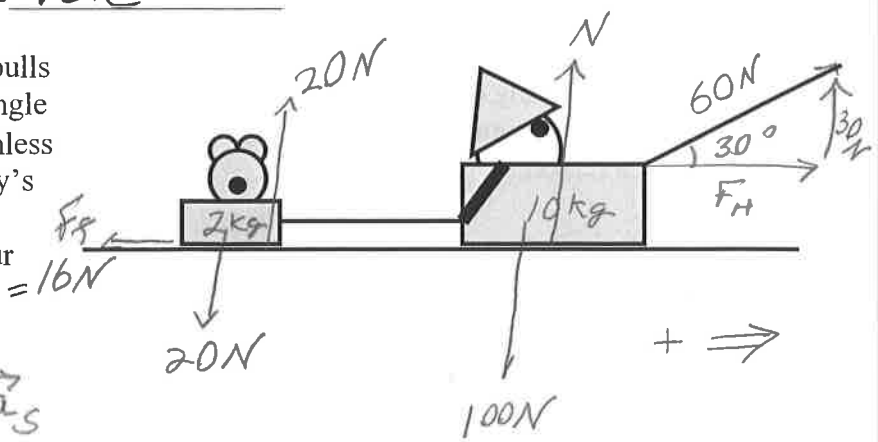
40 pts total Physics F14 MT2 Nov. 4, 2014 Name Pete

1. I pull my little girl (10 kg) in her sled and she pulls Teddy (2 kg). I pull with a tension of 60 N at an angle of 30° above the horizon. The girl's sled is frictionless (on wheels) but the coefficient of friction for Teddy's sled is 0.8.



a) State which of the 4 concepts are central to your solving this problem and why.

Dynamics of a system:

$\sum \vec{F}_S = m_S \vec{a}_S$

b) What is the acceleration of my daughter?

$$\vec{a}_S = \frac{\sum \vec{F}_S}{m_S} = \frac{F_H - F_f}{m_T + m_g} = \frac{52N - 16N}{12\,kg}$$

$$= \frac{36\,\cancel{kg}\,m/s^2}{12\,\cancel{kg}} = 3\,m/s^2$$

4
$F_H = .87$
$\times 60$
52.2

a = $3\,m/s^2$

$a = 3\,m/s^2 \Rightarrow$

16N ← [2kg] → 22N

c) What is the tension of the string pulling Teddy?

$\sum F_T = m_T a_T$: $T - F_f = m_T a_T$

$T = m_T a_T + F_f = 2kg(3\,m/s^2) + 16N$

$= 22N$

T = 22N

2. Your Statements:

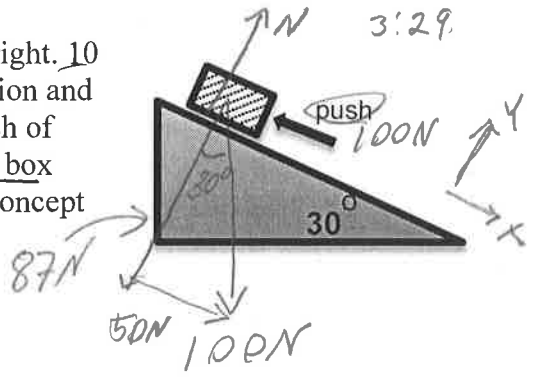
a) Please write and sign the following statement: "I will not communicate any information about this test to those outside the 10 AM class until after 2:00 PM today." I will not communicate any information about this test to those outside the 10 AM class until 2:00 PM Signature Peter Vlahovic

b) If you didn't use a calculator for this test and would like extra credit for it, please write and sign the following statement: "I didn't use a calculator on this test - *your signature*"

I didn't use a calculator Signature Peter Vlahovic

3. (15 pts) Your job is to keep boxes moving up a 30° incline as shown at right. 10 kg boxes are pushed from below on a surface with a 0.3 coefficient of friction and reach you with a speed of 3 m/s. You push the boxes up the next 4 m stretch of ramp with a force of 100 N as shown, and we want to find the speed of the box when you're done pushing it. Clearly show your work, identifying which concept you're using.

a) Find the force of friction.
b) How much heat is liberated in this process?
c) How much work did I do on the system?
d) What is the change of potential energy of the system?
e) What is the final speed at the end of the 4 m stretch?



3:29

a) $\Sigma F_y = 0$ $\quad F_f = \mu N$

$N + F_{g_y} = 0$ $\quad N = 87N$ $\quad F_f = 0.3 \cdot 87N = 26.1N$

b) $Heat = W_{friction} = \vec{F_f} \cdot \vec{\Delta x} = 26.1N \cdot 4m$

$= \underline{104J}$ Heat

c) $W = F \cdot \Delta x = 100N \cdot 4m = \underline{400J}$

d) $\Delta PE = mg\Delta h = 10kg \cdot 10\,m/s^2 \cdot 2m = 200J$ ($4m \cdot \sin 30°$)

e) I need to know $KE_f = \frac{1}{2}mv_f^2$

$E_0 = E_f$ $\quad KE_0 = \frac{1}{2}mv_0^2 = \frac{1}{2}(10kg)(3\,m/s)^2$

$= 45\,kg\,m^2/s^2 = 45J$

$KE_0 + W = KE_f + \Delta PE + Heat$

$KE_f = KE_0 + W - \Delta PE - Heat$

$= 45J + 400J - 200J - 104J = 141J$

$445 - 304 = 141$

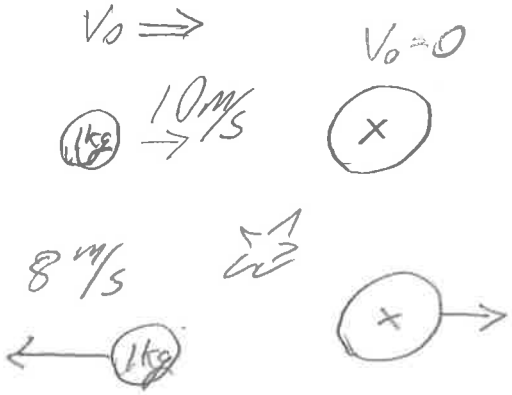
$\frac{1}{2}mv_f^2 = 141J$ $\quad v_f^2 = \frac{2 \cdot 141J}{10kg} = 28\,m^2/s^2 \approx 5.2\,m/s$

3:37

4. A 1.0 kg ball moving at 10 m/s *to the right,* has an *elastic* collision with *stationary* "Ball X" of unknown mass, and is reflected back at 8 m/s *back to the left*. We want to find the mass of Ball X, and its final velocity. Is it a good idea to draw a picture?

a. Without doing any math, can you tell me if the mass of Ball "X" is more or less than 1 kg? please give a reason

$m_x > 1kg$ because the 1kg ball bounces back



b. What is the momentum of Ball X after the collision?

$\vec{p}_x = -\Delta\vec{p}_{1kg}$ $\quad \Delta\vec{p}_{1kg} = -18\ kg\ m/s$

$\vec{p}_x = 18\ kg\ m/s$

c. What is the kinetic energy of Ball X after the collision?

Elastic $\Rightarrow$ conserve E!

$E_0 = \frac{1}{2}(1kg)(10\ m/s)^2 = 50\ kg\frac{m^2}{s^2} = 50J$

$E_{1s} = \frac{1}{2}(1kg)(8\ m/s)^2 = 32J$

$E_{lost\ by\ 1kg} = 50J - 32J = \underline{18J} = KE_x$

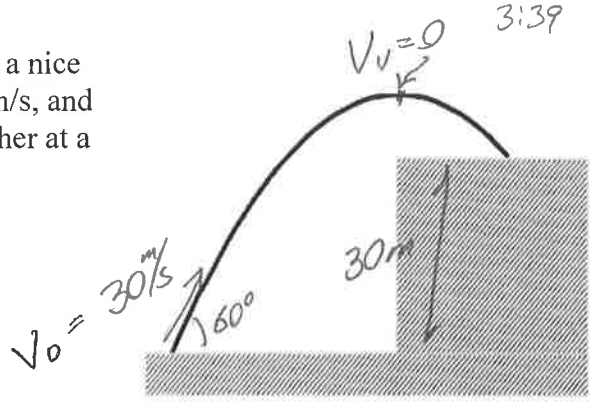
d. *(extra credit)* Find the mass of ball X and the final velocity of ball X.

$KE = \frac{p^2}{2m}$

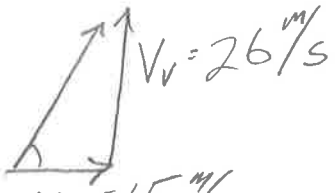
$m = \frac{p^2}{2\,KE} = \frac{(18\ kg\frac{m}{s})^2}{2\ 18J} = \frac{18 \cdot 18\ kg^2\frac{m^2}{s^2}}{2 \cdot 18\ kg\frac{m^2}{s^2}} = 9kg$

$p_x = 18\ kg\ m/s = m_x v_x$ ($m_x = 9kg$) $\quad v_x = 2\ m/s$

5. (7 pts) My friend lives on top of a 30 m plateau, and I want to lob a nice parcel up to her. I have a slingshot that can propel something at 30 m/s, and so I back up from the edge of the plateau and shoot my parcel up to her at a 60° above the horizontal.
About how far from the cliff's base should I put my slingshot so that the parcel clears the edge of the cliff at its highest point (as shown at right)?
If it's not clear how to solve this, find anything else that you can



(Extra Credit: find the final velocity of the parcel as it lands on top of the cliff)



How long will the Projectile be in the air before it is horizontal ($V_y = 0$)

$$a = \frac{\Delta V}{\Delta t} = -10\ m/s^2 = \frac{-26\ m/s}{\Delta t}$$

$$\Delta t = 2.6\ s$$

$$\Delta X = V_H \Delta t = 15\ m/s \cdot 2.6\ s = 39\ m$$

2
87
.30
26.1