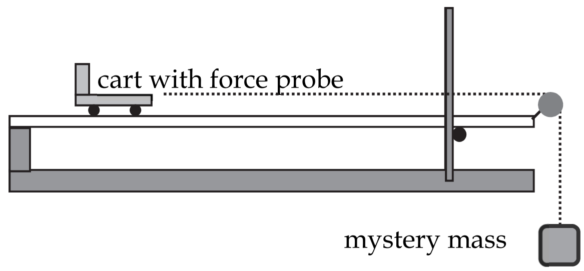
Experiment IV - Dynamic Forces

The apparatus consists of a cart and track as in Experiment I, but now with a pulley at the end of the track. A horizontal string connects the cart to a mass that hangs over the pulley. The cart has a force probe attached, which measures the tension in the string.



Activity 1 “Zero” the force probe with the cart sitting on the track and without the string attached (“0” icon near right of button bar).

Start with the cart as far from the pulley as the string allows. Start Logger*Pro* and hold the cart stationary for about two seconds after Logger*Pro* begins collecting data, then release the cart.

Sketch your data on the axes below. You may, of course, repeat the experiment as necessary.

Activity 2 Assume that the force measured by the force probe is equal to the tension in the string. Mark on your sketch the tension in the string while the cart is stationary. Mark on your sketch the tension in the string while the cart accelerates.

You can get numerical values by averaging the data points as the cart is at rest or as it accelerates. Using Logger*Pro*, select the data points you want, then choose Statistics from the Analyze menu. Write these values in on your sketch.

Draw a free-body-diagram for the cart *M* and another one for the hanging mass *m*.

Is the tension-when-hanging T_H equal to the weight of the hanging mass *m*? Why or why not?

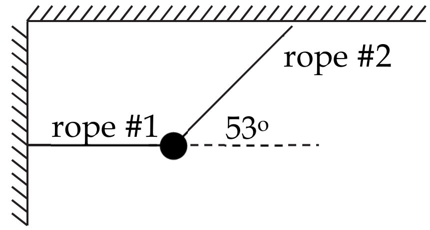
Is the tension-when-falling T_F equal to the weight of the hanging mass *m*? Why or why not?

Graded Activity: [25%; 50%] **Use your measurements of T_H and T_F to determine the mass of the cart *M*** (including the force probe)**.** You should repeat the experiment three or four times and average the values.

Instructor Initials: ____________________	Date: __________

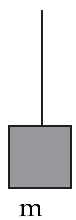
Forces

(1) A 50 kg mass is suspended using ropes as shown. Find the tension in each rope.



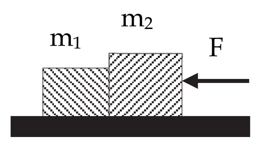
(2) **Free body diagrams.** Each situation contains labeled masses. For each object, draw a free body diagram identifying and labeling all forces acting on it. Lines represent ropes. Assume the mass of the ropes is small and can be neglected and that there is no friction. Note that separate forces need to have unique symbols (thus the weights of m_1 and m_2 can't both be labeled "w" or "mg"; "w_1" and "w_2" or "m_1g" and "m_2g" would be good labels).

a)



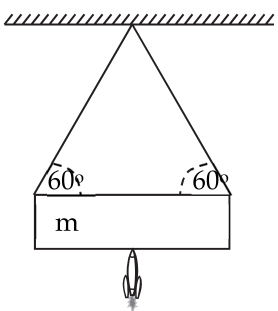
m is pulled by the rope and accelerating upwards.

b)



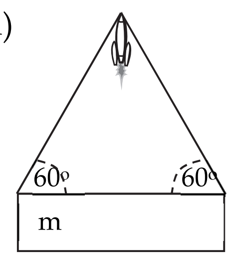
The masses lie on the floor. m_2 is being pushed by force *F*. Draw separate diagrams for the blocks.

c)



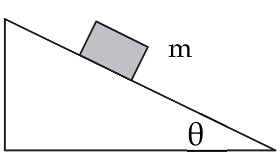
The ropes are attached to the ceiling and taut.

d)

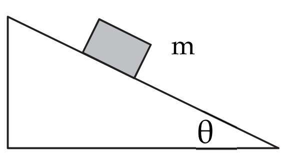


The entire assembly is accelerating downwards.

e)

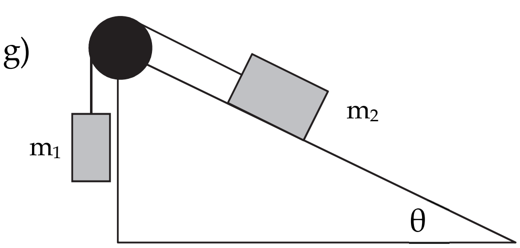


f)



Friction is holding the mass in place.

g)



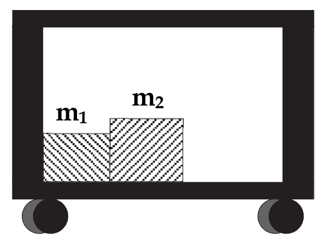
(3) This problem refers to Figure 2c above with m = 400 kg.

a) Suppose the rocket is not present and the beam is not accelerating. What is the tension in each rope?

b) Now, suppose instead that the rocket is present and firing and the tension in each rope is 1000 N. What force must the rocket exert on mass m so that the beam does not accelerate?

(4) In Figure 2d above, m = 400 kg. Initially the mass is moving upwards at 12.0 m/s. Four seconds later its velocity is 16 m/s downwards. Assuming constant acceleration, what is the tension in the ropes during those four seconds?

(5) The car is accelerating to the right at 3.0 m/s^2, m_1 = 10 kg and m_2 = 20 kg.



a) What is the net force on m_2?

b) What is the force exerted on m_2 by m_1?

c) What is the force exerted on m_1 by m_2?

d) Jeopardy question: The question is similar to the first part and the answer is 30 N. What is the question?

e) What is the force exerted on m_1 by the left wall of the car?