Now updated for 2007!!!

1. Convert all of the following into proper mks units:
   (a) 2500 $\frac{feet}{hr}$
   (b) 3 $miles$
   (c) 2 $years$
   (d) 12000 cm^3
   (e) 45 $\frac{gram \times cm}{minute^2}$

2. You are driving along the road at 30 $\frac{m}{s}$, when you notice a deer in the road 40 m in front of you. You immediately slam on the brakes and experience an acceleration of -10 $\frac{m}{s^2}$.

   (a) Where would you come to a stop if the deer were not in your way?

   (b) How fast are you going when you reach the deer's position?

   (c) How long does it take you to get there?

   Luckily this is one smart deer. The deer runs to the side and needs to move a minimum of 1.2 meters to avoid being hit. What acceleration of the deer is necessary to just avoid the collision with your car?

3. Two trains are on the same track. Train A is in the back and is moving with a constant velocity, $v_{0A} = 12\frac{m}{s}$. Train B is ahead of train A by 50 m and is moving with a velocity of $v_{0B} = 10\frac{m}{s}$. Just at this moment Train B spots the trouble and begins to accelerate.

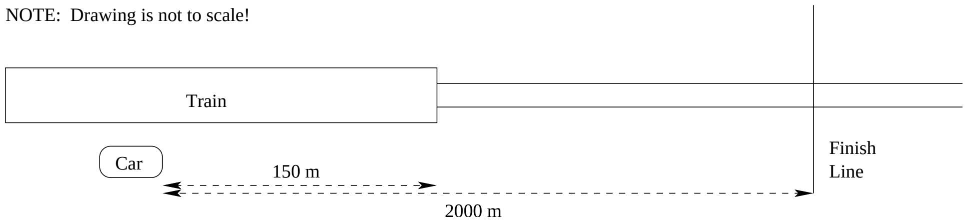
   (a) What is the minimum acceleration necessary to just barely avoid the collision (*i.e.* the trains just touch without crashing).

   (b) What is the velocity of each train when they touch?

   (c) Where are they located when they touch?

   (d) When do they touch?

4. You are a reckless teen racing a train in your car as shown in the figure below. Initially, you and the train both have a velocity of 20 m/s, but the train is ahead of you by 150 meters. The train moves with constant velocity and you accelerate in an attempt to reach the finish line before train does.

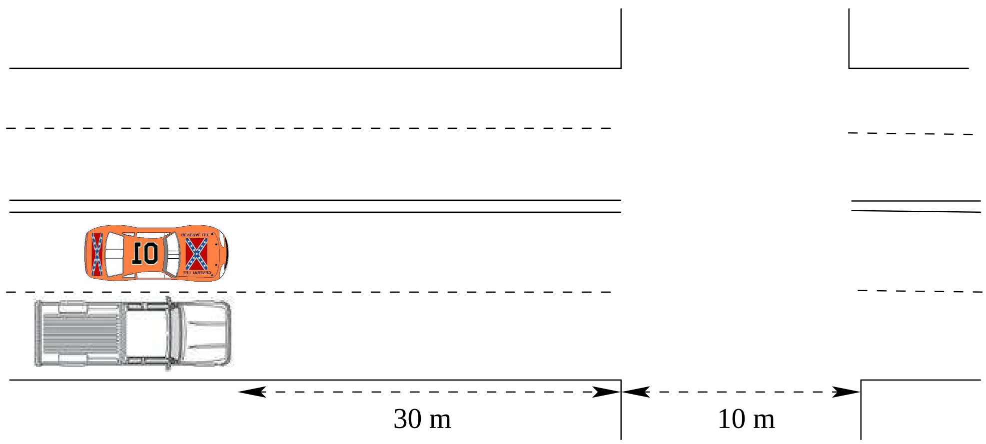


(a) (6 pts) How long does it take the train to reach the finish line?

(b) (7 pts) What acceleration is necessary for you to reach the finish line at the same time as the train?

(c) (7 pts) How fast are you going when you reach the finish line?

5. Bo and Luke Duke are driving in the *"General Lee"* (a famous sports car), and Cooter is driving the pickup truck as shown in the figure below. Both vehicles are moving with initial velocities of 15 $\frac{m}{s}$. When the light changes to yellow, both vehicles are 30 meters from the entrance of the intersection. Bo hits the gas and experiences an acceleration of $+7\ \frac{m}{s^2}$. Cooter hits the brakes and has an acceleration of $-3.2\ \frac{m}{s^2}$.



(a) (7 pts) The light will stay yellow for 2 seconds. Where is the General Lee when the light changes to red?

(b) (7 pts) Where does Cooter come to a stop?

(c) (6 pts) What is the speed of the General Lee as it leaves the intersection (x=40 m).

6. Vector A has a magnitude of 12 $\frac{m}{s}$ and is pointed East. Vector B has a magnitude of 20 $\frac{m}{s}$ and is pointed 30 degrees North of West.

   (a) Find the magnitude and direction of $\vec{A} + \vec{B}$.

   (b) Find the magnitude and direction of $\vec{A} - \vec{B}$.

   HINT: Does your calculator always give you the right result for inverse tangent?

7. One fine morning you decide to take a walk. First, you walk 2 km in a direction 30^o North of East (call this motion vector $\vec{A}$). After this, you continue your walk by moving a distance of 3 km in a direction of 10^o South of West (call this motion vector $\vec{B}$). Then you get a text message on your cell phone requesting that you return home ASAP!! Throughout this problem please use East as the "x" coordinate and North as the "y" coordinate.

   (a) (6 pts) Express the $\vec{A}$ and $\vec{B}$ displacement vectors in component form.

   (b) (7 pts) How far away from home are you when your cell phone rings (Please calculate the *magnitude* of the resulting vector, not just the components)?

   (c) (7 pts) What is the direction from "home" to "you" when the phone rings.

   NOTE: Please express your direction answers with respect to the x axis (as a mathematician would).

8. You launch a projectile at an angle of 30^o above the horizontal from the top of a 10 m tall building. The initial velocity, v_0, of the projectile is 14 $\frac{m}{s}$. Answer all of the following:

   (a) What is the maximum height achieved by the projectile?

   (b) At what time does it reach the maximum height?

   (c) When does the projectile hit the ground?

   (d) Where does the projectile hit the ground?

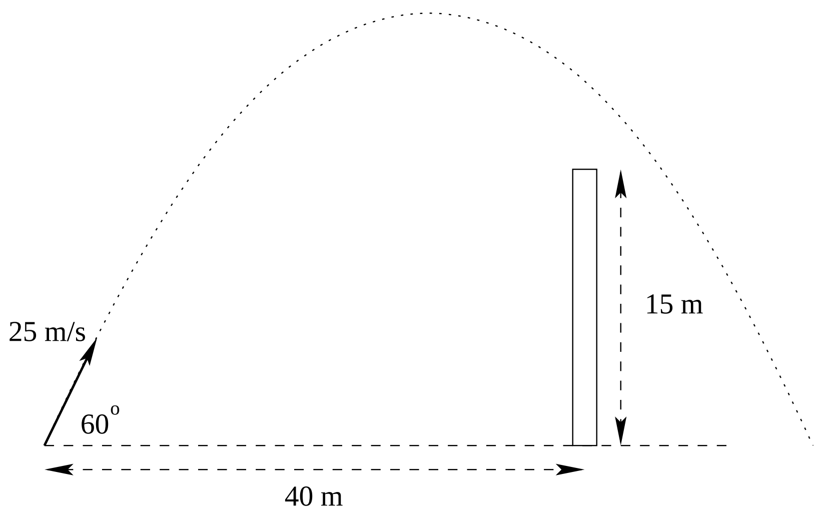
   (e) What is the vertical component of the velocity, v_y when the projectile is 5 meters above the ground?

   (f) What is the vertical component of the velocity 2 seconds after the projectile is launched?

   (g) What is the magnitude of the velocity of the projectile when it is at a height of 2 m off the ground?

   (h) What is the direction at which the projectile is traveling at the moment mentioned ion the previous step?

9. Shrek rode on the shoulders of a giant cookie to get past a tall wall and win his love. You've *eaten* too many cookies to get this kind of cooperation and so you build a catapult to launch yourself over the wall as shown in the figure below (good thing that you're an ogre and can survive the landing!).



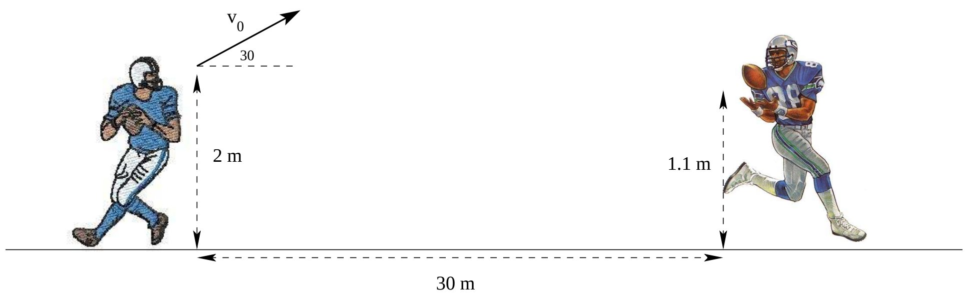
(a) (5 pts) What is the maximum height you reach?

(b) (5 pts) When do you pass over the wall?

(c) (5 pts) What is your height as you pass over the wall (assuming you pass over)?

(d) (5 pts) What is the *magnitude* of your velocity as you sail over the wall?

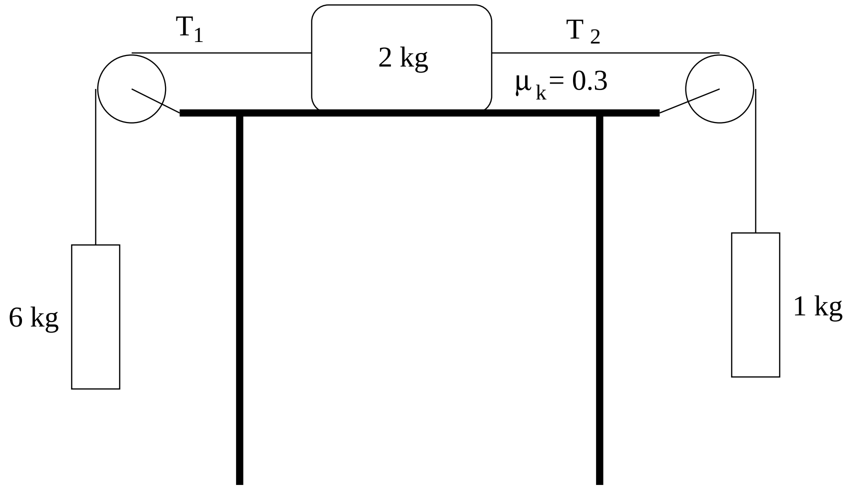
10. You are the quarterback for an NFL team. There is time for only one more play and you need a touchdown. You throw the ball from an initial height of 2 meters at an angle of 30 degrees. Your target is your receiver's arms, 30 meters away and 1.1 meters above the ground. The fans are all hoping that you *succeed*.



(a) (10 pts) What is the initial velocity, v_0, of your throw?

(b) (10 pts) When is the ball caught (time of the catch)?

11. Shown in the Figure below is a system of blocks connected by strings. The central block slides on a table *with friction.* The coefficient of kinetic friction is indicated in the figure.



Find all the following:

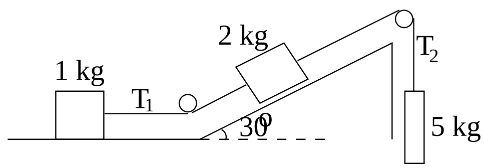
(a) (2 pts) The normal force on the central block.

(b) (6 pts) The acceleration of the system.

(c) (6 pts) The tension T_1.

(d) (6 pts) The tension T_2.

12. Shown in the figure below is a system of three masses connected by strings. The coefficient of friction in all cases is $\mu_k = 0.2$. Find all the following:



(a) The normal force on the 1 kg block.

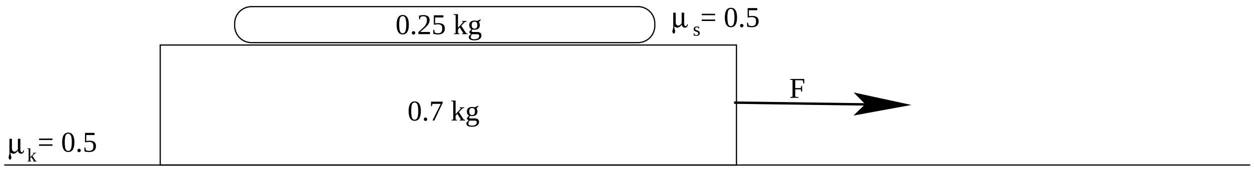
(b) The normal force on the 2 kg block.

(c) The acceleration of the system.

(d) The tension T_1.

(e) The tension T_2.

13. Shown in the figure below is a magazine resting upon a book. If you pull gently upon the book, the magazine will move with it. If you pull strongly on the book, the magazine will slip. Let's assume you pull with enough force that the magazine *just barely* manages to move without slipping.

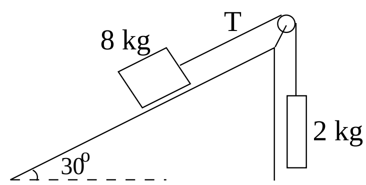


(a) What is the force required to satisfy this condition?

(b) What is the acceleration in this case?

HINT: Don't forget the force of the magazine on the book in addition to the force of the book on the magazine!!

14. Shown in the figure below is a system of blocks connected by a massless string running over a massless pulley. The coefficient of friction on the ramp is $\mu_k = 0.1$. The 8 kg block is sliding *down* the ramp. Find all the following:

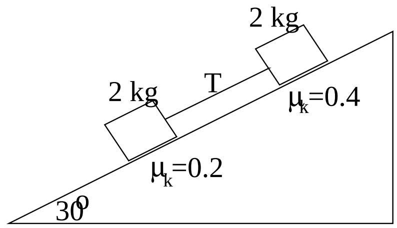


(a) (6 pts) The normal force on the sliding block.

(b) (7 pts) The acceleration of the system.

(c) (7 pts) The tension, T, in the cord.

15. Shown in the figure below are two blocks placed upon a ramp and connected by a string. The upper block is rough on the bottom and high a higher coefficient of friction with the ramp. Find all the following:



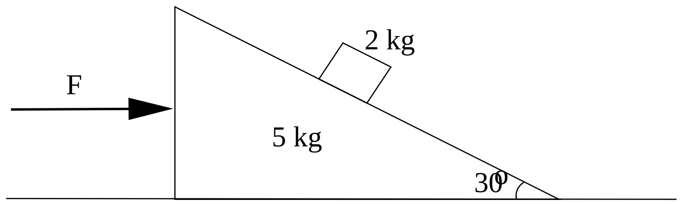
(a) The normal force on each block.

(b) The acceleration of the system.

(c) The tension in the string.

16. The figure below shows a small mass resting on a ramp. The ramp is free to slide frictionlessly across the table and the small mass is free to slide frictionlessly up or down the ramp.

By pushing in the ramp with the force, $\vec{F}$, you cause the system to accelerate. With just the right value of the force, the block will neither slide up nor down the ramp (*i.e.* with more force the block would slide up the ramp and with less force the block would slide down the ramp). Find all the following:

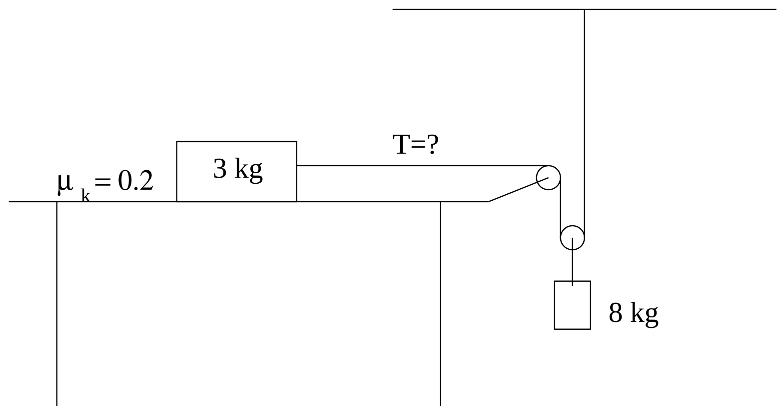


(a) The acceleration of the system for which the block neither slides up nor down.

(b) The force necessary to produce this condition.

(c) The Normal force between the ramp and the block.

17. Shown in the figure below is a series of blocks and pulleys. The 3 kg block will slide along the surface and experience an acceleration a.



(a) How would you compare the acceleration of the 8 kg block to that of the 3 kg block? Same, half, or twice?

(b) Calculate the acceleration of the 3 kg block.

(c) Calculate the tension in the cord.