p - F_k}{m} = \frac{220-189}{55} = \boxed{0.57\ m/}$$

5.



$\leftarrow a$ (a_x = negative x direction

$$F_{s\,max} = \mu_s F_N = \mu_s mg$$

Thus, the maximum deceleration is given from

$$\sum F_x = ma_x$$
$$-F_{s\,max} = -m a_{x\,max}$$
$$-\mu_s mg = m a_{x\,max}$$
$$a_{x\,max} = -0.25g = -2.45 m/s^2$$
(in neg. x).

Kinematics $V_o = 48 \frac{km}{hr} = 48 \times \frac{1000}{3600} \frac{m}{s} = 13.3 m/s$

$V_f = 0 \quad a = -2.45 m/s^2 \quad X_f - X_o = ?$

$$V_f^2 - V_o^2 = 2a(X_f - X_o)$$

$$X_f - X_o = \frac{V_f^2 - V_o^2}{2a} = \frac{0^2 - 13.3^2}{-2 \times 2.45} = \boxed{36.1 m}$$

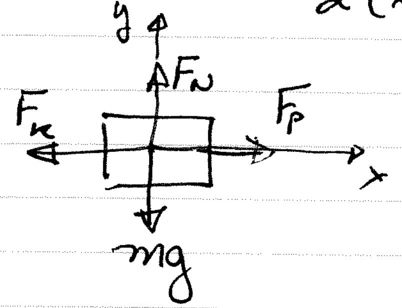
8. Find the acceleration first, then use $\Sigma F_x = m$ to determine force of friction.

$V_0 = 0 \quad V_f = 1.6 m/s \quad x_f - x_0 = 0.9 m \quad a = ? \quad t = ?$

$$V_f^2 - V_0^2 = 2a(x_f - x_0)$$

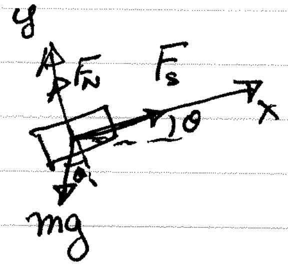
$$a = \frac{V_f^2 - V_0^2}{2(x_f - x_0)} = \frac{1.6^2 - 0^2}{2(0.9)} = 1.42 m/s^2$$

FBD



$$\Sigma F_x = ma_x$$
$$F_p - F_k = ma_x$$
$$F_k = F_p - ma$$
$$\cancel{= 0.250}$$
$$\mu_k mg = F_p - ma$$
$$\mu_k = \frac{F_p - ma}{mg} \quad \cancel{0.25-3.5}$$
$$= \frac{25 - 3.5 \times 1.42}{3.5 \times 9.8}$$
$$= \underline{\underline{0.58}}$$

15.1



$\Sigma F_x = 0 \quad F_s - mg \sin\theta = 0$ —①
$\Sigma F_y = 0 \quad F_N - mg \cos\theta = 0$ —②

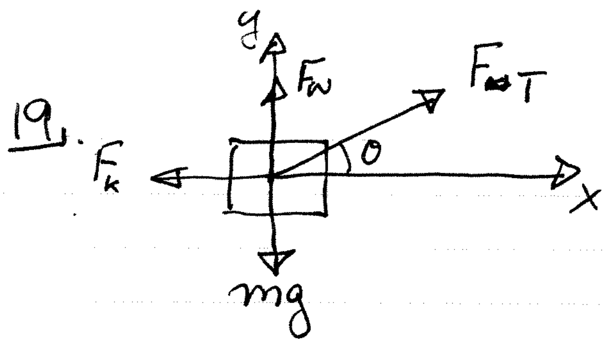
$F_s = \mu_s F_N$ at maximum. Use this relation and solve for θ. (Note $F_N \neq mg$!).

From ② $F_N = mg\cos\theta$ ∴ ① becomes

$$\mu_s mg \cos\theta - mg \sin\theta = 0$$
$$\mu_s = \tan\theta$$
$$\theta = \tan^{-1} \mu_s = 2.3^\circ.$$

(2° to 1 sig. figure).

19.



why?

$\sum F_x = ma = 0$

$F_T \cos\theta - F_k = 0$

$F_k = F_T \cos\theta$

$\mu_k F_N = F_T \cos\theta \quad - ①$

$\sum F_y = 0$

$F_N + F_T \sin\theta - mg = 0 \quad - ②$

$① \Rightarrow \quad F_N = \dfrac{F_T \cos\theta}{\mu_k} \Rightarrow \quad \dfrac{F_T \cos\theta}{\mu_k} + F_T \sin\theta - mg = 0$

What value of θ maximizes the m value.

$$m = \frac{F_T}{g}\left(\frac{\cos\theta}{\mu_k} + \sin\theta\right)$$

$$\frac{dm}{d\theta} = \frac{F_T}{g}\left(-\frac{\sin\theta}{\mu_k} + \cos\theta\right) = 0$$

Clearly $\dfrac{F_T}{g} \neq 0$ so $(\quad) = 0 \Rightarrow \mu_k \cos\theta - \sin\theta = 0$

$\Rightarrow \mu_k - \tan\theta = 0$

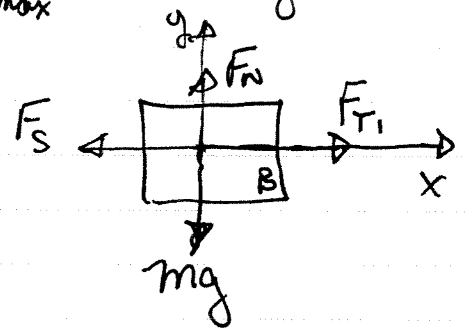
$\Rightarrow \theta = \tan^{-1}\mu_k$

$= \underline{\underline{19.3^\circ}}$

using $\theta = 19.3^\circ$.

$m_{max} = 340\,kg$.

23.

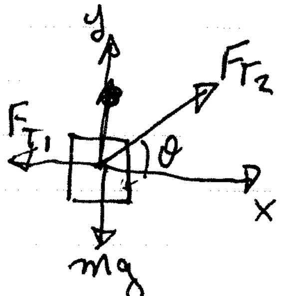


$m_B g = 711N \Rightarrow F_{s\,max} = \mu m_B g$

$= 0.25 \times 71[illegible]$

$= \underline{\underline{178N}}$

This means $F_{T_1} = 178N$ at the ~~abs~~ maximum tension. Any greater tension and the block B will move. Now look at A



$\sum F_y = 0 \Rightarrow F_{T_2} \sin\theta - m_A g = 0 \quad - ①$

$\sum F_x = 0 \Rightarrow F_{T_2} \cos\theta - F_{T_1} = 0 \quad - ②$

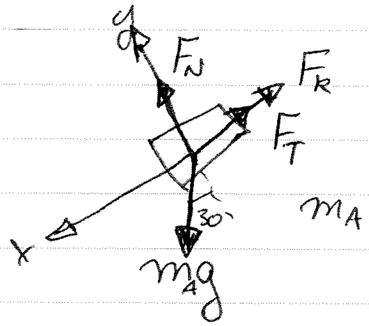
② $\Rightarrow$ $F_{T2} = \dfrac{F_{T1}}{\cos\theta}$ which in ① gives

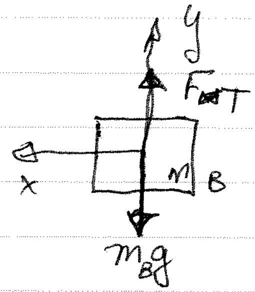
$$\frac{F_{T1}}{\cos\theta}\sin\theta - m_A g = 0$$

$$m_A = \frac{F_{T1}\tan\theta}{g} = \underline{\underline{10.5\,kg}}.$$

Weght is $m_A g = 10.5 \times 9.8 = \boxed{100N.}$

30. Draw a Free Body Diagram for each mass. Note the axes need not be the same! The Tension force is the same magnitude in each case only the direction is different





From m_B figure: $\sum F_y = 0$ (constant velocity means $a=0$)

$$F_T = m_B g$$

From m_A figure: $\sum F_y = 0$

$$F_N - m_A g\cos 30° = 0$$

$$F_N = m_A g\cos 30°$$

$\sum F_x = 0$

$m_A g\sin 30 - F_T - F_R = 0$

$m_A g\sin 30 - m_B g - \mu_k F_N = 0$

$m_A g\sin 30 - m_B g - \mu_k m_A g\cos 30° = 0$

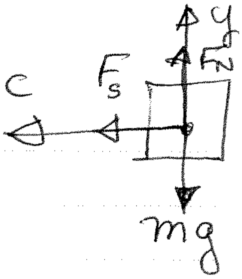
Solve for m_B

$$m_B = m_A\sin 30 - \mu_k m_A\cos 30°$$

$$= 10(\sin 30 - 0.2\cos 30°) = 3.3\,kg$$

44. $\sum F_y = 0$

$F_N = mg$



$\sum F_c = \frac{mv^2}{r}$

$F_s = \frac{mv^2}{r}$ (Equal on verge of sliding)

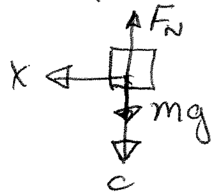
$\mu F_N = \frac{mv^2}{r}$

$\mu \cancel{m} g = \frac{\cancel{m} v^2}{r} \Rightarrow V = \sqrt{\mu g r} = \sqrt{0.6 \times 9.8 \times 30.5}$

$= \boxed{13.4\ m/s}$

45. (a) $T = \frac{2\pi r}{V} = \frac{2\pi\, 10}{6.1} = 10.3\,s.$

(b) At top



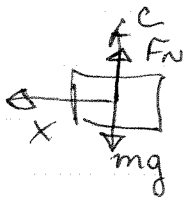
$\downarrow a_c = \frac{v^2}{r}$

$\sum F = ma_c$

$mg - F_N = ma_c \Rightarrow F_N = mg - ma_c = 10\left(9.8 - \frac{6.1^2}{10}\right)$

$= 61\ N$

(c) At bottom



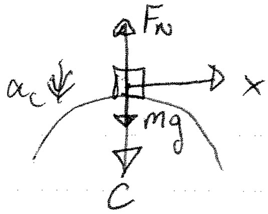
$F_N - mg = ma_c$

$F_N = m(g + a_c)$

$= 10\left(9.8 + \frac{6.1^2}{10}\right)$

$= 135N.$

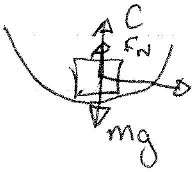
47.



$\sum F_c = ma_c$

$mg - F_N = ma_c$

$F_N = 0 \Rightarrow a_c = g.$

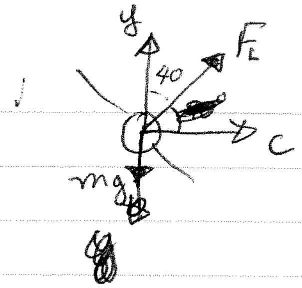


$\sum F_c = ma_c$

$F_N - mg = ma_c$

$F_N = 2mg$ ie 2wice normal weight

53.



$$V = 480\,km/hr = 480\,\frac{km}{hr} \times \frac{1000\,m}{km} \times \frac{1\,hr}{3600\,s}$$

$$= 133\,m/s.$$

$$\sum F_y = 0$$

$$F_L \overset{\cos}{\cancel{\sin}} 40 - mg = 0$$

$$F_L = \frac{mg}{\sin 40}$$

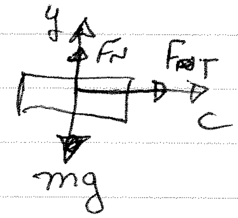
$$\sum F_c = ma_c$$

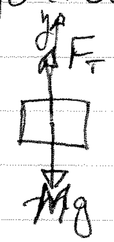
$$F_L \overset{\sin}{\cancel{\cos}} 40° = m\frac{v^2}{r} \quad \text{solve for } r$$

$$r = \frac{mv^2}{F_L \underset{\sin}{\cancel{\cos}} 40} = \frac{\cancel{m} v^2 \overset{\cos}{\cancel{\sin}} 40}{\cancel{m} g \underset{\sin}{\cancel{\cos}} 40}$$

$$= \frac{133^2 \overset{\cos}{\cancel{\sin}} 40}{9.8 \underset{\sin}{\cancel{\cos}} 40} = \overset{2200}{\cancel{1500}}\,m.$$

55. Free Body Diagram for each mass





$$\sum F = 0$$

$$Mg - F_T = 0$$

$$F_T = Mg$$

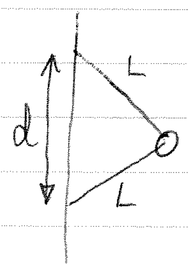
$$\sum F_c = ma_c$$

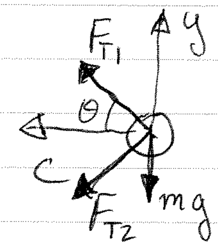
$$F_T = \frac{mv^2}{r}$$

$$\Rightarrow \quad Mg = \frac{mv^2}{r} \quad \Rightarrow \quad v = \sqrt{\frac{Mgr}{m}} = \sqrt{\frac{2.5 \times 9.8 \times 0.2}{1.5}}$$

$$= 1.81\,m/s.$$

59.





~~tan θ~~ = d

$$\sin\theta = \frac{d}{2L}$$

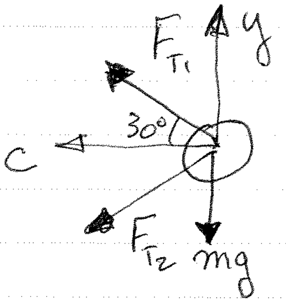
$$\sin\theta = 0.5$$

$\sum F_y = 0 \Rightarrow F_{T1} \sin\theta - mg - F_{T2} \sin\theta = 0$

$\cancel{\sum F_c = ma_c}$

$F_{T2} = \cancel{mg}\ \dfrac{F_{T1}\sin\theta - mg}{\sin\theta}$

$= 35 - \dfrac{1.34 \times 9.8}{0.5} = 8.74N$ (a



To get the magnitude first find the components along c & y.

y— $F_{T1} \sin 30 - mg - F_{T2} \sin 30° =$

$35 \sin 30 - 1.34 \times 9.8 - 8.74 \sin 30° = F_y$

$F_y = 0$ N. (makes sense!)

$F_x = F_{T1} \cos 30° + F_{T2} \cos 30° = (35 + 8.74) \cos 30°$
$= 37.9N.$

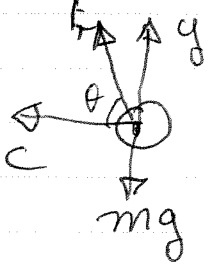
$\sum F_x = ma_c = m\dfrac{v^2}{r}$

$F_c = \dfrac{mv^2}{r}$ $\qquad r = L\cos 30° = 1.47m$

$v = \sqrt{\dfrac{F_c r}{m}} = \sqrt{\dfrac{37.9 \times 1.47}{1.34}} = 6.45 m/s.$

(d) Radially inward.

60,



$\cancel{\tan}\cos\theta = \dfrac{r}{L} \Rightarrow \theta = \cos^{-1}\dfrac{0.15}{0.9}$
$\theta = 80°.$

$\sum F_y = 0 \Rightarrow F_T \sin\theta - mg = 0$

$F_T = \dfrac{mg}{\sin\theta} = \dfrac{0.04 \times 9.}{\sin 80}$

$= 0.4N$

$$\sum F_c = ma_c = \frac{mv^2}{r}$$

Solve for v then use $\frac{\text{circumference}}{v}$ = period.

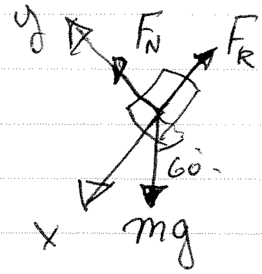
$$F_T \cos\theta = \frac{mv^2}{r}$$

$$V = \sqrt{\frac{F_T r \cos\theta}{m}} = \sqrt{\frac{0.4 \times 0.15 \times \cos 80^\circ}{0.04}} = 0.51\,m/s$$

$$T = \frac{0.94}{0.51} = 1.84\,s.$$

63. Friction (kinetic) always opposes the direction of motion.

Sliding down the plane FBD



$$\sum F_y = 0 \qquad F_N - mg\cos 60^\circ = 0$$

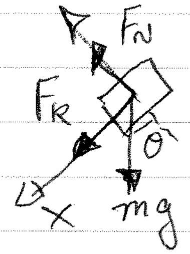
$$\sum F_x = ma_x$$

$$mg\sin\theta - F_k = ma_x$$

$$\cancel{m}g\sin\theta - \mu \cancel{m}g\cos\theta = \cancel{m}a_x$$

$$a_x = g(\sin\theta - \mu\cos\theta) = 7.5\,m/s^2$$ down the ~~down~~ plane.

Sliding up the plane



$$\sum F_y = 0 \Rightarrow F_N = mg\cos\theta$$

$$\sum F_x = ma_x$$

$$mg\sin\theta + F_k = ma_x$$

$$\cancel{m}g\sin\theta + \mu \cancel{m}g\cos\theta = \cancel{m}a_x$$

$$g(\sin\theta + \mu\cos\theta) = a_x$$ down the plane

$$a_x = 9.5\,m/s^2$$