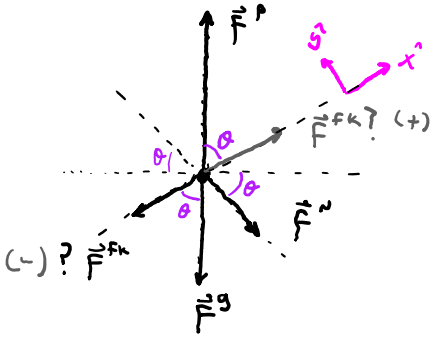
Week 6 Challenge Homework Solutions

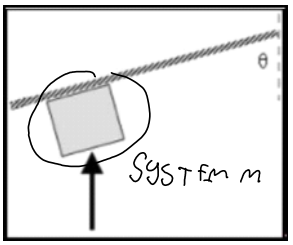
A 2-kg-block is pushed upward from underneath by a constant 50-N vertical force. The block is sliding on the bottom side of an inclined plane that makes an angle of 70° with respect to the vertical. The coefficient of kinetic friction between the block and the plane is 0.2.

(a) (a) Determine if the net force points up or down the incline?

(b) (b) If after traveling a total distance of 4 m the block is traveling at a speed of 4.443 m/s up the incline, what was the initial speed of the block?

(c) (c) Use the *Sign* sense-making technique, along with your answer to part (a), to check whether your answer to part (b) seems reasonable.





$\Sigma F_x = ma_x$

$F^P\cos\theta - F^g\cos\theta \pm F^{fk} = ma_x$

$F^P\cos\theta - mg\cos\theta \pm \mu_k F^N = ma_x$

$\Sigma F_y = ma_y^{\,0}$

$F^P\sin\theta - F^g\sin\theta - F^N = 0$

$F^P\sin\theta - mg\sin\theta - F^N = 0$

$F^N = F^P\sin\theta - mg\sin\theta$

$= 50\sin 70 - 2(9.8)\sin 70$

$F^N = 28.5666\ldots\ N$

$50\cos 70 - 2(9.8)\cos 70 \pm 0.2(28.\ldots) = 2a_x$

w/ $\vec{F}^{fk}$ ↗

$a_x = 8.055\ m/s^2$

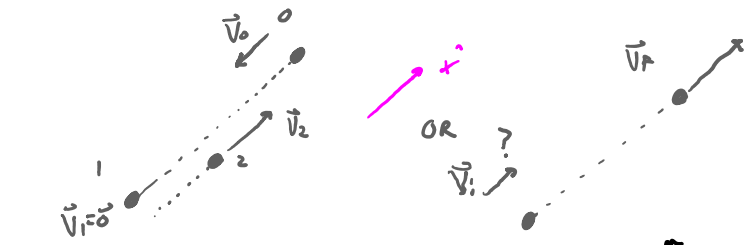
w/ $\vec{F}^{fk}$ ↙

$a_x = 2.342\ m/s^2$

either way $\vec{a}$ ↗ so $\boxed{\Sigma\vec{F}\ \nearrow}$ (a)

Kinematics

2 options



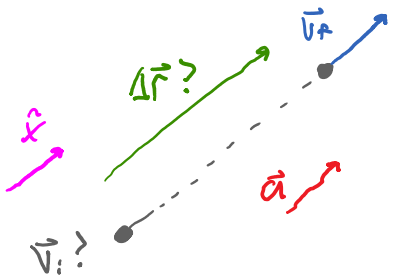
$1 \rightarrow 2$

$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x$

$(4.443)^2 = 0^2 + 2(2.342)\Delta x_{12}$

$\Delta x_{12} = 4.21\,m$

$4.21\,m > 4\,m$ total dist so must be this



K	∪K
$\Delta x = 4\,m$	v_{ix}
$v_{fx} = 4.443\,m/s$	
$a_x = 2.342\,m/s^2$	Δt

$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x$

$(4.443)^2 = v_{ix}^2 + 2(2.342)(4)$

$v_{ix} \approx 1.00\,m/s$

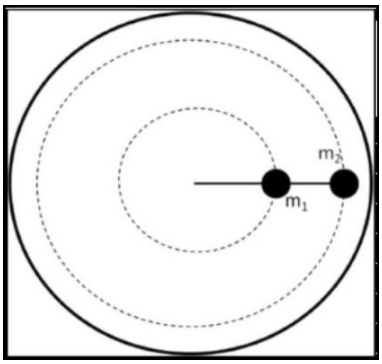
$$\boxed{|\vec{v}_i| = 1.00\,m/s}$$

Question 2

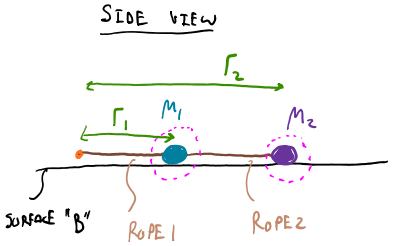
A mass of 3.0 kg is tied via a light string to the center of a table. A second mass of 5.0 kg is tied, also via a light string, to the first mass. Both masses are made to undergo uniform circular motion in the horizontal plane at a rate of 10 revolutions per second. The first mass is 1.2 m from the center of the table and the second mass is 2.0 m from the center of the table.

(a) (a) What is the tension in both strings?

(b) (b) Use *Related Quantities* along with *Proportionality* sense-making technique to check your answer to part (a) behaves the way you'd expect. Should the tension increase if the speed increases? Which tension do you expect to be greater?



a)



KNOWNS

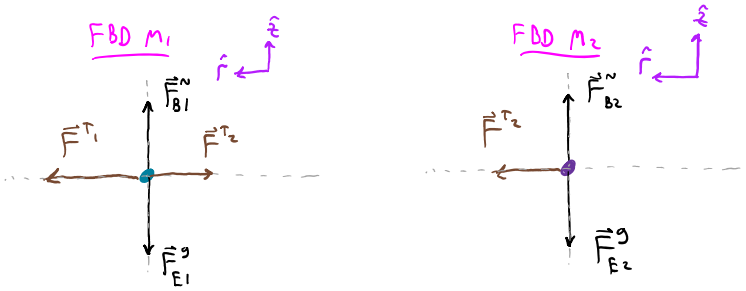
$m_1 = 3\,kg$

$m_2 = 5\,kg$

$f = 10\ Hz$

$r_1 = 1.2\,m$

$r_2 = 2\,m$



$\Sigma F_r = m_1 a_{1r}$

$|\vec{F}^{T_1}| - |\vec{F}^{T_2}| = m_1 \frac{V_{1t}^2}{r_1}$, $V_t = \frac{2\pi r}{T} = 2\pi r f$

$|\vec{F}^{T_1}| - |\vec{F}^{T_2}| = m_1 (2\pi r_1 f)^2 / r_1$

$|\vec{F}^{T_1}| - |\vec{F}^{T_2}| = 4\pi^2 m_1 f^2 r_1$

$\Sigma F_r = m_2 a_{2r}$

$|\vec{F}^{T_2}| = m_2 \frac{V_{2t}^2}{r_2}$, $V_t = \frac{2\pi r}{T} = 2\pi r f$

$|\vec{F}^{T_2}| = m_2 (2\pi r_2 f)^2 / r_2$

$|\vec{F}^{T_2}| = 4\pi^2 m_2 r_2 f^2 \approx 39478\ N$

$|\vec{F}^{T_1}| - 4\pi^2 m_2 f^2 r_2 = 4\pi^2 m_1 f^2 r_1$

$|\vec{F}^{T_1}| = 4\pi^2 f^2 (m_1 r_1 + m_2 r_2) \approx 53691\ N$

b)

F^{T_1} 10^4 N AND F^{T_2} 10^4 N MAKES SENSE THAT ORDER OF MAGNITUDES ARE ABOUT THE SAME SINCE MASS'S ARE SIMILAR AND THEY ARE COUPLED TOGETHER ROTATING W/ SAME FREQUENCY.

AS V ↑ F ↑ AND F^T ↑ ☺