Name _____

Physics 201 Final Exam—Practice

Equations:

$x = x_0 + v_0 \cdot t + \frac{1}{2}a \cdot t^2$
$v = v_0 + a \cdot t$
$v^2 = v_0^2 + 2a(x - x_0)$
$\Sigma \mathbf{F} = m\mathbf{a}$
$\mathbf{F}_{12} = -\mathbf{F}_{21}$
$\mathbf{F}_G = m\mathbf{g}$
$\mathbf{F}_{fr} = \mu_k \mathbf{F}_N$
$\mathbf{F}_{fr} \leq \mu_s \mathbf{F}_N$
$F(G) = Gm_1m_2/r^{2-}$

$v = (\bar{v} - v_0)/2$
$v = \Delta\bar{x}/\Delta t$
$a = \Delta\bar{v}/\Delta t$
$a_r = v^2/r$
$\mathbf{p} = m\mathbf{v}$
$\mathbf{F} = \Delta\mathbf{p}/\Delta t$
Impulse $= \mathbf{F}\Delta t = \Delta\mathbf{p}$
$m\mathbf{v}_1 + m\mathbf{v}_2 = m\mathbf{v}_1' + m\mathbf{v}_2'$
$\Sigma\tau = I\alpha$
$\tau = rF\sin(\phi)$

$v_x = v \cdot \cos(\theta)$
$v_y = v \cdot \sin(\theta)$
$v^2 = v_x^2 + v_y^2$
$\tan(\theta) = v_y/v_x$
$W = Fd \cdot \cos(\theta)$
$KE_t = \frac{1}{2}mv^2$
$GPE = mgy$
$KE_0 + PE_0 + W = KE_f + PE_f$
$SPE = \frac{1}{2}kx^2$
$E = (F/A)/(\Delta l/l_0)$

Material	Elastic modulus	Ultimate strength (tension)
Steel	200×10^9 N/m^2	500×10^6 N/m^2
brass	100×10^9 N/m^2	250×10^6 N/m^2
Aluminum	70×10^9 N/m^2	200×10^6 N/m^2
Concrete	20×10^9 N/m^2	2×10^6 N/m^2
Nylon	5×10^9 N/m^2	500×10^6 N/m^2

1. Define the following terms:

   Velocity:

   Static Friction:

   Impulse:

   Elastic modulus:

Name _____

Spring constant:

Torque:

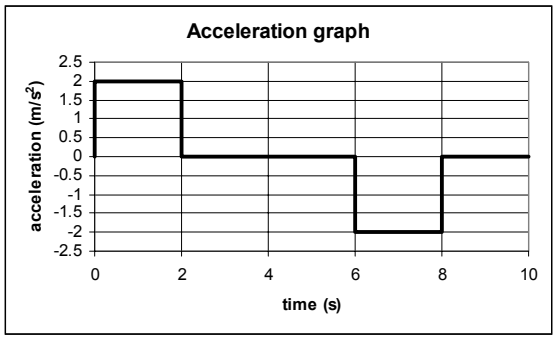
2. A light body and a heavy body have the same kinetic energy. Which has the greater momentum?

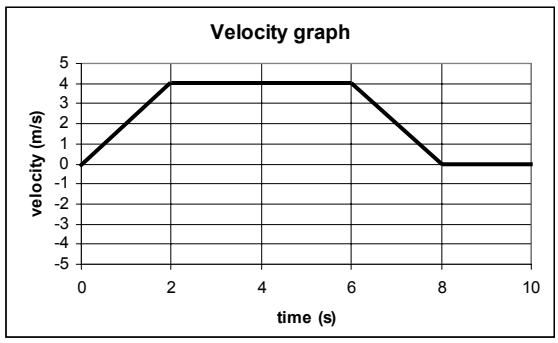
The heavy one. The lighter body will have a velocity greater by the root of the ratio of velocities, $v_2 = (m_1/m_2)^{1/2}v_1$, so when multiplied by the mass to get momentum, the larger one will have more momentum

3. When climbing a steep hill on a bicycle, one often will put the bike in lowest gear. Does this correspond to the largest diameter or smallest gear on the back wheel? Explain why, explicitly mentioning the most relevant of the physics ideas we have studied and how it relates.

This is the largest gear on the back wheel. Using the largest gear maximizes the torque that a foot (via the chain) can put on the back wheel. Since the radius of the wheel is fixed, this will increase the force exerted on the ground by the tire.

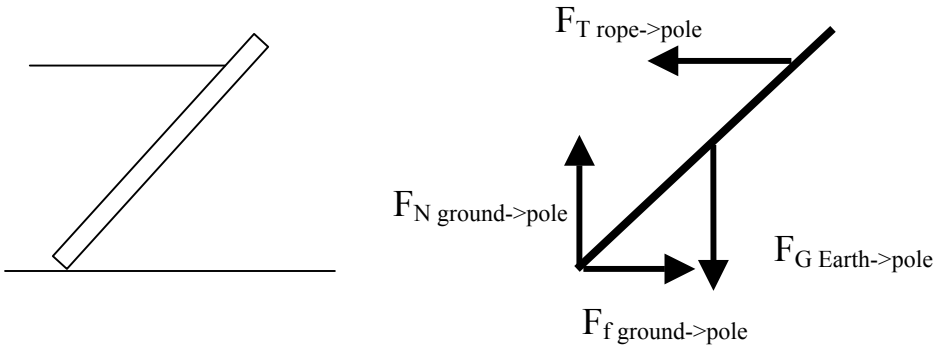
4. Here is an acceleration graph of a car. Draw the velocity graph on the right



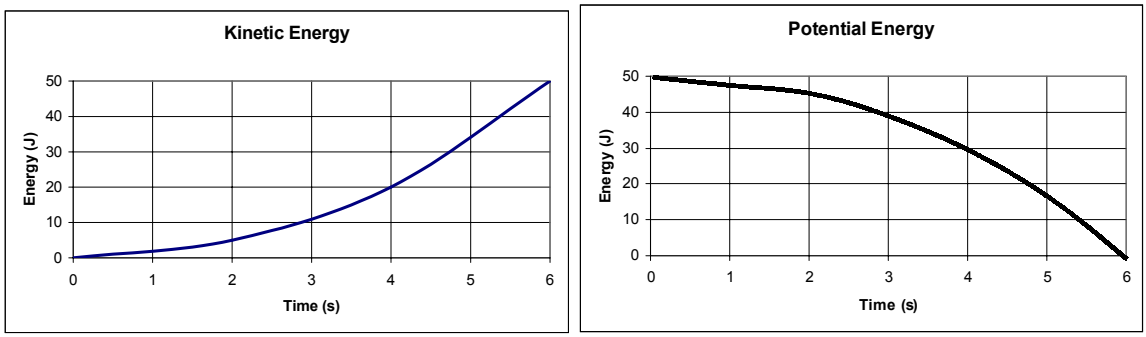


Name _____

5. Draw a torque diagram for the pole being lifted by the cable in this picture.



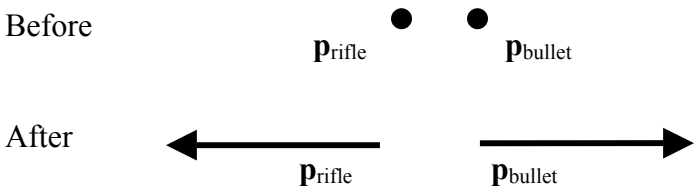
6. A low friction cart rolls on a ramp. The graph on the left shows its kinetic energy as a function of time. Sketch its potential energy in the graph on the right.-



Describe the general motion of the cart between t=0 and t=6.

The cart starts near the top of the ramp, not moving at the beginning, and it rolls down the ramp, speeding up.

7. Draw a momentum diagram for a rifle and the bullet it fires at 150 m/s.



Name _____

8. The tension on a 90 cm nylon guitar string is 54 N. If the diameter is 2.0 mm, how much is it stretched? What would the upper limit of force that can be applied if one uses a safety factor of 10?

$E = (F/A)/(\Delta L/L_0) \Rightarrow \Delta L = (F*L_0)/(E*A)$

$A = \pi r^2 = 3.1416*(0.001\ m)^2 = 3.14x10^{-6}\ m^2$

$\Delta L = (54\ N * 0.90\ m)/(5x10^9\ N/m^2 * 3.14x10^{-6}\ m^2)$

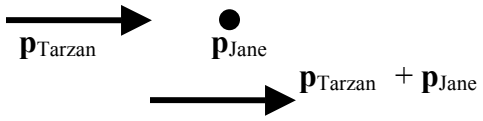
$= 0.003\ m = 3\ mm$

stress = max stress/safety factor = $500x10^6\ N/m^2/10 = 5x10^7\ N/m^2 = F/A$

$F = 5x10^7\ N/m^2 * 3.14x10^{-6}\ m^2 = 157\ N$

9. Tarzan (mass of 75 kg) rescues Jane by swing in at 4.5 m/s and grabbing her so that they then swing off at 2.7 m/s. What must be Jane's mass?

Use momentum.



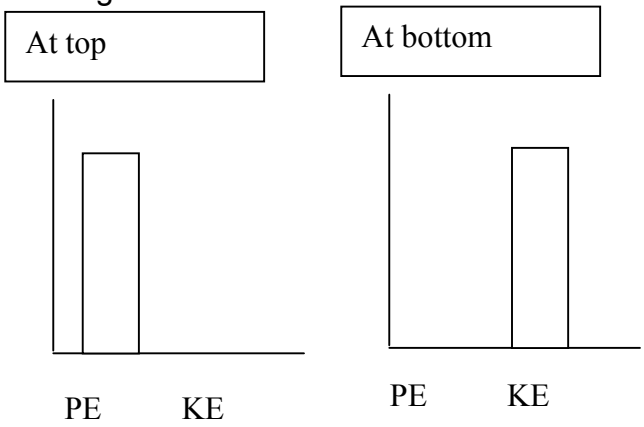
$m_{Tarzan}v_{tarzan\ before} = (m_{Tarzan}+m_{Jane})v_{after}$

$75\ kg * 4.5\ m/s = (75\ kg + m_{Jane})2.7\ m/s$

$75\ kg\ (4.5\ m/s - 2.7\ m/s) = m_{Jane}2.7 m/s$

$m_{Jane} = 50\ kg$

10. Sally and Johnny take their sled up to the top of a 25 m high hill. If friction and air resistance could be ignored, how fast will they be traveling when they get to the bottom?

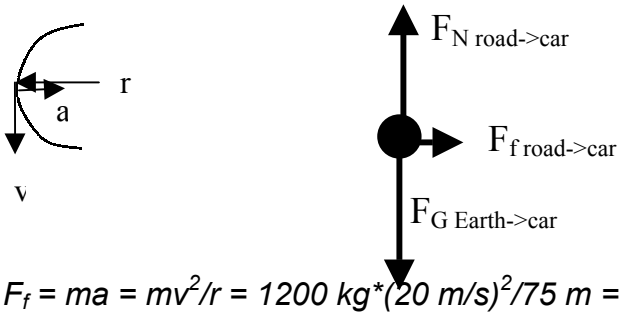


y = 25 m
$g = 9.8\ m/s^2$

PE = KE
$mgy = ½mv^2$
$gy = ½v^2$
$v = sqrt(2gy)$
$v = sqrt(2 \times 9.8 m/s^2 \times 25\ m)$
$v = 22.1\ m/s$

Name _____

11. A 1200 kg car rounds a level curve of radius 75 m at 20 m/s. What is the frictional force on the car? What is the minimum coefficient of friction that must exist between the tires and the road?



F_x) $F_f = ma = mv^2/r = 1200\ kg*(20\ m/s)^2/75\ m = 6400\ N$

$F_r = \mu F_N = \mu mg = \mu * 1200\ kg * 9.8\ m/s^2 = 6400\ N$

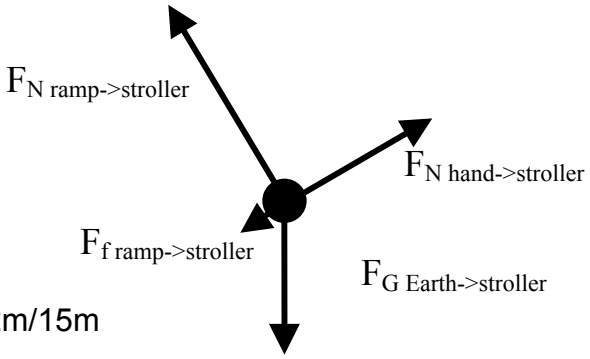
$\mu = 0.54$

12. How much work must be done to push a 0.5 kg stroller with a 25 kg child up a ramp that is 15 meters long and 1.2 meters high if friction can be ignored? If there is a force from the ramp and the wheels of 10 N retarding the stroller, what will be the total work done?

$F_{along\ ramp}$) $F_{N\ hand} - F_G \sin\theta - F_f = ma = 0$

$F_{perp.\ ramp}$) $F_{N\ ramp} - F_G \cos\theta = ma = 0$

$\sin\theta = 1.2\ m / 15\ m$



without friction:

$F_{N\ hand} = F_G \sin\theta = 25.5\ kg * 9.8\ m/s^2 * 1.2m/15m$

$= 19.99\ N$

$W = F*d = 19.99\ N * 15\ m = 300\ J$

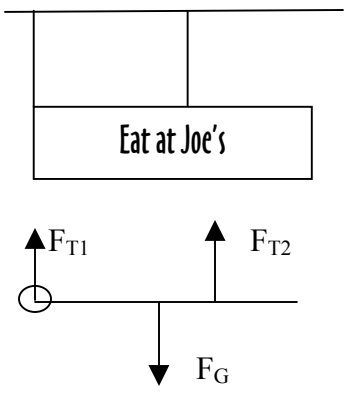
with friction

$F = 19.99\ N + 10\ N = 29.99\ N$

$W = F*d = 29.99\ N = 450\ J$

Name _____

13. A 100 kg sign is to be hung from an overhang as shown. The cable on the right is attached at the end and the other 2/3 of the way to the other end. How much force must be on each cable?



Statics problem: sum forces = 0, sum torques =0

F_y) $F_{T1} + F_{T2} - F_G = 0$

use pivot at left end,

τ) $- 0.5*L*F_G + 0.667*L*F_{T2} = 0$

$F_{T2} = (0.5/0.6667)*(100\ kg * 9.8\ m/s^2) = 735\ N$

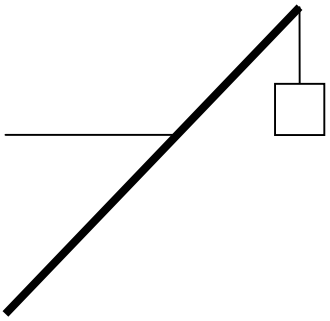
$F_{T1} = 100\ kg * 9.8\ m/s^2 - 735\ N = 245\ N$

Name _____

14. Real world problem. Fill in ONLY the indicated steps of the FOCUS and DESCRIBE steps. DO NOT SOLVE THE PROBLEM

A 15 meter long ship crane is unloading a 400 kg crate. It consists of a 60 kg boom (pole) atached to the deck with a hinge, and a horizontal cable to hold it up attached at the middle of the boom. What must be the tension on the horizontal cable when the boom is tilted from the vertical by 40 degrees? What will be the horizontal and vertical forces of the boom on the deck of the ship?

EVERYDAY LANGUAGE
Sketch with Given Information

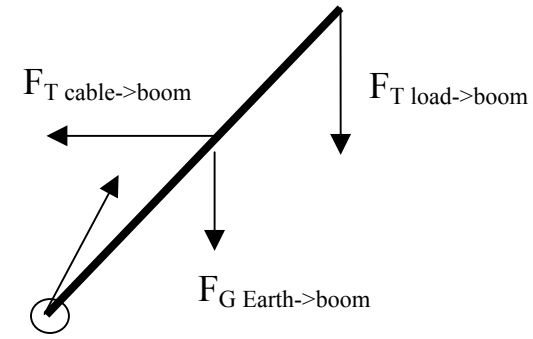


What are you trying to find?

Forces on boom (cable, pivot)

What are the physics principle(s)?
Forces, torque

Physics Description
Diagram



Define Variables

$\boxed{F_{T\,cable} = ?}$
$F_{T\,load} = 400\ kg * 9.8\ m/s^2$
$F_G = 60\ kg * 9.8\ m/s^2$
$\boxed{F_{Nx} = ?}$
$\boxed{F_{Ny} = ?}$
$\theta = 40^o$
$L = ?$

Quantitative Relationships (*Write down ONLY the equations needed to solve this problem.*)

$F_x)\ F_{Nx} - F_{T\,cable} = 0$

$F_y)\ F_{Ny} - F_G - F_{T\,load} = 0$

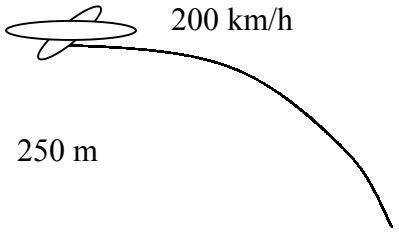
$\tau)\ -\frac{1}{2}LF_G\sin(180^o - 50^o) + \frac{1}{2}LF_{T\,cable}\sin(180^o - 40^o) - LF_{T\,load}\sin(180^o - 50^o) = 0$

Name _____

Real world problem. Fill in ONLY the indicated steps of the FOCUS and DESCRIBE steps. DO NOT SOLVE THE PROBLEM

A military airlift is going to drop supplies to soldiers looking for Al Queda fighters on a small level area the mountains of Afghanistan. If the plane is moving towards the target at 200 km/h and 250 m above the target area, at what distance before the target should it drop the packet? (Ignore air resistance.)

EVERYDAY LANGUAGE
Sketch with Given Information



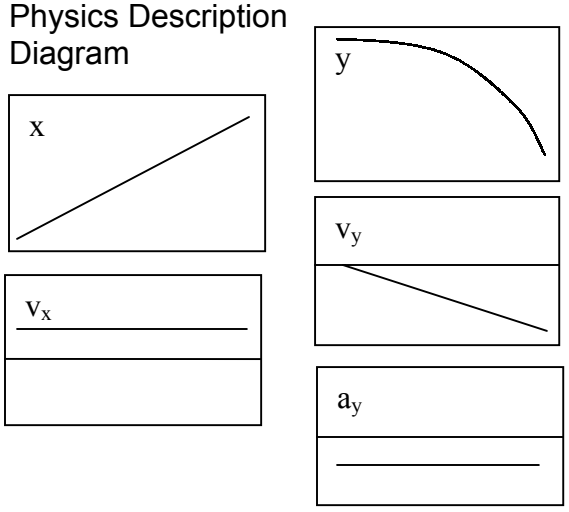
What are you trying to find?

horizontal distance

What are the physics principle(s)?

motion in 2-D

Physics Description
Diagram



Define Variables

$x_o = ?$
$x_f = 0\ m$
$v_{0x} = 200\ km/h$
$= 55.5\ m/s$
$t_0 = 0\ s$

$y_o = 250\ m$
$y_f = 0\ m$
$v_{0x} = 0\ m/h$
$a_y = -9.8\ m/s^2$
$t_f = ?$

Quantitative Relationships (*Write down ONLY the equations needed to solve this problem.*)

$x_f = x_0 + v_{ox}t$

$y_f = y_0 + \frac{1}{2}at^2$