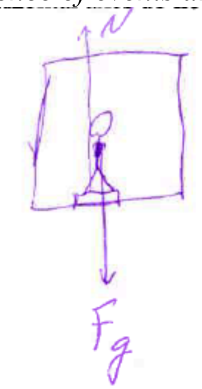
You will be graded on your *communication* of physics understanding.

#2 Your friend has a mass of 50 kg and is standing on a scale inside a 1000 kg elevator. At a height of 20 m (t = 0) she notices that she's moving upwards with constant speed 8 m/s. She continues at this speed for 1 second and then comes to rest at a rate of 4 m/s². Please make the graphs describing her motion. Label the axes to make the values explicitly clear and show what her final height is if you can. The horizontal axes do not have to indicate y = 0. *Hopefully you've made a good drawing or drawings showing the sequence of events and explained why you chose a kinematics lens. Do you find she stops at 36 m?*

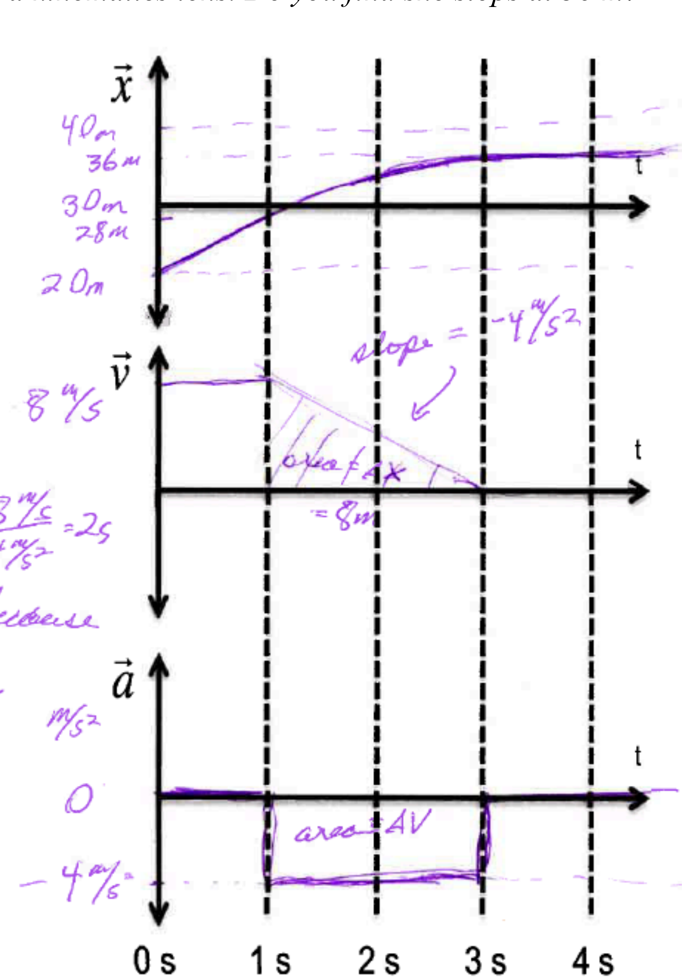
x = 20 m



t = 0

$V = 8\,m/s$ ⇑ + ↑

$a = 0$

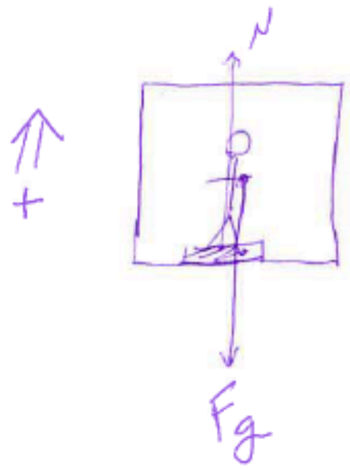


$t = 1s \quad a = {}^{-}4\,m/s^2$ ⇓

$x = 28\,m \quad \Delta V = a\Delta t,\ \Delta t = \frac{\Delta V}{a} = \frac{-8\,m/s}{-4\,m/s^2} = 2s$

I'm using Kinematics lens because I'm given $\vec{x}, \vec{V}, + \vec{a}$ as an explicit function of time

#2 In the problem above what does the scale your friend is standing on read at t = 0, _and_ at t = 2 s. Remember to show your work and thought process completely. Think of convincing someone who is skeptical. *I myself, personally got an "F" on this problem for not being careful… I was supposed to ask you for the acceleration at t = 2s. At t = 3 s, the acceleration changes so you really can't do the problem… for the corrections please do the problem at t = 2s. Hopefully, you've drawn a good picture and explained why you chose a dynamics lens. Did you remember to diagram the vector addition of the forces? Is the normal force of the scale greater than, less than, or equal to the force of gravity on her (a) when she is moving upward at constant velocity, (b) when she's slowing down?*



$t=0$
$a=0$

$t=3s$
$a = 4\,m/s^2 \Downarrow$, so $F_g > N$

~~This is~~ I use a Dynamics lens because Forces (N, F_g) cause $\vec{a}$

$\Sigma \vec{F} = ma$

$N + F_g = m\vec{a} = 0$ ($t=0$), $= 50kg(4\,m/s^2) = -200N \Downarrow$

N Fg $\Sigma F = 0$

$N = F_g = mg = 50kg(10\,m/s^2)\,N$

$= mg = \underline{500N}$

$\Sigma \vec{F} = -200N \Downarrow$ Fg

@t=0s scale reads
= 500N or 50kg
or ~110 lbs.

$N = ma + F_g$

$= -200N + 500N$

$N = 300N$

@ t=3s, scale reads 300N, or 30 kg, or ~66 lbs.

#3 Jane (50 kg) is glad to see Tarzan (100 kg) and is running toward him at 5 m/s to give him a big hug. He is standing in a tree 5 m above the ground and swings down in the opposite direction to hug her. **Ka-smack!** They hit each other just as Tarzan reaches the ground, and they swing off together.

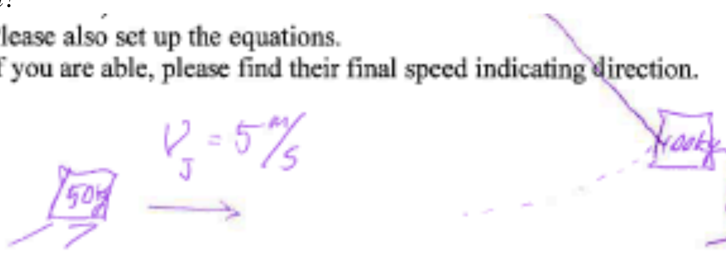
a) Please explain exactly how you would calculate the final speed of these two people holding the vine (and each other).

b) Please also set up the equations.

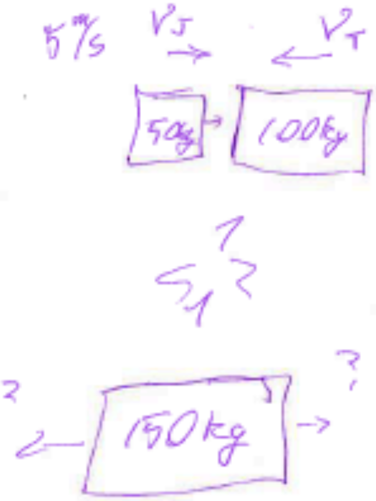
c) If you are able, please find their final speed indicating direction.

Hopefully, you took the time to make a few diagrams showing the sequence of events. Did you recognize that we'll need two lenses to solve the whole problem? I got that their final speed was 5 m/s, in which direction?

b) Please also set up the equations.
c) If you are able, please find their final speed indicating direction.



I'm going to use 2 lenses. $\vec{p}$ lens will give us the final velocity after the collision because the $\vec{p}$ of the system is conserved w/out outside forces, but first I need an Energy lens because Tarzan's $E_{PG} \Rightarrow E_K$. This will give me v_{Tarzan}



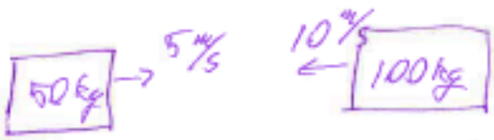
$E_i = E_f$ (Tarzan)

$E_p = E_K$

$mgh = \frac{1}{2} m v^2$

$v = \sqrt{2gh} = \sqrt{2(10\,m/s^2)5\,m} = \sqrt{100\,m^2/s^2} = 10\,m/s$

$\Leftarrow +$



$\vec{p}_J = -250\,kg\,m/s$ $\qquad \leftarrow 1000\,kg\,m/s = \vec{P}_T$

$\Sigma \vec{P}_i = \Sigma \vec{P}_f \Rightarrow -250\,kg\,m/s + 1000\,kg\,m/s = +750\,kg\,m/s$

$P_f = m_f v_f \qquad v_f = \frac{P_f}{m_f} = \frac{750\,kg\,m/s}{150\,kg} = 5\,m/s \leftarrow$

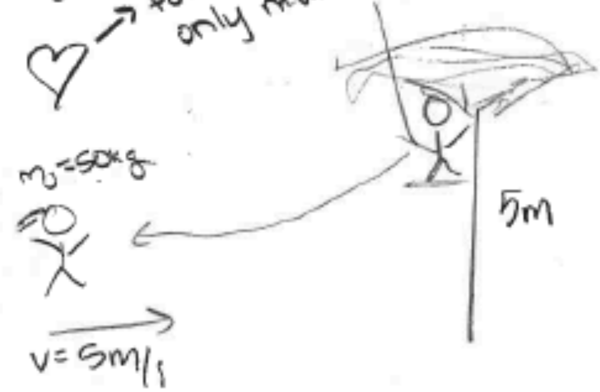
a) Please explain exactly how you would calculate the final speed of these two people holding the vine (and each other).

b) Please also set up the equations.

c) If you are able, please find their final speed indicating direction.

force of attraction?

only momentum is a true lover...



a) I know that momentum is conserved in a closed system, so I would chose the momentum lense (momentum is also my ~~true~~ true lover since energy is lost to heat in the collision...)

b) this would go as shown below

$$m_J v_J - m_T v_T = (m_J + m_T)(v_{JT})$$

a) However, I am missing the velocity of Tarzan. In order to find his velocity I will use the energy lense since his potential energy is transferred to kinetic energy. As shown

b) $\frac{1}{2} m v^2 = mgh$ or $\frac{1}{2}(\cancel{100kg})\, v_{tarzan}^2 = (\cancel{100kg})(10m/s^2)(5m)$

$$v_{tarzan} = 10 \, m/s$$

c) $(50kg)(5m/s) - (100kg)(10m/s) = (150kg)(v_f)$

$$v_f = -5m/s$$

A

The final velocity is in the direction of Tarzan and towards momentum's true love!

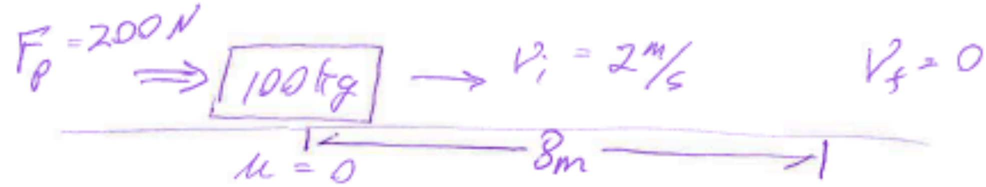
#4 Your friend is on a sled (combined mass: 100 kg) moving at a speed of 2 m/s on flat, smooth snow. To speed him up, you push him forward with a force of 200 N over 8 m.

a) Please find my friend's final speed after I am done pushing him.

b) Explain how you would estimate the average power I put out as I push him. You don't have to calculate it.

c) *To shorten the exam I dropped this part, but please do it for the corrections… because it's lovely:* Let's say that for the last 4 m of the 8 meters I pushed, we ran over a rough patch with a coefficient of friction of 0.1 between the snow and the sled. How would this change the problem? If you can, find the new final speed.

Hopefully, you've made a good diagram explaining what's happening. You might explain why you'd use a dynamics lens… but it would get complicated and require some kinematics. Then you might try an energy lens instead to solve part a. I got a final velocity of 6 m/s, and using an energy lens for (b) an average power of 800 W. For friction, can you show how this consideration would result in a final speed of just a little less than 5 m/s.



a) I could use a dynamics lens ⇒ $\vec{a}$ ⇒ $\vec{V}_f$
but I would need time requiring Kinematics
I'd rather use an Energy lens because ~~sue~~

$W_{Pete} \Rightarrow \Delta E_K$ $\qquad E_i + W_p = E_f$

b)
$P = \frac{\Delta E}{\Delta t} = \frac{W}{\Delta t} = \frac{1600 J}{\Delta t}$

$V_{ave} = \frac{2 m/s + 6 m/s}{2} = 4 m/s$

$\Delta t = \frac{\Delta x}{V} = 2s$

$E_{K_i} + F \cdot \Delta x = E_{Kf}$

$\frac{1}{2} m_o v_i^2 + F \cdot \Delta x = \frac{1}{2} m_o V_f^2$

$\frac{1}{2}(100 kg)(2 m/s)^2 + 200N \cdot 8m = \frac{1}{2} m_o V_f^2$

$200 J + 1600 J = 1800 J$

I can see his Kinetic energy increased by a factor of $\underline{9}$ so his speed must have increased by a factor of $\sqrt{9} = \underline{3}$, so $V_f = 6 m/s$
- or, just solve $\frac{1}{2} m V_f^2 = 1800 J$

$V_f = \left(\frac{1800 J \cdot 2}{100 kg}\right)^{\frac{1}{2}}$ $\quad \left(kg \frac{m^2}{s^2}\right)$

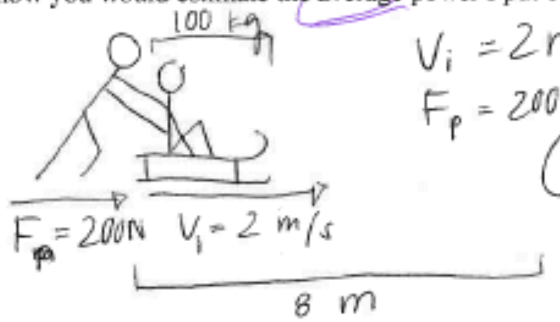
$= 6 m/s$.

c) $F_f = N\mu = mg\mu$
This Force is in the opposite direction
Producing heat $= F_f \cdot \Delta x_f = \mu mg (4m)$

Name leaving less E_K for my friend.

Here's someone who used the dynamics / kinematics way to do the same calculation. They did a pretty good job, but it's a little more work and thought than the energy transformation method:

b) Explain how you would estimate the average power I put out as I push him. You don't have to calculate it.

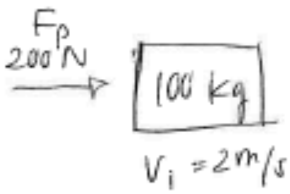


$V_i = 2$ m/s $\quad V_f = ?$

$F_p = 200$ N $\quad \Delta x = 8$ m

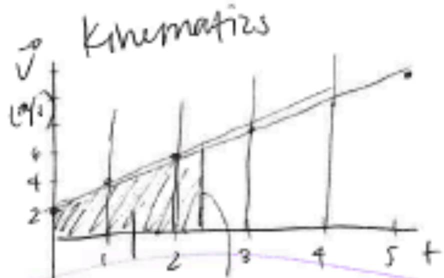
1st

Dynamics lens - forces causing ~~change~~ acceleration



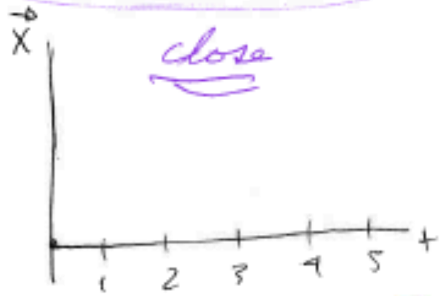
$a = \frac{F}{m} = \frac{200\text{ N}}{100\text{ kg}} = 2\text{ m/s}^2 \rightarrow$

but try an E lens?



≈ 8m $\quad \approx 6.5$ m/s

close



2nd

I would use ~~mon~~ energy lens to calculate the average power you put ~~out~~ out as you push him.

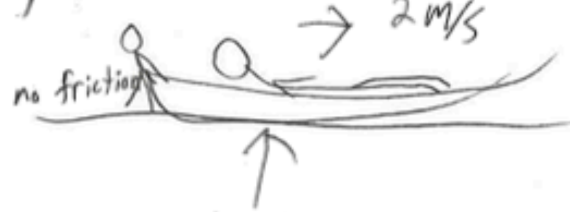
$P = \frac{dE}{dt} = \frac{F \cdot dx}{dt} = \boxed{F \cdot V}$

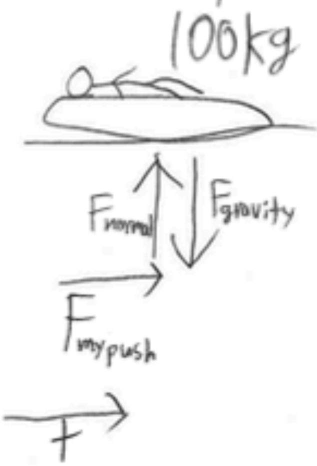
I'd use this formula to use the velocity I found prior and multiply it by the force (200 N)

$(200\text{ N})(6.5\text{ m/s}) = \boxed{1300\text{ W}}$

when?

B+ A-a)





The push I apply is a force. Forces cause acceleration, and $\sum \vec{F} = m\vec{a}$, so I will use a force lense.

given this FBD, I know that my friend will accelerate to the right.

$$\sum F = m \cdot a$$

$$200N = 100kg \cdot a$$

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

how did you calculate this?

Time(s)	Position
0	0 m
1	3 m
2	8 m

Time(s)	speed
0	2 m/s
1	4 m/s
2	6 m/s

I now use a kinematics lense, because I am looking for displacement over time in order to determine how long I accelerated the sled for.

A

At time=2sec, I have pushed my friend for 8m

Initial v

$2\,m/s + 2\,m/s^2 \cdot (2sec)$

$\boxed{6\,m/s}$

b) If I was looking for power, I would calculate how long I pushed on my friend in seconds, and how far I pushed him in meters.

From there, I would calculate power through the equation $Power = \frac{J}{s} = \frac{N \cdot m}{s}$ for example, $\frac{200N \cdot 8m}{2sec} = \boxed{800\ watts}$

Name ______________________