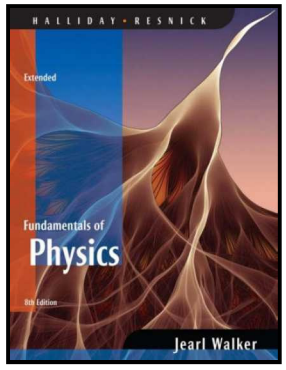
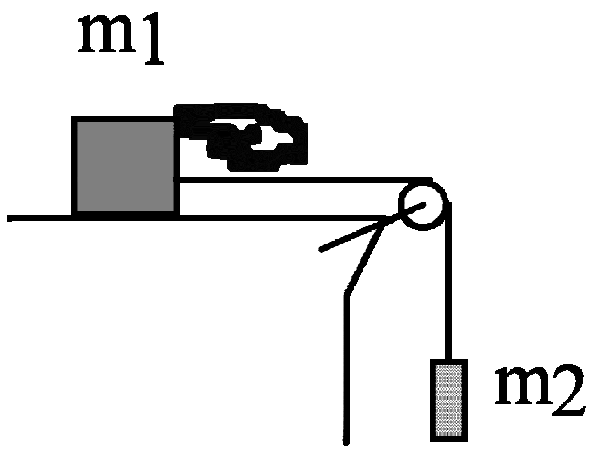
University Physics I

Week 5 : Day 1



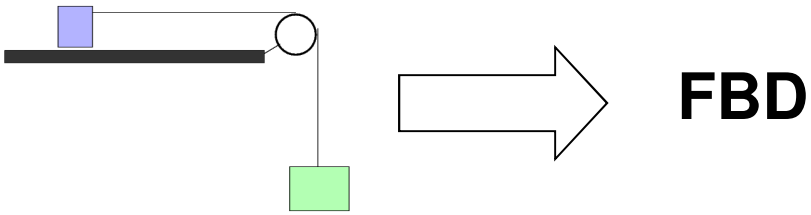
Problem 5

- **Two blocks, masses m_1 and m_2, are connected by an ideal string passing over an ideal pulley. One block is on a horizontal frictionless surface and the other can move vertically and only touches the string. Find the acceleration of each block and the tension in the string in terms of the masses and constants.**



Activity – Modified Atwood Machine

- **Modified Atwood Machine**
  - Set-up experimental apparatus



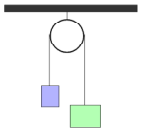
  - Procedure
    - *Using a stopwatch, measure the time it takes the cart to slide various distances*
      - Make at least three trials at each distance, and write a neat table with all your measurements.
    - *Make a graph of your measurements.*
      - Place time squared on the horizontal axis, and distance moved on the vertical axis. Fit a straight line to the data, and compute its slope. **Also** compute the uncertainty in this slope.
    - *What are the units of the slope?*
      - What does the slope represent?
      - Use your kinematics equations to understand what the slope of a plot of distance as a function of time squared means.

$$x(t) = x_0 + v_0 t + \frac{1}{2} a t^2$$

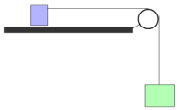
Modified Atwood Machine

Today you will use a "modified Atwood's machine" to compare the actual forces and accelerations of objects to the values you derive from theory.

What's an *Atwood's machine*? Simply a device in which two objects are connected by a cord over a pulley, so that as one falls down, the other rises:



Our device is "modified" by placing one of the objects (a cart) on a horizontal table.



If there is no friction, draw a free-body diagram for the cart, which has mass M_c, and write out the equation for its motion along the track. You should end up with one equation and two unknowns.

Draw a free-body diagram of the hanging weight, which has mass m_h, and write out the equation for its motion as it falls. Again, you should end up with one equation and two unknowns.

The unknowns will be the tension in the rope, and the acceleration. Solve for the acceleration.

Using Newton's Second Law: Acceleration

Set up a modified Atwood's machine of your own.

First, gather a cart, a force sensor with hook, plus a pair of mass bars. We aren't going to connect the force sensor to the computer, we're just using it to increase the mass of our cart. Level the track as best you can (use an unweighted cart to determine if it is out of level).

Put a track on the table and attach a pulley to one end. Get one of the blue mini-mass sets from the shelf and figure out how to assemble a hanging mass of 15 grams. Attach this hanging mass to a long piece of string, so that it can pull the cart from one end of the track almost to the other end.

Verify that you can cause the cart to roll smoothly from a standing start over a distance of at least 60 or 70 cm.

For Next Time

- **Submit a summary (each person) for the Modified Atwood Experiment – including the following:**
  - A table of data
    - *Indicate all units and uncertainties for data*
  - A graph of the data
    - *Graph the data by hand*
    - *Determine the slope*
  - Analysis of data
    - *Estimate the error in the slope*
    - *Compare the slope value with the predicted value*