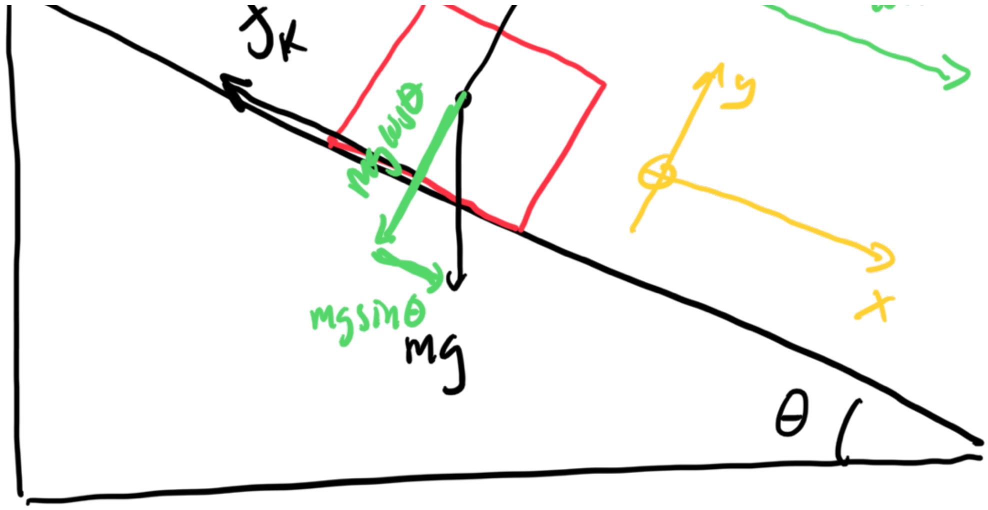
Physics 201 - Lecture 17

- More Assignment 5
- These questions are going to get more challenging as the assignment progresses, but.....

IF WE FOLLOW THE PROCESS, WE CAN SOLVE THEM IN THE SAME WAY AS FOR THE EASIER PROBLEMS

3.



① FBD

(i) identify forces

(ii) choose coordinate system

(iii) resolve into components

friction $\begin{cases} \rightarrow \text{static / kinetic ?} \\ \rightarrow \text{direction ?} \end{cases}$

X	Y
$\Sigma F_x = ma_x$	$\Sigma F_y = ma_y = 0$
$mg\sin\theta - f_K = ma_x$	$N - mg\cos\theta = 0$
	$N = mg\cos\theta$
	$f_K = \mu_K N$

②

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

$f_k = \mu_k mg\cos\theta$

$$\boxed{a_x = g\left(\sin\theta - \mu_k\cos\theta\right)}$$

$= 1.5\ m/s^2$

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b) "constant velocity" $\rightarrow \vec{a} = 0$

$\boxed{a_x = 0}$, $a_y = 0$

$$0 = g\underbrace{\left(\sin\theta - \mu_k\cos\theta\right)}_{=0}$$

$\sin\theta - \mu_k\cos\theta = 0$

$\sin\theta - \mu_K \cos$

$\mu_K \cos\theta = \sin$

$\mu_K = \frac{\sin\theta}{\cos\theta}$

$= \tan\theta$

$$\boxed{\mu_K = \tan\theta}$$

0.100

$$\theta = \tan^{-1}\left(\mu_K\right)$$

.100

$$\boxed{\theta = 5.71^\circ}$$

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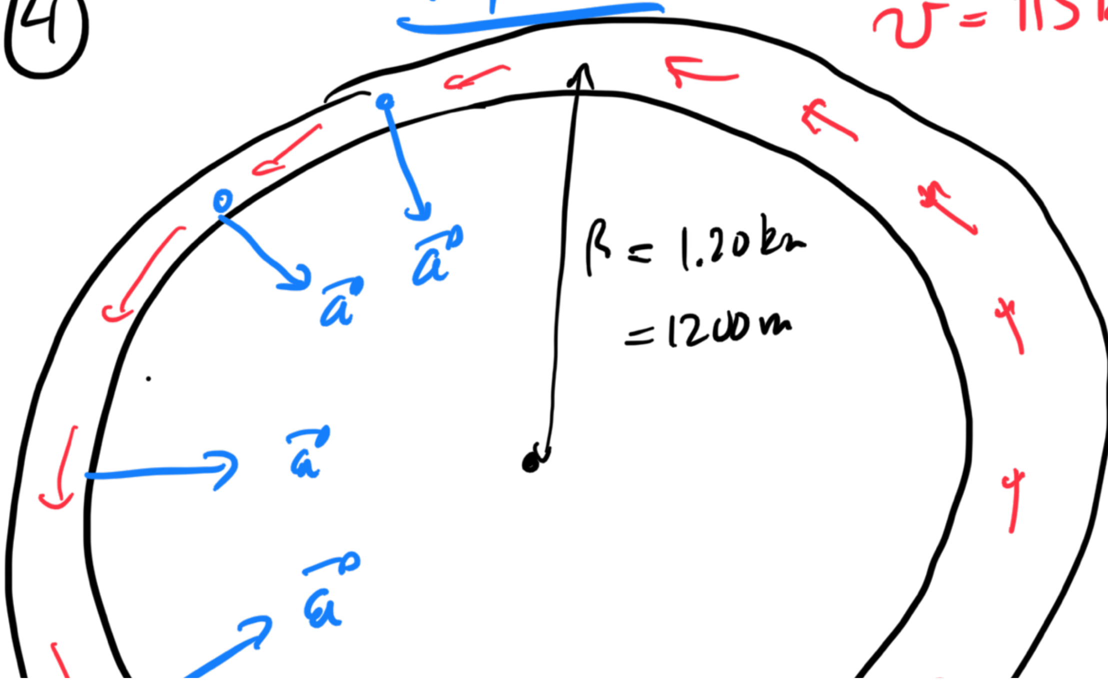
④

Top View

$v = 115 \text{ km/h}$



"uniform circular motion"

$$|\vec{a}_c| = \frac{v^2}{R} = \frac{(31.94)^2}{1200}$$

$$= 0.850 \ m/s^2$$

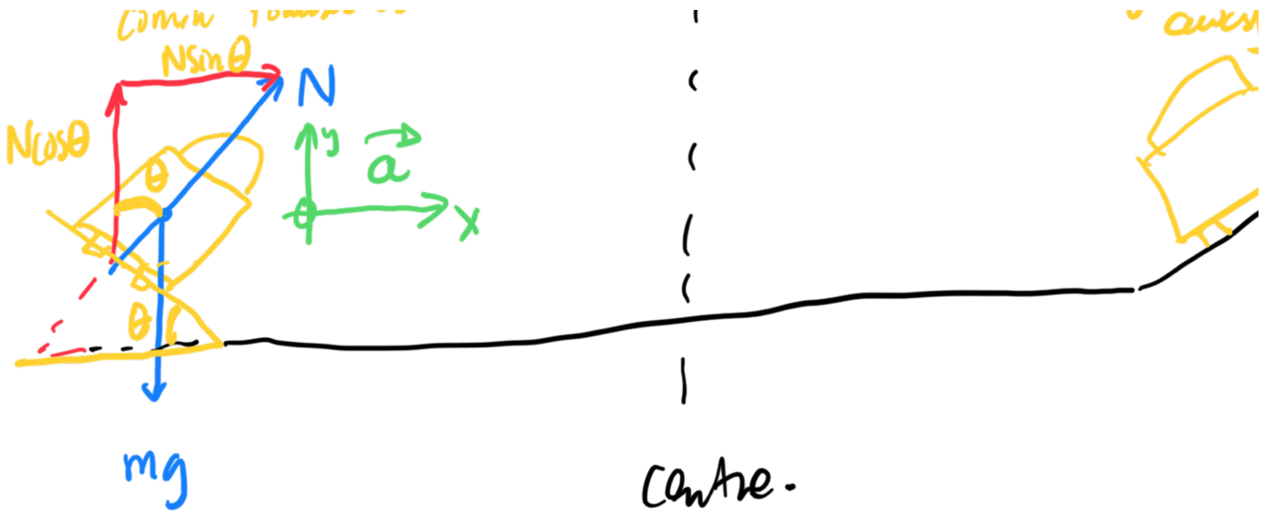
$$v = 115 \frac{km}{hr} \times \frac{1000 \ m}{km} \times \frac{1 \ hr}{3600 \ s}$$

$$= 31.94 \ m/s \leftarrow$$

Side View

"ideal banking angle"

↳ no friction!



FBD – identify forces

→ coordinate system.

such that x-axis is in the direction of the acceleration.

→ resolve into components.

X	Y
$a_x = 0.850\ m/s^2$	$a_y = 0$
$N\sin\theta = ma_x$	$N\cos\theta - mg = 0$

mg

$$\boxed{N = \frac{\quad}{\cos\theta}}$$

$$\left(\frac{\cancel{m}g}{\cos\theta}\right)\sin\theta = \cancel{m}a_x$$

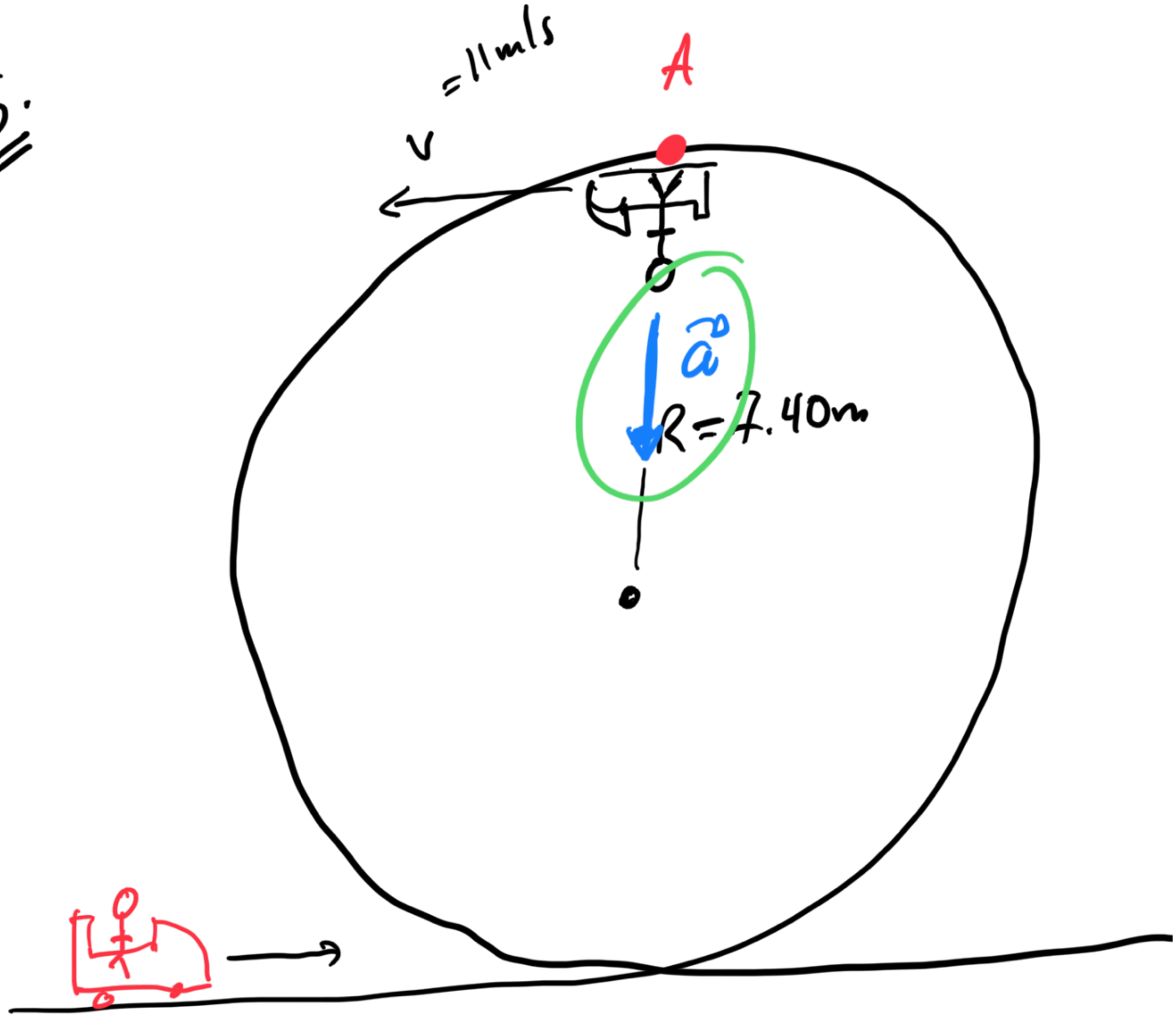
$$g\tan\theta = a_x$$

$$\tan\theta = \frac{a_x}{g}$$

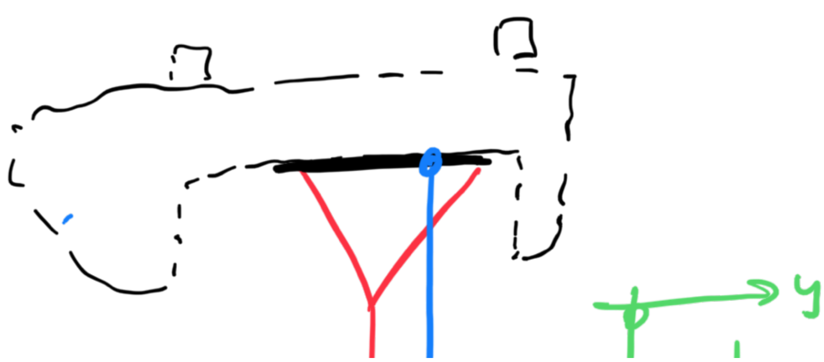
$$\boxed{\theta = \tan^{-1}\left(\frac{a_x}{g}\right)}$$

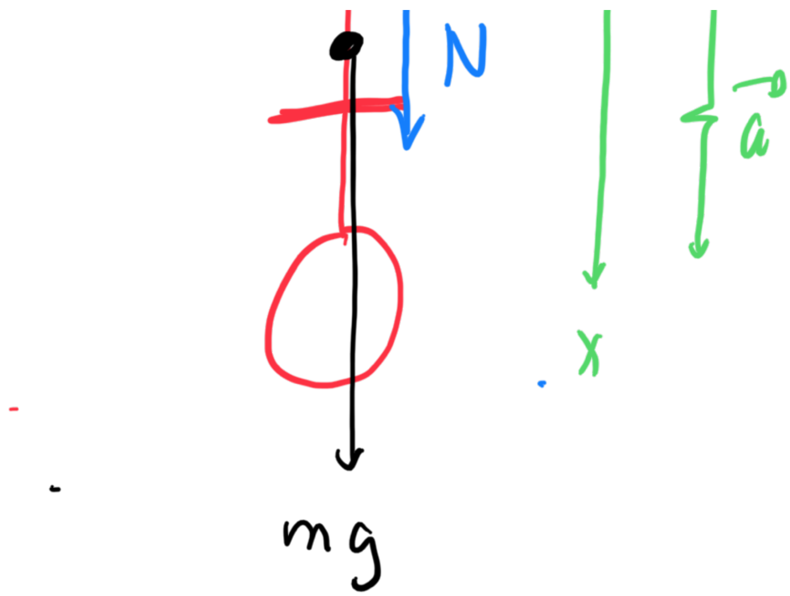
$$= 4.96^\circ$$

5.



$$|\vec{a}|_c = \frac{v^2}{R} = \frac{(11.0)^2}{7.4} = 16.35 \text{ m/s}^2$$





$$mg + N = ma$$

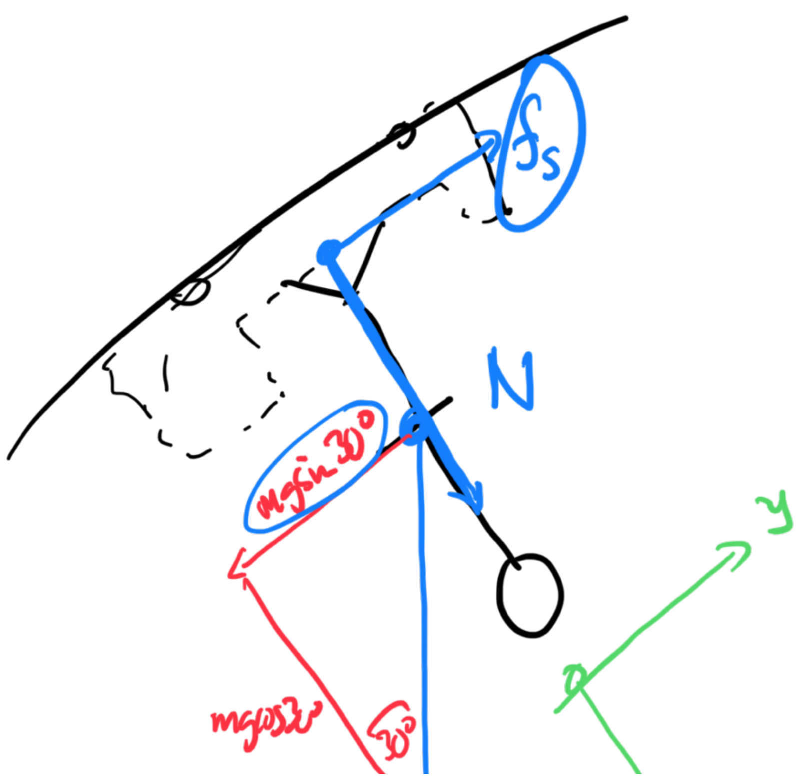
$$N = ma - mg$$

$$= m(a - g)$$

$$= 40\,kg\,(16.35 - 9.8)$$

$$|\vec{Normal}| = 262\ N$$

$$|\vec{a}|_c = v^2/R = 19.14\ m/s^2$$



mg

$+$ $\vec{a}$

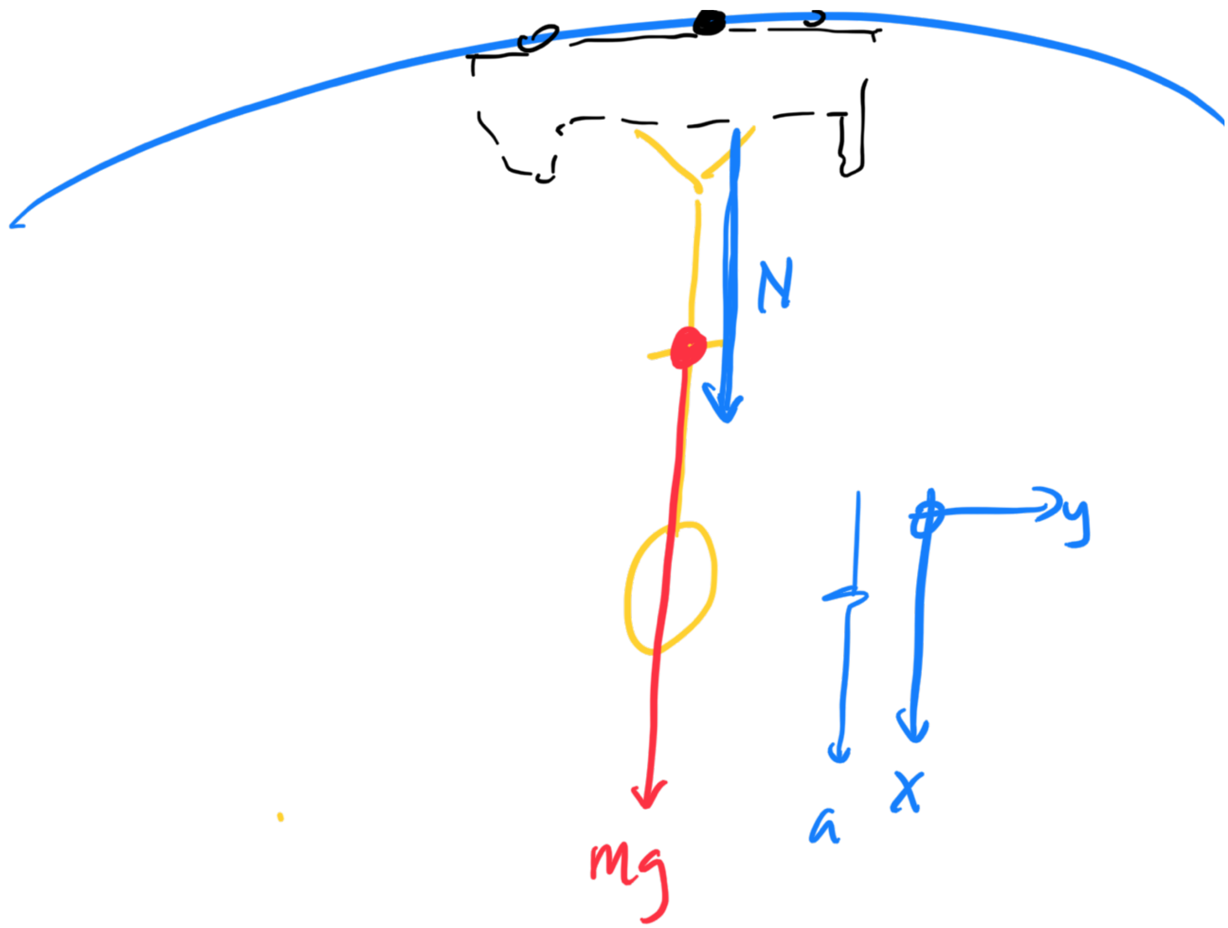
X	Y
$a_x = 19.14\ m/s^2$	
$N + mg\cos 30^\circ = ma_x$	

$$N = ma_x - mg\cos 30^\circ$$

$$= (40)(19.14) - (40)(9.8)(\cos 30^\circ)$$

$$\boxed{N = 426\ N}$$

A



$$\overset{=0}{\cancel{N}} + \cancel{m}g = \cancel{m}a_x$$

When do you fall out of your seat?

$$N = 0 \;!$$

$$\boxed{a_x = g}$$ falling!

$$\frac{v^2}{R} = g$$

$$v^2 = gR$$

$$v = \sqrt{gR}$$

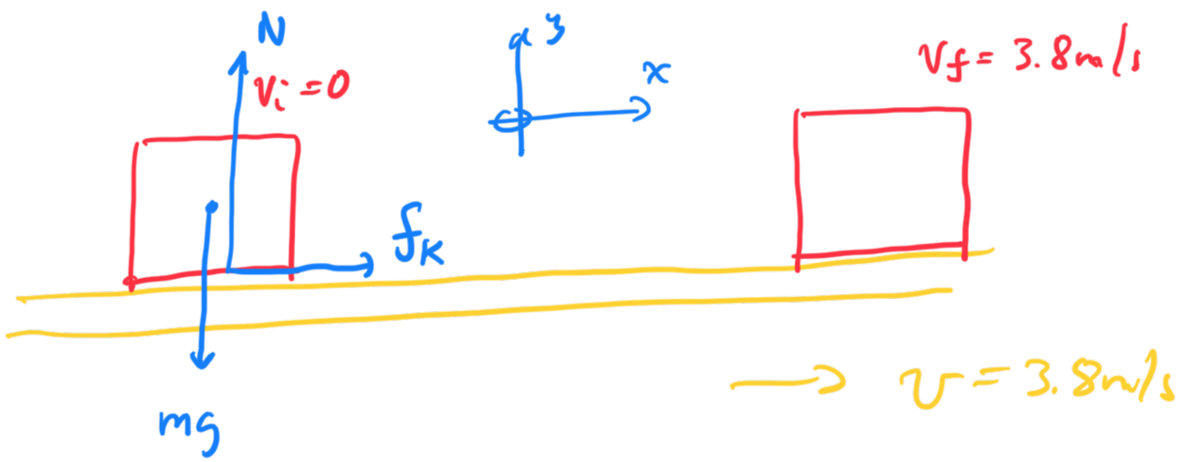
$$= \sqrt{(9.8)(7.4)}$$

$$\boxed{v = 8.52\ m/s}$$

close!!!

"weightlessness"

6.



$$f_K = m a_x \qquad N - mg = 0$$

$$N = mg$$

$$\mu_K \cancel{m} g = \cancel{m} a_x \qquad f_K = \mu_K N = \mu_K mg$$

$$\boxed{a_x = \mu_K g} = (0.25)(9.8) = 2.45 \, m/s$$

$$V_i = 0$$

$$V_f = 3.8 \, m/s$$

$$a = 2.45 \, m/s^2$$

$$t = ?$$

$$v_f = \cancel{v_i}^{\,0} + at$$

$$t = \frac{v_f}{a} = \frac{3.8\,m/s}{2.45\,m/s^2} = \underline{\underline{1.55\,s}}$$

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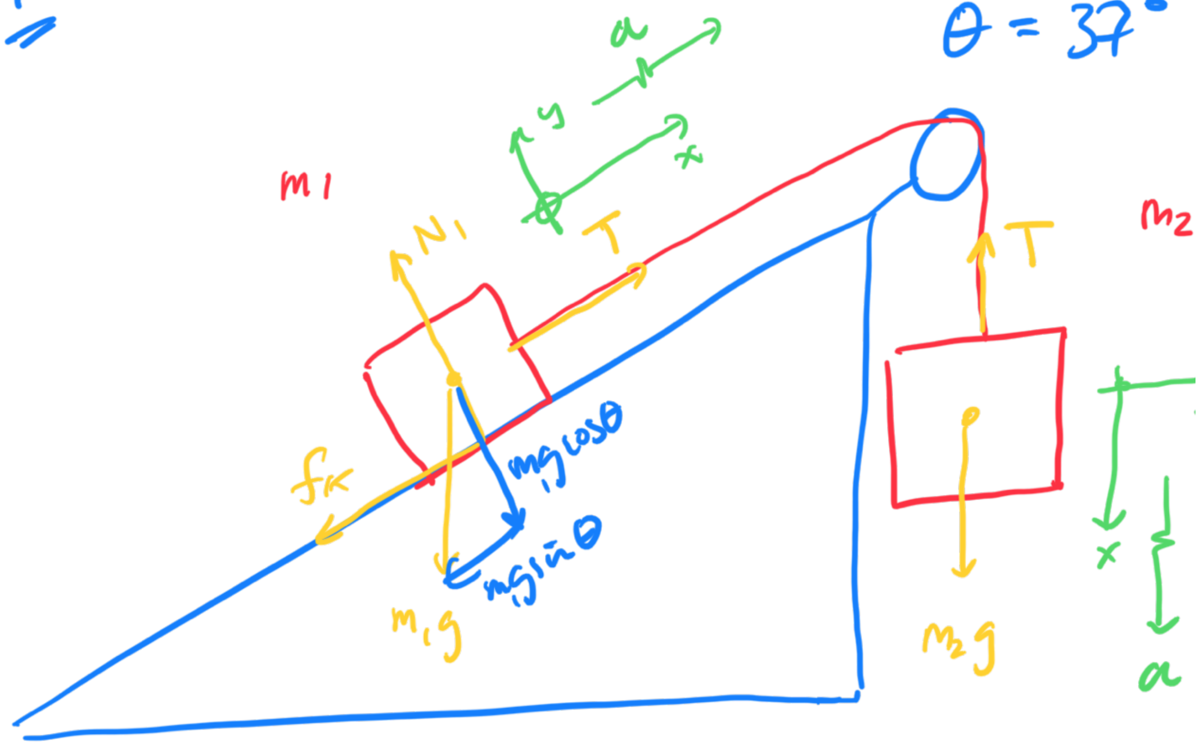
7. $m_1 = 3.0\,kg$, $m_2 = 7.0\,kg$, $\mu_K = 0.46$

$\theta = 37°$



$m_2 > m_1$, therefore system must move

to the right

	X	Y
1: $T - m_1 g - f_K = m_1 a$		$N_1 - m_1 g\cos\theta = 0$ $N_1 = m_1 g\cos\theta$ $f_K = \mu_K m_1 g\cos\theta$

$$\boxed{T - m_1 g - \mu_K m_1 g\cos\theta = m_1 a}$$

2: $\boxed{m_2 g - T = m_2 a}$

ADD !

$$m_2 g - m_1 g - \mu_K m_1 g\cos\theta = (m_1 + m_2)a$$

$$a = g\left[\frac{m_2 - m_1 - \mu_k m_1 \cos\theta}{m_1 + m_2}\right]$$

$$\boxed{a = 4.01\ m/s^2}$$