Force and Motion 6

Name: ________________

Date: ________________

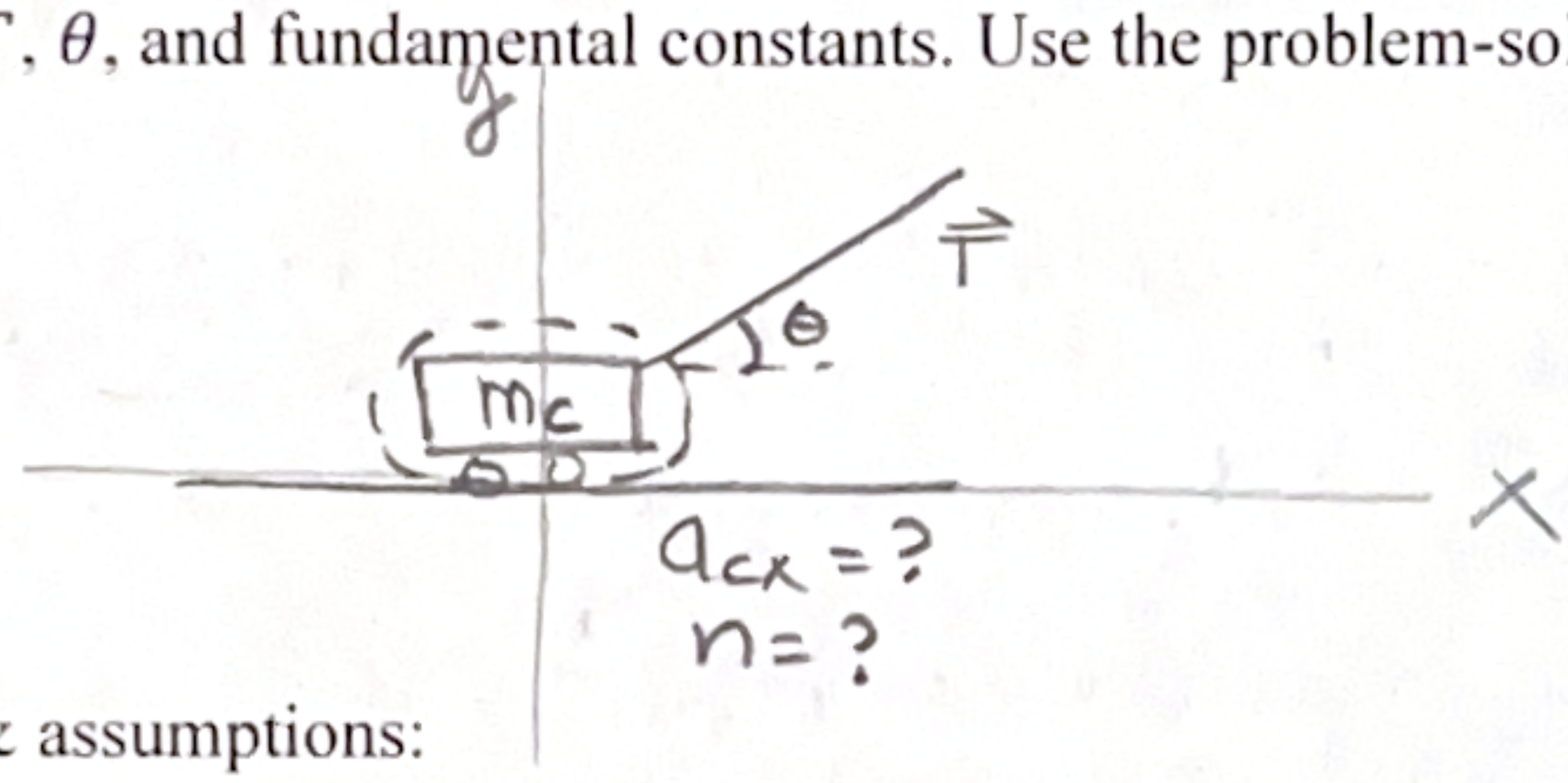
As stated on the syllabus:

- You may consult posted solutions for help. If doing so, first write a * at the point in your work where you look at the solutions (every time). After looking at the solutions, close them or move to another room to continue your work.
- You must use the solutions to check your completed work for correctness. Correctly re-do anything you missed.
- No writing of any kind is ever allowed while the solutions are visible to you.

1. A cart (mass m_c) is pulled along a horizontal track by a string that exerts a constant force of $\vec{T}$ on the cart . The string is at an angle of θ above the horizontal. Assume friction is negligible.

a. Find symbolic expressions for the acceleration of the cart (a_{cx}) and the magnitude of the normal force n in terms of m_c, T, θ, and fundamental constants. Use the problem-solving strategy, but skip the Evaluate step.

Sketch and Translate

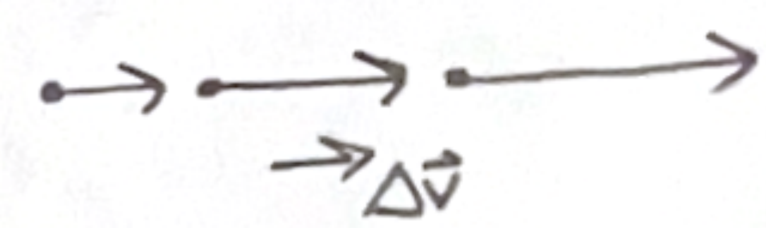


Simplify and Diagram

Simplifications & assumptions:

- no friction
- point particle
- constant accel, forces

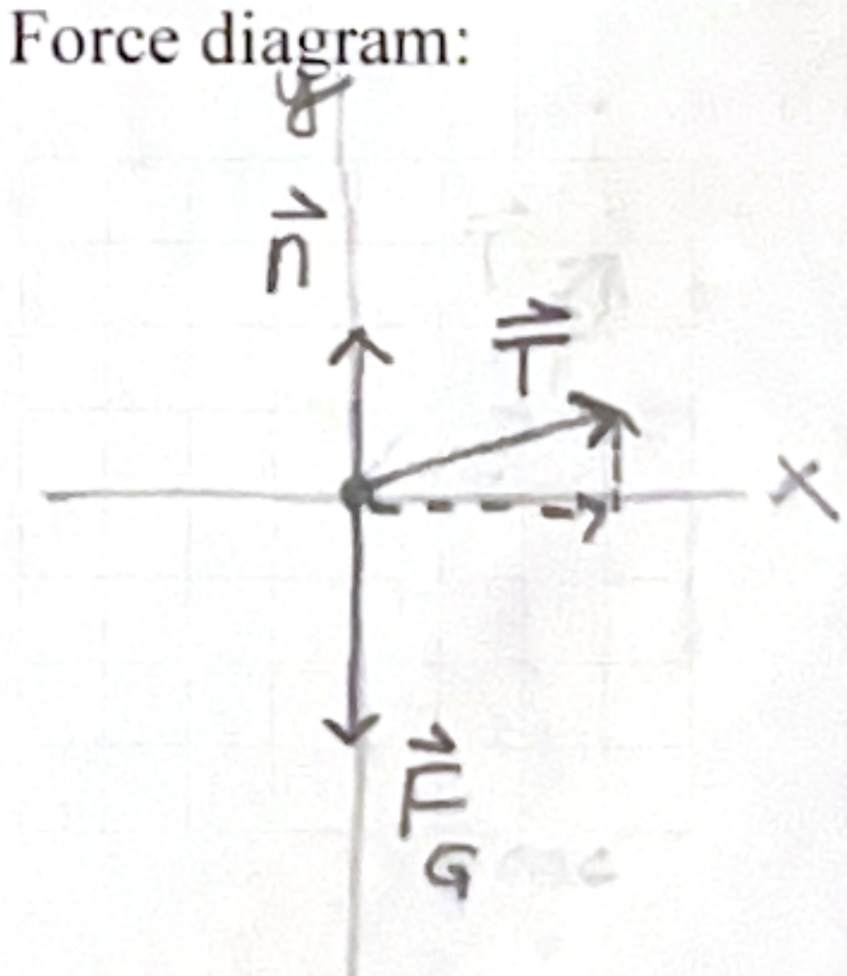
Motion Diagram:



Force organizer:

$\vec{F}$	by ___ on ___	F_x	F_y
$\vec{T}$	by string on cart	$T_x = +T\cos\theta$	$T_y = +T\sin\theta$
$\vec{F}_G$	by Earth on cart	$F_{Gx} = 0$	$F_{Gy} = -m_c g$
$\vec{n}$	by track on cart	$n_x = 0$	$n_y = +n$

Force diagram:



Represent mathematically and Solve

Finding a_{cx} and n:

$$a_{cx} = \frac{\Sigma F_{on\,c\,x}}{m_c}$$

$$a_{cx} = \frac{+T\cos\theta + 0 + 0}{m_c}$$

$$a_{cx} = \frac{T\cos\theta}{m_c}$$

$$a_{cy} = \frac{\Sigma F_{on\,c\,y}}{m_c}$$

$$0 = +T\sin\theta + (-m_c g) + n$$

$$-T\sin\theta + m_c g = n$$

b. Calculate values for a_{cx} and $n_{t\ on\ c}$ if the mass of the cart is 400 g, the magnitude of the tension force exerted by the string is 0.25 N, and the angle of the string is 60° above the horizontal.

The a_{cx} is .31 m/s² and the normal force magnitude is 3.8 N.

$$a_{cx} = \frac{T\cos\theta}{m_c} = \frac{(0.25\,N)(\cos 60^\circ)}{(.4\,kg)} = \boxed{.31\ m/s^2}$$

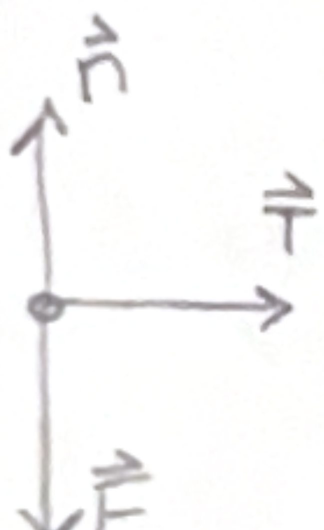
$$n = -T\sin\theta + m_c g = -(.25\,N)\sin 60^\circ + (.4\,kg)(10\,N/kg) = -.2165\,N + 4\,N = \boxed{3.8\,N}$$

c. What is the acceleration $\vec{a}$ of the cart? What is the normal force $\vec{n}$ exerted by the track on the cart?

$\vec{a} = (.31\ m/s^2, +x\text{-dir.})$ or $(.31\ m/s^2, 0^\circ)$

$\vec{n} = (3.8\,N, +y\text{-dir.})$ or $(3.8\,N, 90^\circ)$ or $(3.8\,N, \text{up})$

2. If the same magnitude of tension force was exerted on the cart by a string that was horizontal instead of at an angle…



a. Would the acceleration of the cart increase, decrease, or stay the same? Provide reasoning.

The accel of the cart is $a_{cx} = \frac{T\cos\theta}{m_c}$. If the string is horizontal, the numerator is T instead of $T\cos\theta$. Since $T > T\cos\theta$, the acceleration would increase.

b. Would the normal force exerted on the cart by the track increase, decrease or stay the same? Provide reasoning.

The normal force is the only force to balance F_G in this new scenario, whereas when the string was at an angle, part of the tension force was also pulling up. So now $\vec{n}$ has to do all the supporting and it will be increased.

3. Copy the new facts into your physics facts booklet. Memorize the equations for the quiz!