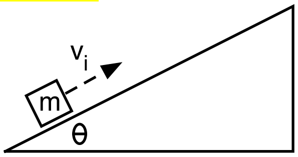
ABRHS PHYSICS

NAME: KEY

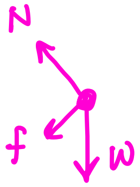
Force Problems III

For all 4 questions, include a correct free body diagram for each mass.

1. A 200 gram mass is launched up an incline with a speed of 3 m/s. There is a frictional force of 0.8 N acting on the mass and the base angle of the incline is 35°. How far up the incline does the mass travel?



$m = 0.2$ kg
$v_i = 3$ m/s
$f = 0.8$ N
$\theta = 35^\circ$



Note: friction <u>opposes</u> motion

$\Sigma F_\perp = 0$

$N - mg\cos\theta = 0$ | Not needed for this problem, but get the practice!

$\Sigma F_\parallel = ma$ | acceleration is down the hill, so this is calling that direction +

$f + mg\sin\theta = ma$

So $a = \frac{0.8 + (.2)(10)\sin 35}{0.2} = \underline{\underline{9.74 \text{ m/s}^2}}$

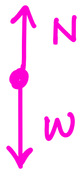
So distance up incline is

$v_f^2 = v_i^2 + 2a\Delta x \rightarrow 0 = (3)^2 + 2(\underset{\uparrow}{-9.74})d$ $\boxed{d = 0.46 \text{ m}}$

down the hill; this way d is +

2. You are having an enjoyable day in Boston going up and down the elevators in the Prudential Building. You are at the top of the building and press the down button. You also happen to be standing on a great metric bathroom scale, and you notice that the scale reads only 600 N while you are accelerating down. (Your real mass is 65 kg.) What was your acceleration?

$N = 600$ N
$m = 65$ kg



Calling up +: $\Sigma F = ma$

$N - mg = ma$

$600 - (65)(10) = (65)a$

$600 - 650 = 65a$

$-50 = 65a$

$\boxed{a = -0.77 \text{ m/s}^2}$

Note: there are no other forces acting on you! Nothing else is touching you.

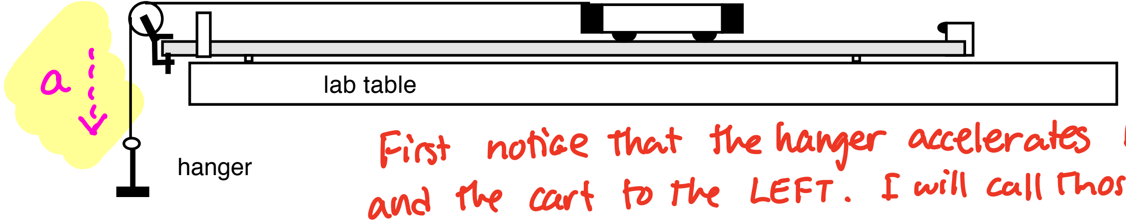
You are in fact accelerating DOWN

Name: ____________________

Force Problems III

For #3 & #4, also write out Newton's Second Law for each mass and for the system.

3. A hanger of mass m is suspended by a string whicch is attached to a cart of mass M on a level, frictionless track. (Like the lab setups.) What is the tension in the string?



First notice that the hanger accelerates DOWN and the cart to the LEFT. I will call those directions +.

Hanger:

$\Sigma F = ma \rightarrow \boxed{mg - T = ma}$

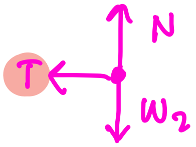
System:

$\Sigma F_{sys} = m_{sys} a$

$mg = (m+M)a$

(So could say $a = \frac{mg}{m+M}$)

Cart



$\Sigma F_y = 0 \rightarrow \boxed{N - Mg = 0}$

$\Sigma F_x = Ma \rightarrow \boxed{T = Ma}$

T is internal, N3L pair

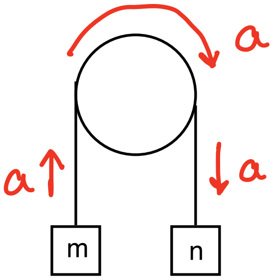
So 2 equation w/ 2 unknowns:

So $a = \frac{T}{M}$ which makes $mg - T = m\left(\frac{T}{M}\right)$

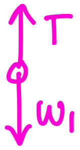
$Mmg = mT + MT$

$\rightarrow \boxed{T = \frac{mMg}{m+M}}$

4. Two masses are connected by a string around a massless, frictionless pulley. Mass m is 3 kg. The system is accelerating at a rate of 2.5 m/s² in a clockwise direction. What is the mass of "n" and what is the tension in the string?

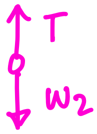


"m"



$\Sigma F = ma$ $\boxed{T - mg = ma}$

"n"



$\Sigma F = na$ $\boxed{ng - T = na}$

System:

$\Sigma F_{sys} = m_{sys} a$

$ng - mg = (m+n)a$

So from "m" we have:

$T - (3)(10) = (3)(2.5)$

$T - 30 = 7.5$

$\boxed{T = 37.5 \text{ N}}$

and from "n"

$n(10) - T = n(2.5)$

$10n - 37.5 = 2.5n$

$7.5n = 37.5$

$\boxed{n = 5 \text{ kg}}$