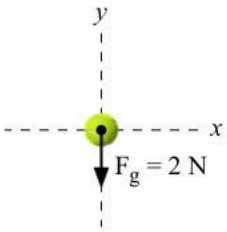
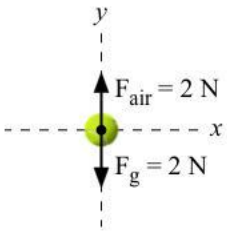
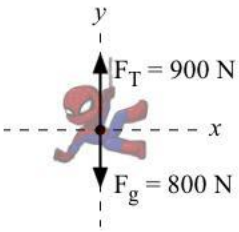
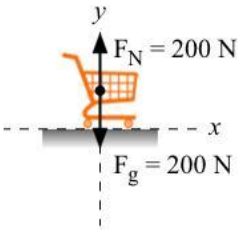
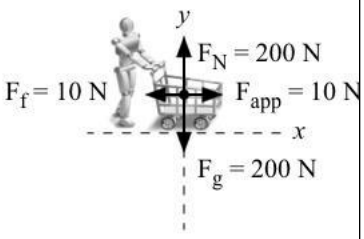
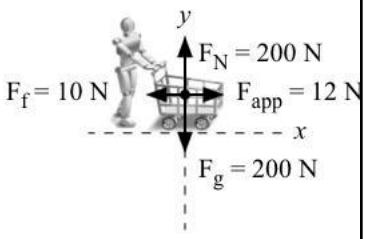
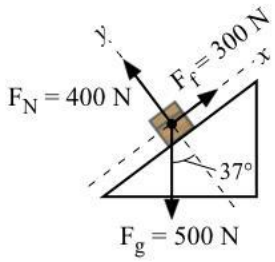
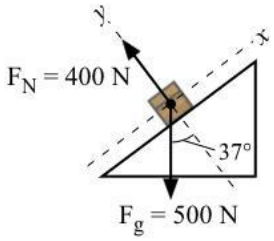
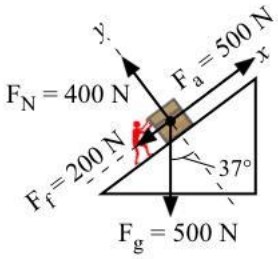
Net Force & Newton's 2nd Law

PE1: The diagrams below show several forces acting on an object. In each case, calculate the net force (a.k.a. the resultant force) including direction.

Falling Ball	Falling Ball w/ Air Resistance	Swinging Spider-Man
		
F_{net} = _____	F_{net} = _____	F_{net} = _____
Shopping Cart	**Pushing Shopping Cart**	**Pushing Shopping Cart**
		
F_{net} = _____	F_{net} = _____	F_{net} = _____
Crate on Incline	**Crate on Frictionless Incline**	**Pushing Crate on Incline**
		
F_{net} = _____	F_{net} = _____	F_{net} = _____

SKIP THE BOTTOM THREE IMAGES UNTIL WE HAVE STUDIED INCLINED PLANES toward the end of this chapter..

In which situations is the object accelerating? In which situations is the object either stationary or moving with constant velocity?

PE2: A net force F acts on a box of mass m. The box accelerates with an acceleration a. If a net force $2F$ acts on a box of mass $4m$, determine the acceleration of the box?

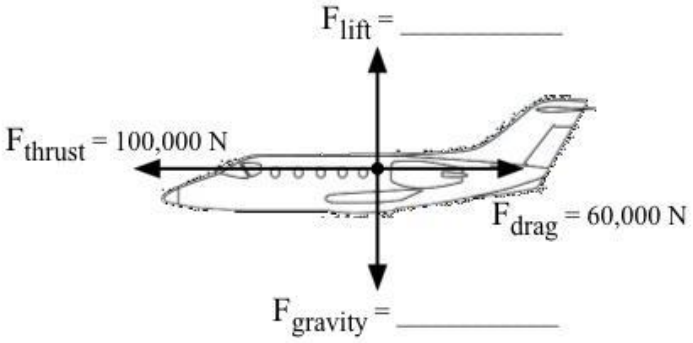
Forces & Single Body Dynamics Problems

PE3: The acceleration due to gravity at the surface of the moon is approximately one-sixth the acceleration due to gravity at the surface of the Earth. The mass of a suited astronaut on the surface of the Earth is 120 kg. The weight of the astronaut on the surface of the Earth is approximately 1200 N. Which of the following statements about the mass and weight of the astronaut on the moon is correct? Justify your answer choice.

a) The mass of the astronaut is 20 kg and the weight is 200 N.
b) The mass of the astronaut is 20 kg and the weight is 1200 N.
c) The mass of the astronaut is 120 kg and the weight is 200 N.
d) The mass of the astronaut is 120 kg and the weight is 1200 N.

PE4: Consider the free body diagram for the jet plane shown below. The plane has a mass of 5000 kg and is in level flight traveling parallel to the ground.

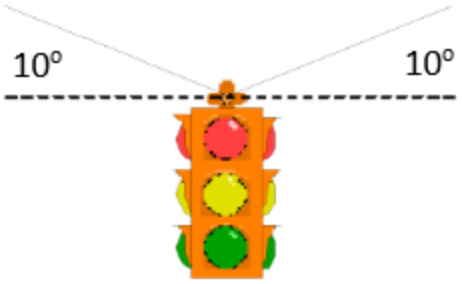
A) Complete the free body diagram with values for the force of gravity and the lift force. Justify your answers with either work or an explanation to the right of the picture.

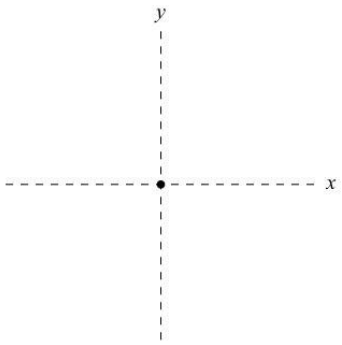


B) Calculate the acceleration of the plane.

C) If all other forces remain unchanged, what thrust force would be needed to maintain a constant speed for the plane? Justify your answer.

PE5:

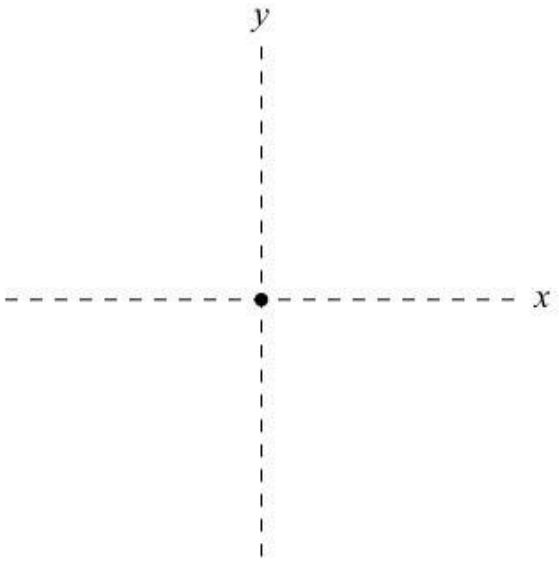




A traffic signal is suspended from two cables as shown above. The ends of the cables are attached to poles not shown in the diagram. The mass of the sign is 50 kg.

A) Draw the free body diagram on the axes above. DO NOT INCLUDE COMPONENTS!

B) On the axes below, redraw the diagram and, using appropriate trigonometry, include the components for each tension.



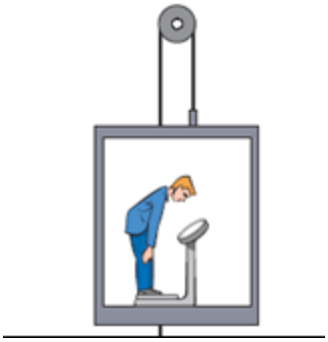
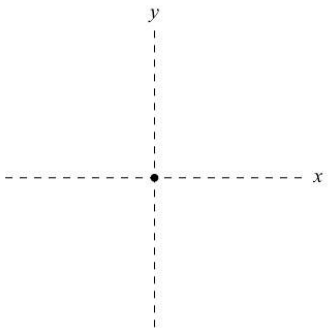
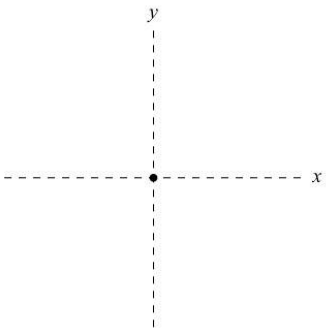
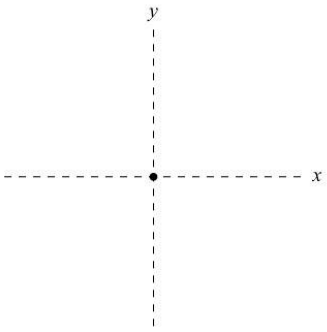
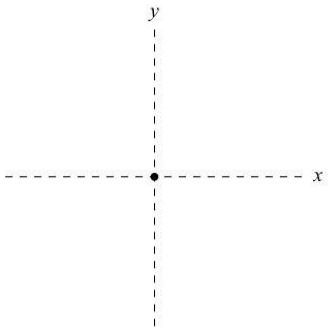
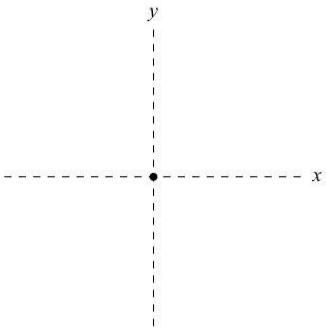
C) Write the equation to balance the horizontal forces in the free body diagram.

D) Write the equation to balance the vertical forces in the free body diagram.

E) Use your equations from parts C) & D) to solve for the tension in the cables.

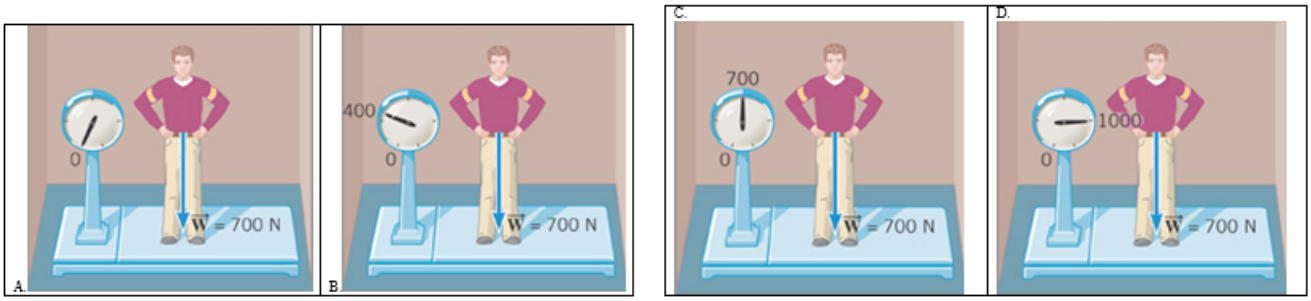
F) Explain why it is impossible for both cables to be perfectly horizontal.

PE6: A 70-kg person stands in an elevator on a bathroom scale. For each of the situations described below, draw the free body diagram for the man. Do not include any numbers, but clearly indicate whether the normal force is less than, equal to, or greater than the force of gravity by drawing appropriate length vectors.

	Stationary	Moves at constant speed of 0.4 m/s
		
Accelerates upward at 0.5 m/s/s	**Accelerates downward at 0.5 m/s/s**	**Accelerates downward at 10 m/s/s**
		

A)	Calculate the force of gravity on the person and label it in your free body diagrams above.	F_g =	
		Net Force	Normal Force
B)	What is the net force acting on the person when the elevator is stationary? What is the normal force acting on the person when the elevator is stationary?		
C)	What is the net force acting on the person when the elevator moves at constant speed? What is the normal force acting on the person when the elevator moves at constant speed?		
D)	What is the net force (including direction) acting on the person when the elevator accelerates upward at 0.5 m/s^2. What is the normal force acting on the person?		
E)	What is the net force (including direction) acting on the person when the elevator accelerates downward at 0.5 m/s^2. What is the normal force acting on the person?		

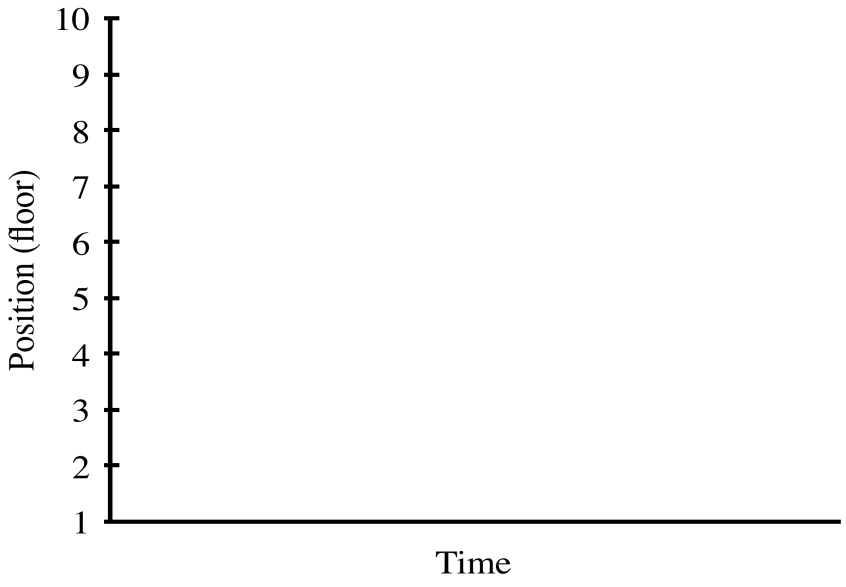
PE7:



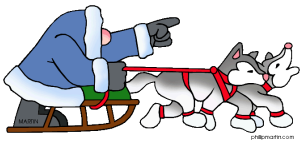
The man above takes an elevator trip described by the steps below. Match each descriptions of the elevator's motion below with the correct picture shown above. Pictures may be used more than once.

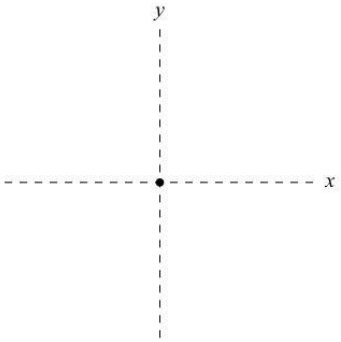
Elevator doors close on 1st floor and it has not yet moved	
Elevator first begins moving upward toward 10th floor	
Elevator rises at constant speed toward 10th floor	
Elevator arriving at the 10th floor	
Elevator stopped at 10th floor	
Elevator first begins moving downward toward 7th floor	
Elevator descends at constant speed toward 7th floor	
Elevator arriving at the 7th floor	
Elevator stopped at the 7th floor	
Cable snaps and elevator undergoes free fall	

On axes below, sketch a possible position versus time graph for the trip described above.



PE8: Sled dogs pull a sled and driver (with a combined mass of 100 kg) across the snow at constant speed. The coefficient of kinetic friction between the sled and the snow is 0.1. Draw the free body diagram for the sled and use it to calculate the tension force in the rope connecting the dogs to the sled.



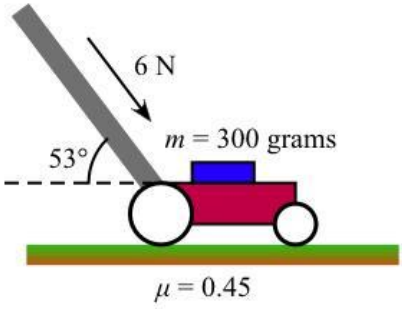


PE9:

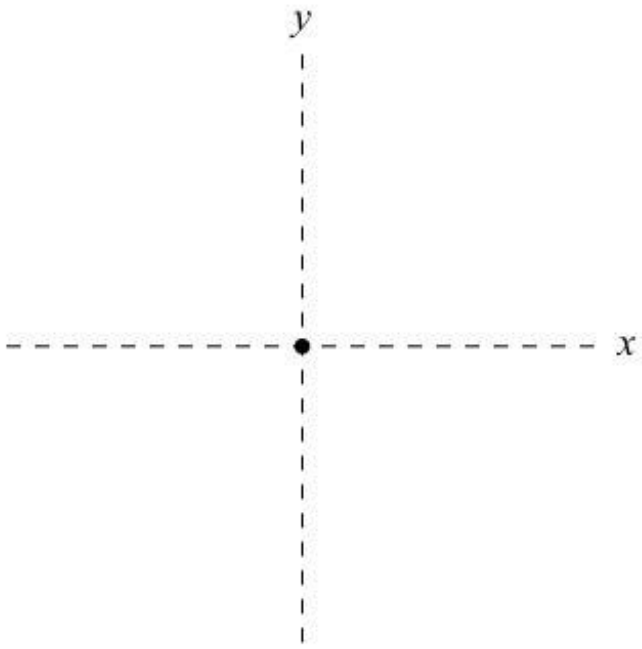
A crate rests on the bed of a pickup truck as shown above. The truck accelerates to the left as shown and the crate does not slide along the truck bed. Which of the following statements about the frictional force acting on the crate is true?

a) There is no frictional force acting on the crate since it is not moving relative to the truck bed.
b) A frictional force acts to the right to oppose the motion. It is kinetic friction since the crate is moving to the left.
c) A frictional force acts to the right to oppose the motion. It is static friction since the crate does not move relative to the truck bed.
d) A frictional force acts to the left to accelerate the crate with the truck. It is kinetic friction since the crate is moving to the left.
e) A frictional force acts to the left to accelerate the crate with the truck. It is static friction since the crate does not move relative to the truck bed.

PE10:



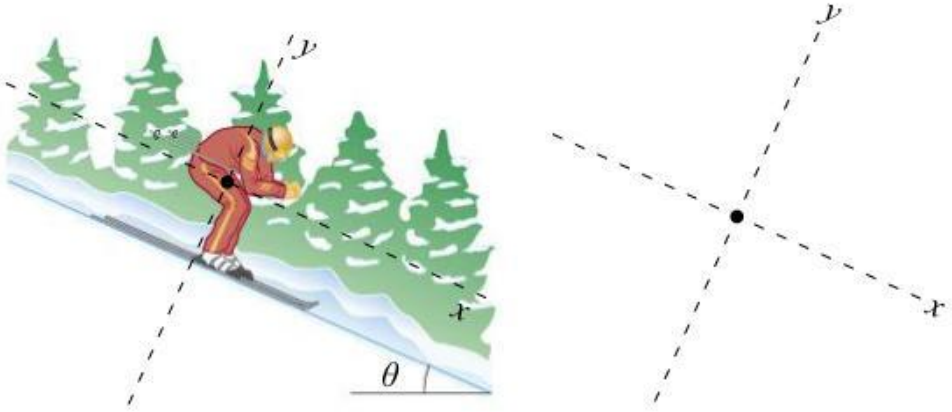
A child applies a force of 6 N downward along the handle of the toy lawn mower shown above. Determine the acceleration of the lawn mower.



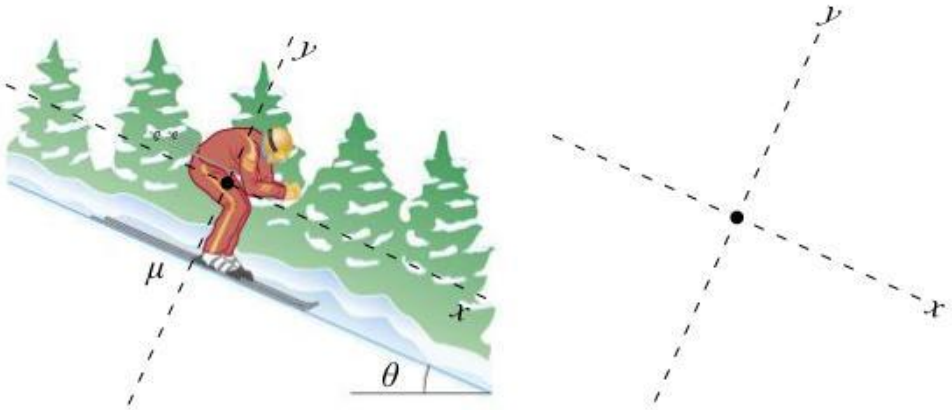
Dynamics Problems on Inclines

PE11: A skier slides down a hill inclined at an angle θ above the horizontal. Determine:

A) the acceleration of the skier if friction is negligible.

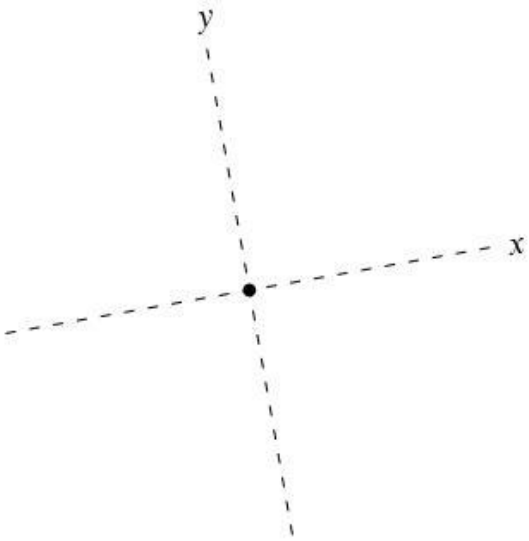


B) the acceleration of the skier if the coefficient of kinetic friction is μ.



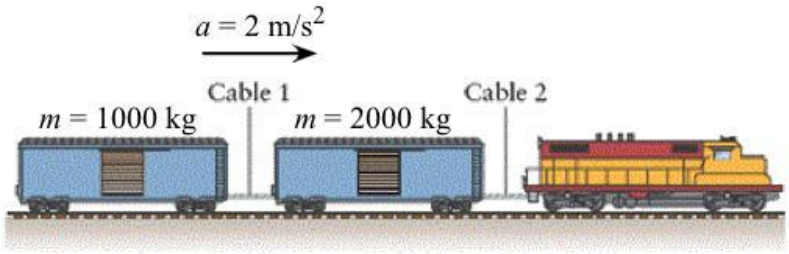
C) Assume the hill is inclined at 15° and the coefficient of kinetic friction between the skis and the snow is 0.1. If the skier starts from rest, determine the speed of the skier after ten seconds.

PE12: Ed pushes a 50-kg sofa up a moving ramp at constant speed. The ramp makes an angle of 10° with the horizontal. The coefficient of kinetic friction between the sofa and the ramp is 0.3. Determine the force that Ed must exert parallel to the ramp.



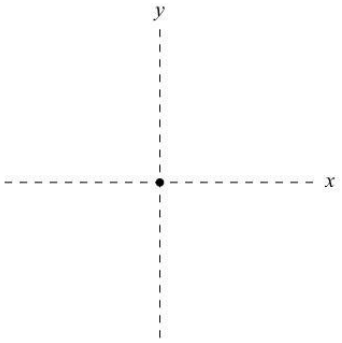
Two-Body Dynamics Problems

PE13:

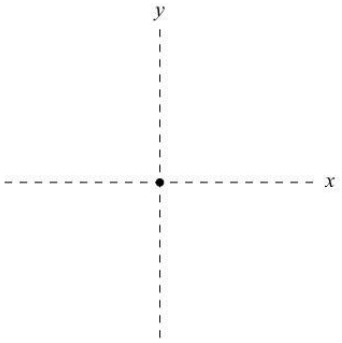


Two train cars are pulled forward with an acceleration of 2 m/s^2 as shown. Neglecting friction between the wheels and the track, determine the tension in Cable 1 and Cable 2.

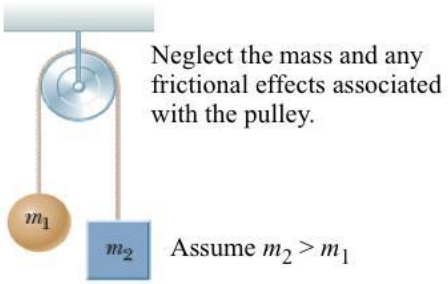
1000 kg car



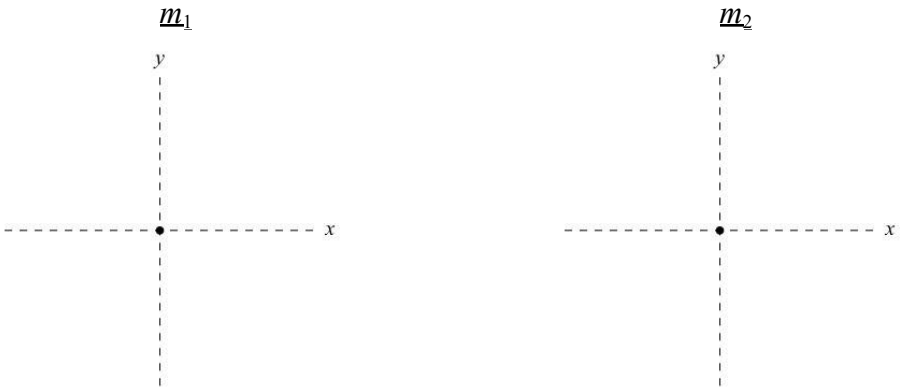
2000 kg car



PE14: The arrangement shown below is known as Atwood's machine.

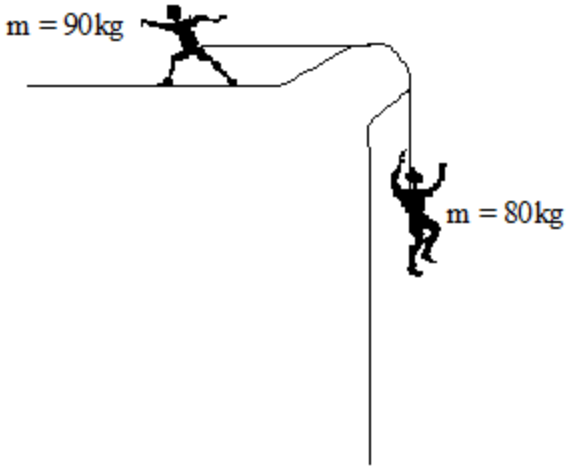


A) Determine a general formula for the acceleration of the masses in terms of m_1, m_2, and g.



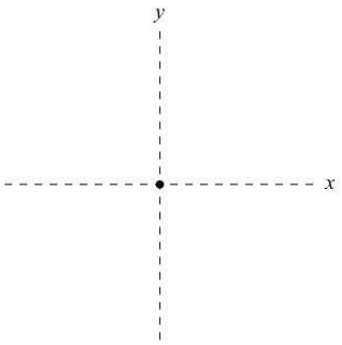
B) Assume the masses are 2 kg and 3 kg. Determine the magnitudes of the acceleration of the masses and the tension in the string.

PE15:

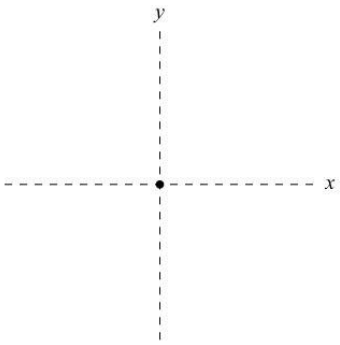


Mike and Mark go exploring. A safety rope connects the two. Mike falls over the edge of a cliff. Neglect friction between the rope and the ground. The coefficient of friction between Mark's feet and the ground is 0.2. Determine the magnitude of the acceleration of the two men.

Mark



Mike



Whole Body