PHYS-141 Sept. 22 Quiz 1. Name___________________________

1) For the system identified, label all the forces that come into play.
2) Please Indicate the "third law pairs"

3) (on the back) Make a free body diagram of the object when it is moving downward at constant speed.
4) (on the back) Make a free body diagram when it is moving upward but slowing down.

PHYS-141 Sept. 29 Quiz 2. Name___________________________

A 4 kg mass is moving at 10 m/s up a frictionless ramp at an angle of 30 degrees. It is also pulling another mass behind it, and so has a string pulling it backwards with a force of 10 N. Go through the protocol and find the acceleration. Put extra work on the back if necessary.

$a = 7.5\ m/s^2$

PHYS-141 Oct. 3, Group Quiz1. Names___________________________

A 4 kg mass has an instantaneous velocity (at t = 0) of 10 m/s up a ramp at an angle of 60 degrees above the horizontal. The surfaces of the block and the ramp have an associated coefficient of friction of 0.7 (kinetic friction), and 1.0 (static friction). Go through the protocol and find the acceleration.

1) Estimate the acceleration on the way up. $\sim 12\ m/s^2$
2) Does the block stop at the top? No, please show that the static friction is less than the parallel component of gravity.
3) Estimate the acceleration on the way down (if you found that the block stopped at the top, then give it a push downward to get it going). $\sim 5.2\ m/s^2$

Group Work #4 141 Schwartz Due Tuesday. Name_____________________

1) A 2.0 kg block is being pushed across a wooden ceiling with a force of 40 N at a 60 degree angle with respect to the horizontal. If the coefficent of friction between wood is 0.2, and the static coefficient of friction is 0.3, please find the acceleration of the block if it starts at rest. $\sim 8.5\ m/s^2$

2) (20 pts) Solve the infamous "catching the bus" problem. The bus is at your stop, and you're running at a constant speed of 7 m/s from behind in order to catch it. However, just when you're 20 m behind it (or behind the bus driver to be exact), the bus begins accelerating away from you at $1\ m/s^2$, and will continue accelerating at $1\ m/s^2$ unless you can meet eyes with the driver. Set up the problem properly with the right equations, substitution, solving the problem, and only at the end substituting the values in and solving the problem while canceling units properly.
   a) Do you catch the bus? If so, at what time? If not, how close do you come?
   b) Draw the displacement – time, and velocity – time graphs. Graph yourself and the bus together on each graph.

3) (10 pts) Repeat #1 with the change that the bus starts driving away when you are 30 m behind the driver.

4) (10 pts). Let's say a vehicle on a track has acceleration of $a = 20\frac{m}{s^3}t - 4\frac{m}{s^4}t^2$, for the first 5 seconds. This is a stark departure from the constant acceleration that we've always used. Please graph the acceleration, velocity, and displacement as a function of time until the rocket comes to rest.

Group Work #5 141 Schwartz Due Wednesday. Name____________________

Hey, Quiz tomorrow!

No Calculators! No use of internet resources!

5) Today's work involves two questions…. I can't overstate the importance of these two questions. Friendships have dissolved, cocktail parties have exploded, Thanksgiving dinners have been destroyed, physics instructors have lost their jobs, and empires have crumbled over these two questions*:
   a) What keeps the water in the bucket when it's overhead?
   b) Do you weigh more at the North Pole or the Equator? Why?
      i) I never use the word "weigh" because it is ambiguous. By "weight" we mean what you read on a scale… your book uses the term "apparent weight".
      ii) Assume for this problem that the earth is a perfect sphere, but is rotating.

   I have yet to see an explanation for these two questions in my 20 years of teaching this stuff that didn't involve an explicit use of ***the protocol***. So the question is up to you: Do you want to rise to the challenge of being the first, or do you want to use the protocol?

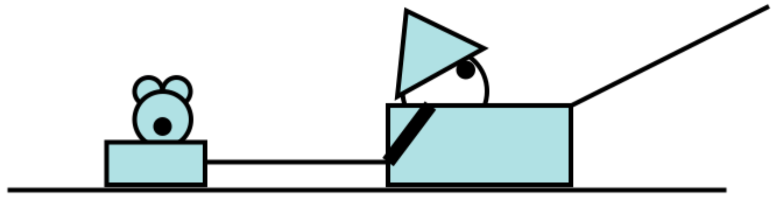
   For both (but particularly for the second one) do some thought experiments to see if you answer makes sense…. Remember what kind of people physicists are.

PHYS-141 Oct. 6 Quiz 6. Name__________________________

A friend of mine gives me a ride in his dragster on level ground. When he takes off, I notice that the fuzzy dice hanging from the roof of the car make an amazing 20 degree angle with the horizontal roof of the car!

a) Estimate our acceleration ~ 30 m/s^2
b) Estimate the coefficient of friction between the hot tires and the road. ~ 3…HUGE

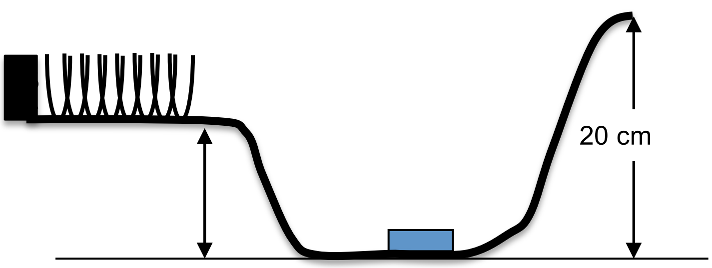
Group Quiz #7 Oct. 18, 2011 Names____



1. Remember this? You will now solve it withOUT using the sum of the forces = ma. I pull my little girl (10 kg) in her sled and she pulls Teddy (2 kg). I pull with a tension of 50 N at an angle of 30° above the horizon. The coefficient of friction is 0.3 for both sleds. I pull her for 10 meters.

a) How much work do I do? ~433 J
b) How many joules are converted to heat in each sled? ~285
c) What is the final velocity? ~ 5 m/s
d) What is the final kinetic energy of the teddy's sled? ~ 25 J
e) How much work was done on the little teddy's sled by the tension in the string? ~ 85 J (don't forget the heat resulting from friction)
f) What must be the tension in the string to have done this much work? ~ 8.5 N
g) Use the final velocity to find the acceleration of the sleds. ~ 1.23 m/s^2

Group Quiz #8 Oct. 19, 2011 Names____



2. You see a small cart on a track racing to the left after it dropped from rest at upper right. The mass of the cart is .5 kg and the spring constant is 100 N/m.
   a) What is the compression of the spring when the cart stops? ~ 17 cm
   b) What if the flat section at the bottom is one half meter long, with a coefficient of friction of 0.3. The rest of the track is frictionless. Now how far does the spring compress? ~ 12 cm
   c) With the 0.3 friction as stated above, the cart starts with an initial speed of 2 m/s at the top. Now how far does the spring compress? ~ 19 cm
   d) If you let the cart in the above question continue after it compresses the spring, how far will the cart come up the opposite side of the track? Will it reach the top? It should rise to a total height of 40 cm above the ground
   e) For c) above, where is the acceleration of the cart the greatest? Find this maximum acceleration! Where the spring has maximum compression: 19 cm => 38 m/s^2

Quiz #9 Oct. 20, 2011 Name____

3. I want to launch a 2 kg brick with a spring (k = 20,000 N/m). I compress the brick 4 cm and launch it straight up.
   a) How fast is the brick going at a height of 60 cm? 2 m/s
   b) What is the acceleration of the brick immediately after I engage the spring to launch the brick? 390 m/s^2 don't forget gravity.

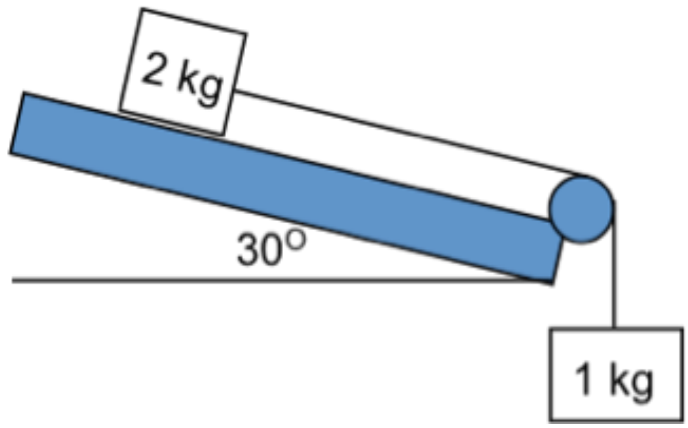
ɜroup work 10. Oct. 25, 2011 Energy Diagrams

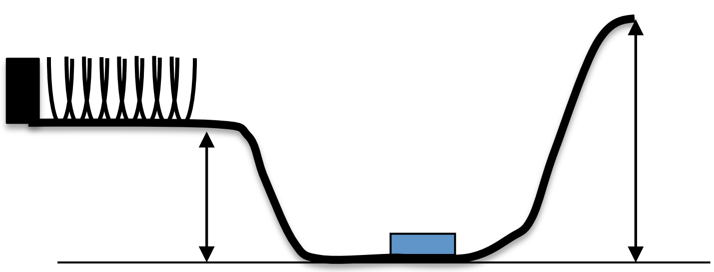
.. I want to launch a 2 kg brick with a spring
k = 20,000 N/m). I compress the brick 4 cm and launch it straight up.
\) How fast is the brick going at a height of 60 cm?
ȝ) What is the acceleration of the brick immediately after I engage the spring to launch the brick?

ʌake an energy diagram for
a) Before I pull the pin
b) Immediately after the spring is extended
c) When the mass is at the top of its journey
d) When the mass is at a height of 60 cm
ʌake an energy diagram as a function of height.
(Put potential energy on the y axis)

ꝛ. (15 pts) The system at right is started from rest. ˀhe coefficient of friction is 0.3. The strings and ɹulleys are massless and frictionless. The 1 kg mass ɩits the ground after falling 2 meters

ʌake a before and after energy diagram





4. You see a small cart on a track racing to the left after it dropped from rest at upper right. The mass of the cart is .5 kg and the spring constant is 100 N/m.
   f) What is the compression of the spring when the cart stops?
   g) The flat section at the bottom is one half meter long, and has a coefficient of friction of 0.3. The rest of the track is frictionless. Now how far does the spring compress?
   h) With the 0.3 friction in place, the cart starts with an initial speed of 2 m/s at the top. Now how far does the spring compress?
   i) If you let the cart continue after it compresses the spring, how far will the cart come up the opposite side of the track? Will it reach the top?

****For d) above, can you make a before and after Energy diagram?
****Can you make an energy diagram as a function of distance?

.. There is a 10 kg mass in the air above a spring that has a spring constant of 800 N/m, or on the spring, or compressing the spring.

a) Draw the potential energy diagram of the mass's potential energy as a function of it's height. Assume that the spring can compress many meters if necessary.

b) Find the equilibrium height of the mass in this potential well. Is it a stable equilibrium? How do you know?

c) Imagine the motion of the mass as it moves in this vertical potential for several different energy levels… that is you can hit it to give it more energy. How does its motion in this potential change for different amount so of energy?

d) Make a force versus displacement diagram, showing force in the y direction as a function of y displacement.

1. LEO (Lower Earth Orbit) is where the space shuttle orbits…. Just scraping the top of the atmosphere: 200 km above the earth's surface. Is this high? Can we presume gravity is still about 10 m/s^2? Remember that the atmosphere drops off in density and pressure like $e^{-\left(\frac{h}{7000m}\right)}$, so it's a good bet there's very little atmosphere up there…. Just enough to make the surface glow a little bit – my first experiment with Princeton Plasma Physics Laboratory was the Space Craft Glow Experiment – NASA didn't like the fact that the shuttle glowed because this corroded the surfaces and it also makes the shuttle more visible at night.

   a) Assuming the acceleration of gravity in LEO as ~10 m/s^2, estimate the speed of the space shuttle in this orbit. Of course, no calculators! ~ 8 km/s

   b) Estimate the amount of time it takes the space shuttle to orbit the earth. Put time in minutes and hours. How many times do the people orbiting in LEO see a sunrise each day? Wikipedia says 16 times… is this about what you got?

   c) What if we move the space shuttle up to an elevation of 6400 km (the radius of the earth)? Using only ratios and our previous answers, we will find out how this will change the force, acceleration, velocity, and period. Using only ratios, find the new:

      i) Force

      ii) Acceleration ~2.5 m/s^2

      iii) Speed ~ 5.7 km/s

      iv) Period ~ 4 hours

   d) e) Now double the orbital radius again to be 4 earth radii, and then to 8 earth radii, until you come up with a orbital period that is higher than one day. At 8 earth radii, I get 31 hours… so I'd guess between 4 and 8, but closer to 8.

   e) We assumed that the acceleration in LEO ~10m/s^2. Was this a reasonable estimate? By what fraction have you multiplied the distance to the center of the earth? By what percentage should this change the force of gravity? The acceleration of gravity at this altitude should be about 6% less than on the earth's surface… so it's small, but not negligible, no?

Quiz 12. Oct. 27, 2011 Name

.. At the end of an amusement car ride, your 1000 kg cart is still going 10 m/s and needs to come to a rest. You build the contraption at right. The cart first slides along 5 m on a level surface having a coefficient of friction of 0.2. Then it rides up an elevation of 2 m as shown (at an angle of 30 degrees to the horizon). You come to rest against a spring of k = 10^4 N/m.

a) how far does the spring compress? 2 m

b) What is the maximum acceleration you're exposed to? 20 m/s^2

Quiz 13 – we never did this one. I recommend reading it, and contemplating how force comes from the rate of change of momentum of the water. The answer is that getting hit by the firehose provides a significant amount of force.

Oct. 27, 2011 Name

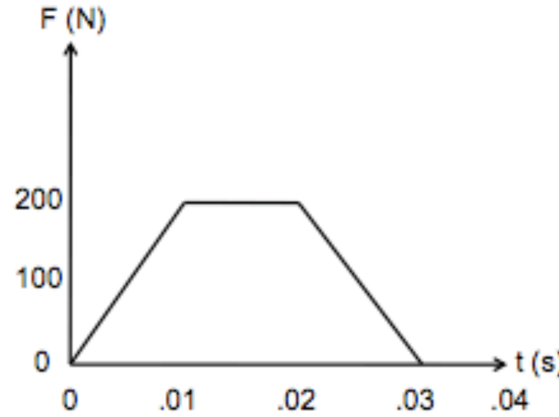
1. I learned a lot today about fire hoses from http://www.firehouse.com/forums/showthread.php?t=100761 See it if you like. Say you are a fireman and have been called to spray some Occupy SLO protestors to get them to move away from the courthouse.
   a) Assume water comes from a hose of nozzle diameter D, at some speed v. It shoots out some distance *l*. Find the momentum in the water of this column length.
   b) How long does it take the water to move the full length of this column?
   c) Then, the water hits something and is dispersed evenly in all directions. What is the momentum of the water now?
   d) Estimate the force that must be exerted on the water by the thing it hit. By the thing that dispersed it.
   e) I got this information from a an exam on the web: A fire hose nozzle has a diameter of 1 and 1/8, According to some fire codes, the nozzle must be capable of delivering at least 300 gal/min. Calculate how fast this water must be going. Calculate the force this would exert on a person if it hit them. Estimate the person's acceleration from this force.
   f) If you are holding a straight fire hose, should there be any force you need to put on the hose to hold it up. How suppose there is a little bend in the hose. Consider the forces on the water. Where do they come from? Now is there a large force you need to put on the hose?

   For the next two problems:
   a) 4 kg m/s
   b) 2 m/s
   c) you do it: a force is a single interaction between two bodies affecting each in opposite directions… right?
   d) -4 kg m/s
   e) -3 m/s
   f) 0
   g) 2.5 kg m/s
   h) How does final and initial kinetic energy compare? $K_i = K_f = 6 \frac{1}{4}$ J. This is a perfectly elastic collision!!!

In the collision problem, the 1 kg mass should move off in the lower right (at a 45 degree angle) with a speed of about 5.7 m/s… The other cart didn't lose kinetic energy, so we've created kinetic energy in the collision. Maybe there was a small bomb on the bumper or a compressed spring that did some work during the collision.

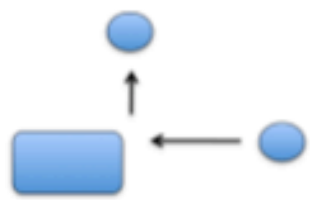
A 2 kg mass is stationary on a frictionless plane and is hit by a ½ kg mass approaching from the left at a speed of 5 m/s. The force on the 2 kg mass is shown

a) Find the impulse that the 2 kg mass receives.
b) What is the final speed of the 2. kg mass?
c) Graph the force on the ½ kg mass.
d) What is the impulse that the ½ kg mass receives?
e) What is the final speed of the ½ kg mass?
f) What is the total impulse that the system receives?
g) Find total momentum: initial *and* final



As shown at right you see from above, a 200 g ball moving at 20 m/s hit a 1 kg mass and bounce off at the same speed

a) Is there an impulse given to the ball? If so, please calculate it, finding magnitude and direction. If there is not, state how you know.
b) Find the impulse given to the 1 kg mass, including angle
c) Find and show the final speed of the 1 kg mass.
d) Is this scenario possible? If not, why now, or if so, under what circumstances?



Quiz 14. Nov. 1, 2011 Names

.. A mass moving along through space, runs into a stationary object three times its mass, and the nasses stick together.

g) A describe the subsequent motion (of course you already drew a picture, no?)
h) By what factor did the mass of the moving system change? 4
i) By what factor did the momentum of the moving system change? 1.. meaning no change
j) By what factor did the velocity of the moving object change? ¼
k) By what factor did the kinetic energy of the moving object change? 1/16
l) By what factor did the kinetic energy of the entire system change? ¼
m) Is kinetic energy conserved in this interaction? If not, where did it go? If so, how do you know? heat

:). You witness a horrible accident (actually, no one is hurt). A 1 Ton sports car heading due south t a speed of 30 m/s hits a 2 Ton pick up headed due east at 20 m/s. The vehicles stick together.
.) Immediately after they collide, what is the velocity of the car-truck object? ~ 16.7 m/s
) Find the kinetic energy before and after the collision. Is kinetic energy Why shouldn't it be onserved?

Quiz 15. Nov. 2, 2011 Names

.. Two masses approach each other head-on with equal speeds (v_0 = 10 m/s). The one from the left ıas three times the mass as the one from the right.

a) Let's say they have a (totally) inelastic collision, sticking together. What's the final speed? $v_o/2$
b) This speed is called the speed of the center of mass. Put yourself in this reference frame… pretend you're moving at this speed watching the collision. What do you see happen (Provide numbers and draw the picture? from the left, 3m comes at ½ v_o, from the right 1.5 v_o
c) For b) above, what is the momentum of the ball approaching from the left? From the right? Are they equal and opposite?
d) For c) above, now say that they have a perfectly elastic collision. What must be the speed of each ball after the collision in this reference frame? How do you conserve momentum and energy?
e) What would the person in the laboratory frame (the earth's reference frame) see? What are the final speeds of each ball? The 3 m_o is motionless, the m_o mass is moving at twice its original velocity in the opposite direction, off to the right.
f) Please check if kinetic energy was conserved in this elastic collision. It should be!

Nov. 3.
2. Repeat the above protocol for the following scenario: Object A at speed v_0 (use 10 m/s if you like) strikes (stationary) object B. Object A has three times the mass of object B. The collision is perfectly elastic. This is akin to a weighted billiard ball hitting an unweighted ball.
Using the above protocol, please find the final speed of both objects. Do you get that the moving ball finishes at half its original velocity, and the stationary ball goes off at 1.5 times the original speed of the other ball?
Find the total momentum of the system before and after the collision
Find the total energy of the system before and after the collision
Was momentum and energy conserved?

What if the mass of the moving object gets very, very large? How does this explain adiabatic compressive heating? As the ball from the left gets up to infinite mass, its speed won't change, and the stationary ball will move off with twice the speed of the heavy ball.

Nov. 8 (after MT #2)

Rotationally displace your book 1.5 radians.
Rotate your book at 0.5/s

Rotationally accelerate your book from -2/s to 2/s at a rate of $0.5/s^2$.
-Make a graph of (rotational) acceleration, velocity, displacement as a function of time.
-What is the total rotational displacement during this time?

Group Quiz 17 Nov 8, 2011 Name

1. I have a bike with 700 mm wheels… meaning the diameter of the wheels, tire and all, is 700 mm. I ride by you at 10 m/s. Find for me:
   a) The rotational velocity of the wheel in radians per second. Give direction as well, as this is a vector. Omega = 28.6/s directed to the rider's left
   b) The rotational displacement of the wheel in 0.1 sec. Theta = 2.86 (to the left)
   c) The velocity you see for the top edge of the wheel when I go by you. 20 m/s
   d) Did you draw a picture? I sure hope so! (see other side of paper)

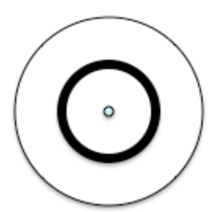
   If I accelerate such that the angular acceleration of the wheel is $.5/s^2$ for 4 seconds, please find:
   e) The new angular velocity, omega_final = 32.86/s
   f) The total rotational displacement of the wheel in that 4 seconds theta = 123.4
   g) The total distance I traveled on my bike in this 4 seconds. ~43 m
   h) If I want to slow down as fast as possible without skidding, would you use the static or kinetic coefficient of friction? Why? static
   i) If I lock up the breaks when I try to stop, would you use the static or kinetic coefficient of friction? Why? Kinetic

Group Quiz 18 Nov 8, 2011 Name

1. As we ended class yesterday: You have a wheel of mass m_0, of radius r_0, and it is moving along the ground rolling at speed v_0, without slipping. You pick it up without stopping it, so you are holding it by the hub and it is spinning.
   a) what is the angular speed of the wheel in terms of things you know? v_o/r

   If all the mass of the wheel is on the rim of the wheel….
   b) what is the kinetic energy of the wheel spinning in your hand? ½ m v_o^2

   c) What was the total kinetic energy of the wheel as it was rolling on the ground (before you picked it up)? mv_o^2

   If all the mass is located inside the wheel at a radius of $r_0/2$… like in the drawing at right:
   d) what is the kinetic energy of the wheel spinning in your hand? (1/8) m v_o^2

   e) What was the total kinetic energy of the wheel as it was rolling on the ground? (5/8) m v_o^2

   If all the mass is located on the hub of the wheel like in the drawing at right:
   f) what is the kinetic energy of the wheel spinning in your hand? 0

   g) What was the total kinetic energy of the wheel as it was rolling on the ground? ½ m v_o^2

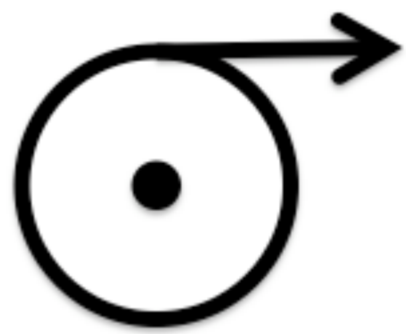
2. What is the Energy Transition you see in the demo I show you. Maybe it was potential to rotational kinetic and translational kinetic?

3. We have a race down a track and there are many things that will roll down. State them in order of first to last – show work below, and put the letters in order of fastest to slowest, or state if they all finish at the same time and why:
   A) A frictionless mass that slides down the track first
   B) A ring that rolls without slipping last
   C) A Disk that rolls without slipping
   D) A hollow ball that rolls without slipping
   E) A Solid ball that rolls without slipping

4. If a ring rolls down the hill next to a frictionless mass, and the mass finishes at speed v_f, what will be the speed of the ring when it finishes? v_f/(root 2)
   A) if this gives you trouble, please "construct" this experiment in your mind and calculate final speeds.
   B) Does the radius of the ring matter? If not, why not? If so, what is the relationship on size?

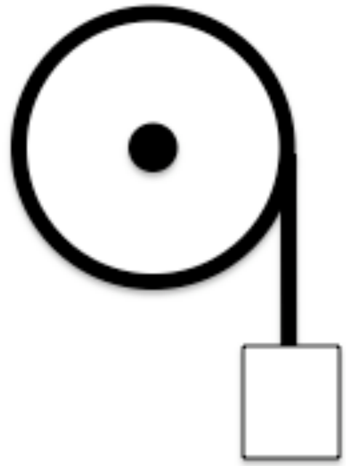
Quiz 19 Nov 10, 2011 Name______________________________

1. You have a 5 m rope wound around a solid disk of radius 0.5 m and mass 4 kg. The disk is free to rotate on an axis as shown. You pull the rope off with a force of 40 N.
   a) What is the energy flow? My work turns to rotational kinetic energy
   b) What is the final angular velocity of the wheel? ~ 28/s
   c) What is the angular acceleration of the wheel while I am pulling the string? ~ 40/s^2



ɩroup work 19 Nov. 10, Names

.. You have a 5 m rope wound around a solid disk of radius 0.5 m and mass 4 kg. The disk is free to rotate on an axis as shown. You tie the rope to a 4 kg mass and let it fall!



a) How is this different from the last problem? Do you expect the wheel to be turning faster than the problem you just did, or slower? Why? The tension in the rope is not 40 N, as the mass is accelerating. The work of gravity (same as the work I had to do above) must also go to kinetic energy of the mass, so the wheel must have less energy.

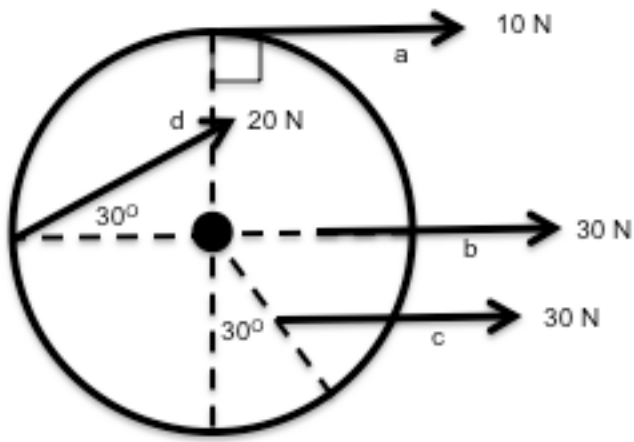
b) What is the energy flow?

c) What is the final angular velocity of the wheel? See a few pages below for all answers.

d) What is the angular acceleration of the wheel while the mass is falling?

)uiz 20 Nov 14, 2011 Name____________________________

.. See a wheel at right of radius 80 cm free to rotate about its center, but not free to move in the x-y plain. The lines that look horizontal and vertical are horizontal and vertical. Forces are applied to the wheel at the rim and at a distance of half the radius as shown. Please find the torque that each force provides about the center of rotation (indicate direction):



a) 8 Nm (into the paper)
b) 0
c) ~10,4 Nm (outward)
d) 8 Nm (into the paper)
e) Find the total torque (include direction) 5.6 Nm (in)
f) If the wheel is 2 kg and has the mass evenly distributed over the area of the wheel, find the angular acceleration of the wheel. ~$8.75/s^2$ into the paper

:. I have a large grinding wheel that is a solid sphere of radius 0.6 meters and mass 40 kg. It spins around twice per second. I am sharpening my ax (the ax that I have to grind) by pressing the blade against the wheel with a force of 20 N. Assume a coefficient of friction between steel and stone of 0.4.

a) What is the torque put on the wheel by my grinding my ax? 4.8 Nm

b) If the power goes out, what will be the angular acceleration that the wheel experiences while I continue to grind my ax? ~$0.83/s^2$

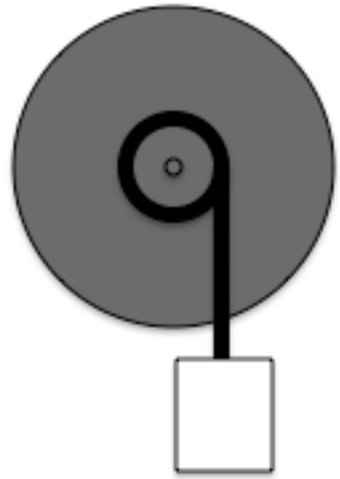
c) What angle will the wheel rotate through during this time before coming to a rest? What is the total distance traveled by the outer edge of the wheel? ~ 95, ~ 57 m

d) Find the following energies and compare them:

i) The work done by the frictional force on the wheel.

ii) The work I did with the torque I put on the wheel.

iii) The rotational kinetic energy the wheel had at the beginning. ~455 J n-class Work 21 Nov. 15, Tuesday Names______________________________



2. (5 pts) A similar problem to the last problem set! You have a 5 m rope wound around a solid disk of radius 0.5 m and mass 4 kg. The rope is wound around a massless pulley wheel of radius 0.125 m (1/4 the radius of the wheel) and connected to a 2 kg mass. The disk is free to rotate on an axis as shown. You let the mass fall

d) In terms of tension, find the torque, angular acceleration of the wheel and acceleration of the mass!
Torque = 0.125m*T
Alpha = Torque/I, where I = ½(4 kg)(.5m)^2
a = (20N – T)/(2kg)

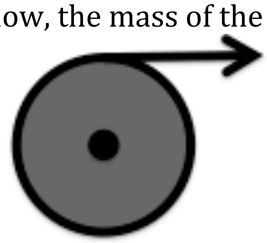
e) Solve the simultaneous equations to find the Tension and Alpha!
Alpha = 80/17s^2 = ~4.7/s^2, acceleration of the block 0.6m/s^2, T ~ 19 N

f) Find the final speed and rotational speed after the block has fallen the full 5 m. omega ~ 19/s, v ~ 2.4 m/s

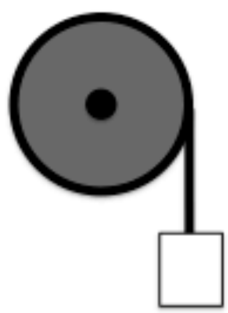
g) Find the final kinetic energy of the system, and see if it is what you expect! It should be equal to the loss of potential energy of the mass = 100J

h) Suppose that the wheel bearing has friction, causing 2 Nm of torque. How would this consideration change things? Now find the acceleration and final speeds. (Final omega ~8.5/s??). rotational work is torque * Theta = 80 Joules of lost work to heat. The bearings will get hot.

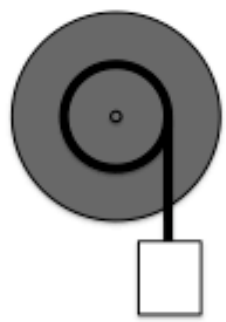
Below, the mass of the bock and wheel is 4 kg



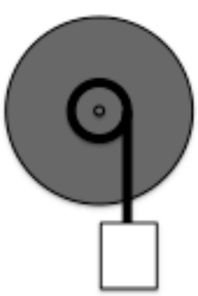
W => K_{rot}
ω_f = ~28/s
α = ~ 40/s^2



W => K_{rot} + K_{linear}
v = ω*r
ω_f = ~16/s
α = ~ 13/s^2
r = R



W => K_{rot} + K_{linear}
v = ω*r
ω_f = ~23/s
α = ~ 13/s^2
r = R/2



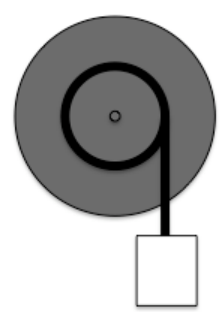
W => K_{rot} + K_{linear}
v = ω*r
ω_f = ~27/s
α = ~ 9/s^2
r = R/4

n-class #22 Angular Work, Angular Momentum Names_____________________________

. A bicycle is a beautiful thing to me. Imagine that I step down with the full force of gravity of my 70 kg body onto the pedal that is 20 cm long, and am able to maintain that force for some time as I pedal along. Let's say that I am able to rotate at 50 rotations per minute (this is about 5.2 radians / s) (most professional racers maintain over 90 rpm). Imagine that I am riding uphill at constant speed.

A) Find the torque my legs put on the pedals and the omega of the pedals. 140 Nm
B) Find the power I'm putting out. ~ 733 W
C) I'm in my highest gear, so the diameter of the pedal gear is 20 cm, and the diameter of the gear driving the rear wheel is 4 cm. Please find the tension in the chain, and the torque the chain produces on the rear wheel. T = 1400 N, Torque = 28 Nm
D) Given the speed of the chain and the tension in the chain, what is the power I deliver to the chain? ~733 W
E) What is omega of the rear wheel? What is the power the torque of the chain delivers to the rear wheel? ~ 26/s
F) If the diameter of the rear wheel is 700 mm, what is the force that the torque on the rear wheel delivers to the road (assume that there is no slipping). 80 N
G) What is the speed of the surface of the rear tire surface (which is equal to the speed of the bike)? And what is the power that this surface delivers to the bicycle? v ~ 9.2 m/s
H) At some time, I change gears, putting the chain on a rear gear cluster on a gear that is 8 cm in diameter (doubling the diameter of the rear gear), and I am able to continue putting the same amount of force on the pedals. What change to I experience? What do I notice in my pedaling? what would be the new:
   i) The torque on the rear wheel? I get twice the torque
   ii) The power to the rear wheel? I get twice the power
   iii) The speed of the chain? It must double
   iv) Omega of my legs? I have to pedal twice as fast to keep moving at this speed.

. Remember this problem at right? Please calculate



a) the torque on the wheel
b) The time it takes the 5 m of rope to unroll from the spool
c) The final energy of the rotating wheel (don't include the energy of the weight)
d) The average power delivered to the wheel
e) The power the rope delivered to the wheel at the very end of the fall.

Make a graph of the power delivered to the wheel as a function of time from the moment the mass is released to the moment that the 5 m of rope is used up.

$W \Rightarrow K_{rot} + K_{linear}$
$v = \omega * \underline{r}$
$\omega_f = \sim 23/s$
$\alpha = \sim 13/s^2$

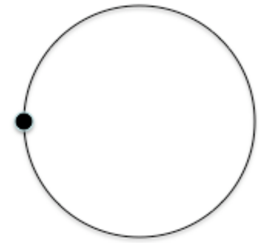
n-class #23 Nov. 17. Parallel Axis Theorem, CM Name_____________________________

1. I have a mass that is about 70 kg. I stand on the edge of aboard (hanging 10) that is 4 meters long and 130 kg. If you want to balance the board (with me on it) on the edge of an "I beam" perpendicular to the orientation of the board I am standing on, at what position under the board would you put the "I beam"? 140 cm from the edge of the board I'm standing on

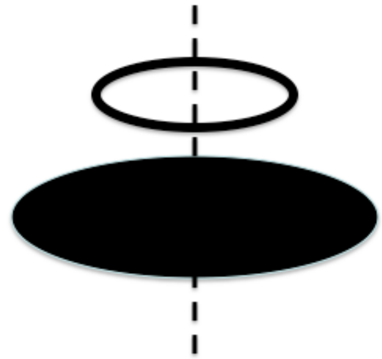
2. A steel ring of mass 2 kg, and radius 80 cm is free to rotate about one point. I let it go from rest at an angle of 90 degrees from equilibrium position (shown at right).

a) Find the angular acceleration immediately after I let it go. 6.25 $/s^2$

b) Find the angular velocity when it passes through the stable equilibrium position. ~ 3.5/s



In-class #24 Nov. 21. Conservation of angular momentum Name____________________________



1. A 4 kg bicycle wheel with all the mass on the rim at radius 0.5m is spinning on a vertical axis with omega of 10/s upward. It is dropped onto an 18 kg solid disk of radius 1 m. The solid disk is stationary but free to rotate about the vertical axis as shown. The wheel sticks to the disk after the frictional forces act between the surfaces for 0.2 seconds.

a) Describe the subsequent motion

b) Find the final rotational velocity of the system. 1/s

c) Find the change in angular momentum of the bicycle wheel (its angular impulse). -9kgm^2/s

d) Find the torque on the bicycle wheel from the frictional interaction with the disk. -45 Nm

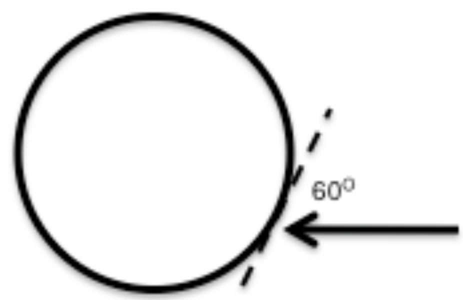
c) Find the angular acceleration of the both the bicycle wheel and the disk. -45/s^2 and +5/s^2

d) What is the initial and final mechanical energy of the system? Was energy conserved? 50 J and 5 J;

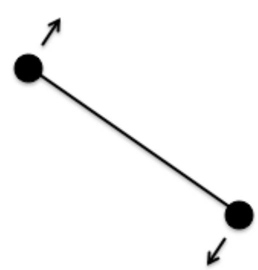
45 J was "lost" to heat.

2. A 5g bullet moving at a speed of 500 m/s strikes a 100 kg solid sphere of radius 0.5 m out in space. It strikes the surface at a 60 degree angle and sticks inside the sphere. Describe the subsequent motion and find the final rotational velocity of the sphere.

It moves with velocity 0.025 m/s and rotates with omega = 0.0625/s



In-class #25 Nov. 22. Conservation of angular momentum Name____________________________



1. Two masses are rotating about each other at angular frequency, ω_O with kinetic energy K_O in space connected by a string of length, s_O. At one moment, a motor in the middle of the string pulls the string to half the length… that is $s \Rightarrow \frac{1}{2} s_O$

How do the rest of these quantities change?

a)Angular momentum $l \Rightarrow$ ___ l_O

b)moment of inertia: $i \Rightarrow$ ___ i_O

c)Angular Velocity $\omega \Rightarrow$ ___ ω_O

d) Rotational Kinetic Energy: K => _4__ K_O

e) Is kinetic energy conserved? If so, why, if not, where did the extra energy come from (or go)? Motor?

2. Take a wheel and give it a spin. Hold it at one end of the handle, and let the spinning wheel fall. A) Describe the motion.

B) Identify the direction of the angular momentum of the spinning wheel.

C) Identify the direction of the torque put on the wheel by the force of gravity and your hand. Correlate this torque with a small change in angular momentum over a small change in time.

D) Measure the wheel diameter, assume it has a mass of m_0 which should cancel, because mass enters in torque and moment of inertia, and that all the mass is on the rim. Measure the period of precession (now long it takes to precess all the way around) and also the rotational velocity of the wheel – by counting the number of rotations in a full precession… or any other way you like. If you can't finish the calculations in time, please at least get the measurements so we can finish the calculations over the weekend. From your measurements,

i)Estimate the angular momentum of the wheel.

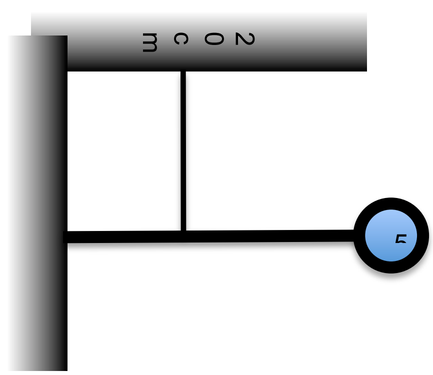
ii)Now estimate the torque on the wheel by gravity.

iii)Estimate the torque on the wheel by finding the rate of change of angular momentum… which is 2π times the angular momentum of the wheel over the time it took the wheel to precess.

How well do your answers for ii) and iii) match?

Quiz 26 Statics Nov. 28, 2011 Names:

Not printed out before: I'm 100 kg. I'm standing 1 m from the left end on a 4 m long board that is 200 kg. There are supports under the board at the left end, and 1 m from the right end. Find the forces on each support. 1333 N, 1667N



1. A 100 kg sphere is suspended in front of a store as a sign. It is at the end of a 3 m bar and a cable is connected just one meter along the bar from the store front as shown.

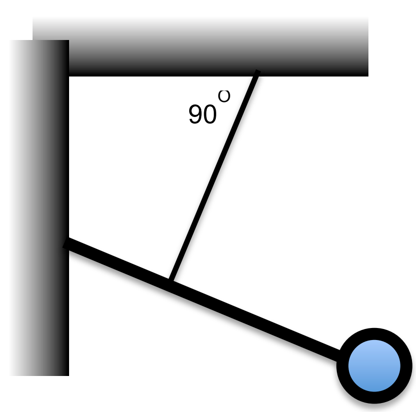
a) Label all the forces on the bar.

b) Find the tension in the cable. 3000 N

c) Find the force supplied to the bar by the store front. -2000N y

d) If the mass of the bar was 100 kg as well, what would be the tension then? 4500N

e) What would happen if we moved the cable's connection point on the bar closer and closer to the store front? How do you know?



2. A 100 kg sphere is suspended in front of a store as a sign. It is at the end of a 3 m bar and a cable is connected just one meter along the bar from the store front as shown.

a) Label all the forces on the bar.

b) Find the tension in the cable. 2600N

c) Find the force supplied to the bar by the store front.

-1300N x + -1250 y

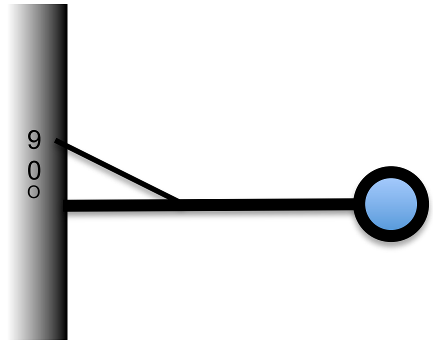
3. A 100 kg sphere is suspended in front of a store as a sign. It is at the end of a 3 m bar and a cable is connected just one meter along the bar from the store front as shown. The cable makes a 30 degree angle with the bar.

a) Label all the forces on the bar.

b) Find the tension in the cable. 6000 N

c) Find the force supplied to the bar by the store front. 5200N x + -2000N y

d) what would happen to the tension in the cable if we made that 30 degree angle smaller and smaller? How do you know?

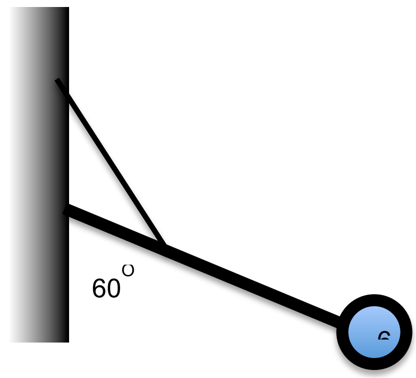


4. A 100 kg sphere is suspended in front of a store as a sign. It is at the end of a 3 m bar and a cable is connected just one meter along the bar from the store front as shown. This may be more difficult than I expect you to do.

a) Label all the forces on the bar.

b) Find the tension in the cable. 5200N

c) Find the force supplied to the bar by the store front. 2600N x + -3500N y



Quiz 27 Statics Nov. 29, 2011 Names:

1. A 50 kg 8 m ladder leans up against a frictionless wall at an angle of 60 degrees with respect to the ground. I am 70 kg, and the coefficient of static friction with the floor is a dangerous 0.40. At first, no one is on the ladder.

a) I hope you already drew a great diagram! … and labeled all the forces? And thought about all the torques?

b) How much force can we depend on the friction to provide for us? Is this the actual force friction is providing, or don't we know? 200 N. the actual amount of frictional force is going to depend on how hard we push on it. This will be equal to the normal force provided by the wall… as long as this normal force is less than 200 N. Also remember that the frictional force increases when I get on the ladder.

c) Let's see if we need more thant this… what force is pushing against the frictional force? Normal force of the wall.

d) What is the best point to measure the torques about if we want to find the amount of force that the friction is working against? Why do you know? Pick the point where the ladder meets the ground.

e) Does the ladder slip when I let it go? What is the normal force from the building? The normal force ~ 144N, which is less than the 200 N necessary to break the static friction of the ladder on the ground.

f) Now I step on the ladder at the bottom… how does this change the situation? It increases the static frictional force at the bottom of the ladder to 480 N

g) As I walk up the ladder, what changes in the problem? Does it get more dangerous? How do you know? Increase in Torque about the base of the ladder. Increases the normal force of the wall.

h) Will I make it to the top of the ladder? Find out by doing an analysis with me at the top of the ladder, and see if the ladder will slide. Show that the new normal force from the wall is is 548 N, more than enough to break the static friction… I'm going to fall.

i) If we were to do this problem again, and we lowered the angle that the ladder made with the ground, would this make the situation safer, or more dangerous? How do you know? What would this do to the torque produced by the force of gravity on me? What would this do to the torque of the normal force of the wall? What would both of these do to the size of the normal force from the wall?