Applying Newton's Laws – Activity 4

$m = 180g = .180\ kg$

$T_{1 on o} = 1.0N$

Find $F_{E on o}$:

$F_{E on o} = m_o g$
$= (.180\ kg)(10\frac{N}{kg})$
$= 1.8N$

Cards:

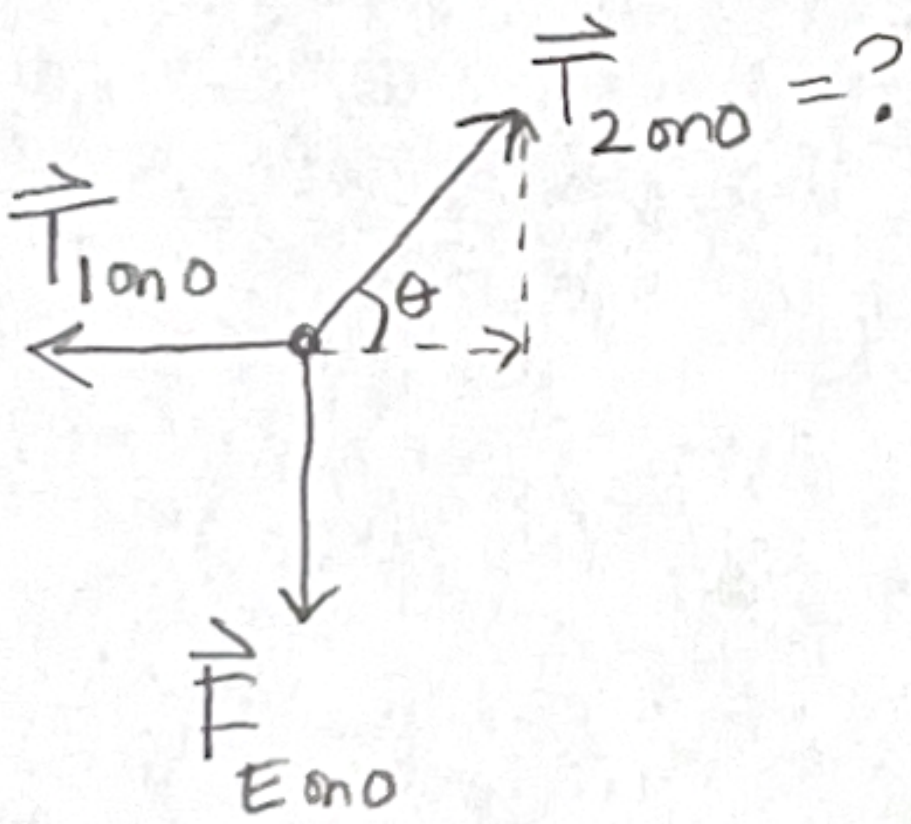
- point particle
- Static equilibrium
- Newton's Laws

$a_{sx} = 0$ | $a_{sy} = 0$

$\Sigma F_{on s x} = 0$ | $\Sigma F_{on s y} = 0$

motion diagram: • (at rest)

force diagram:



Force organizer:

$\vec{F}$	F_x	F_y
$\vec{T}_{1 on o}$	$T_{1 on o x} = -T_{1 on o}$ $= -1N$	$T_{1 on o y} = 0$
$\vec{T}_{2 on o}$	$T_{2 on o x} = T_{2 on o}\cos\theta$	$T_{2 on o y} = T_{2 on o}\sin\theta$
$\vec{F}_{E on o}$	$F_{E on o x} = 0$	$F_{E on o y} = -F_{E on o}$ $= -m_o g$

Represent mathematically:

using the x-direction:

$$a_{ox} = \frac{\Sigma F_{on o x}}{m_o}$$

$$0 = \frac{T_{1 on o x} + T_{2 on o x} + F_{E on o x}}{m_o}$$

$$0 = T_{1 on o x} + T_{2 on o x} + F_{E on o x}$$

now put in the symbols for each component

$$0 = -T_{1 on o} + T_{2 on o}\cos\theta + 0$$

solve for $T_{2 on o}$

$$T_{2 on o} = \frac{T_{1 on o}}{\cos\theta}$$

put in values

$$T_{2 on o} = \frac{1N}{\cos\theta} \quad (1)$$

I have two unknowns, so I need another equation, which I can get from the y-direction Newton's 2nd Law

$$a_{oy} = \frac{\Sigma F_{on o y}}{m_o}$$

$$0 = \frac{T_{1 on o y} + T_{2 on o y} + F_{E on o y}}{m_o}$$

$$0 = 0 + T_{2 on o}\sin\theta + (-m_o g)$$

Solve for $T_{2 on o}$

$$T_{2 on o} = \frac{m_o g}{\sin\theta}$$

$$T_{2 on o} = \frac{1.8N}{\sin\theta} \quad (2)$$

I have 2 equations and 2 unknowns!

$$T_{2\,on\,O} = \frac{1N}{\cos\theta} \quad (1)$$

$$T_{2\,on\,O} = \frac{1.8N}{\sin\theta} \quad (2)$$

Now I can solve simultaneous equations. I will eliminate T_2:

- Start with equation (1)

$$T_{2\,on\,O} = \frac{1N}{\cos\theta}$$

- substitute equation (2) for $T_{2\,on\,O}$

$$\frac{1.8N}{\sin\theta} = \frac{1N}{\cos\theta}$$

- If I could get $\sin\theta/\cos\theta$, it would become $\tan\theta$, and then I could do $\tan^{-1}$ to find θ. So I multiply both sides by $\sin\theta$.

The "N" units cancel out.

$$1.8N = \frac{1N}{\cos\theta}(\sin\theta)$$

$$1.8 = \tan\theta$$

$$\tan^{-1}(1.8) = \theta$$

$$61° = \theta$$

- Now I need to find the magnitude of $T_{2\,on\,O}$. I'll use eqn (1), but you could also use eqn (2).

$$T_{2\,on\,O} = \frac{1N}{\cos 61°}$$

$$T_{2\,on\,O} = 2.1N$$