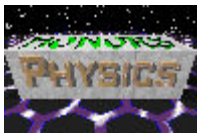


HONORS PHYSICS

L524A : Atwood's Machine

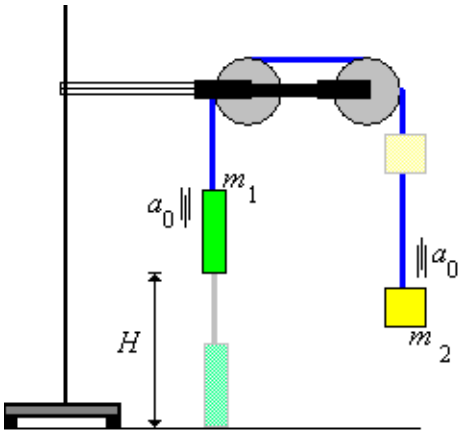
created: 2007 1112 revised: 2008 1105

OVERVIEW

The somewhat pretentious name of "the simple Atwood Machine" is given to a system consisting of two weights connected by a light string hung over a pulley. If the masses are unequal, each will accelerate when released. In this lab, you will use Newtonian analysis to derive a theoretical value for that acceleration. Then you will construct an Atwood Machine and check your prediction.

THEORY

Consider the simple Atwood machine at right. Let $m_1 > m_2$. It should be clear that m_1 will descend with a constant acceleration a_0 while m_2 rises at the same rate. That rate will depend on the masses, of course, and can be computed using standard Newtonian methods (free body diagram, second law, etc.)



You'll use the LabQuest plus a sensor called a *photogate* to measure the velocity, which will let you fit the acceleration. The photogate is an electric eye that senses when its beam is interrupted; by measuring how often this happens, the photogate can tell us how fast the string on the pulley is moving.

It should be possible to get agreement to within about 6% without excessive effort.

PROCEDURE

There are two parts to this lab:

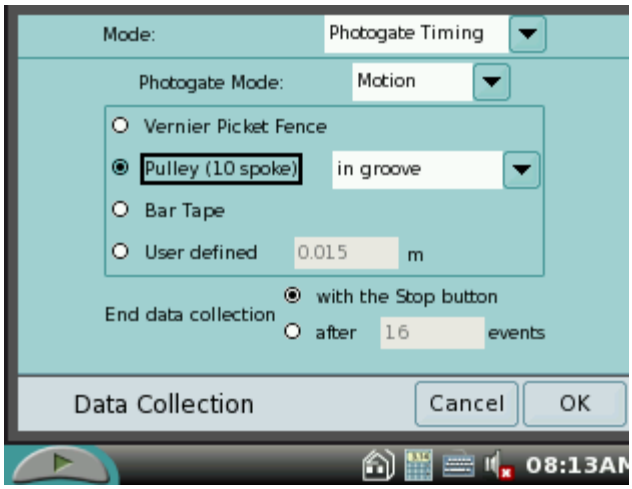
(a) You will take acceleration data on the Atwood's Machine.

(b) You will derive a theoretical expression for the acceleration and compare it to your data.

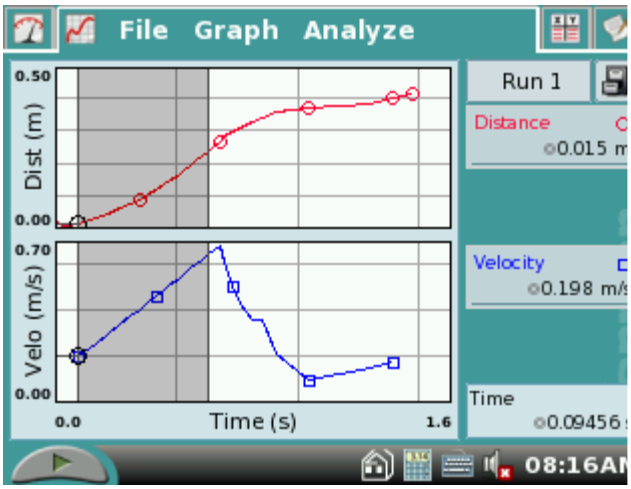
Working out the theoretical expression is a good opportunity for practice in Newtonian problem solving. You find result should give a_0 as a function of m_1 and m_2 (and will include g). In your work, assume $m_1 > m_2$.

In building the Atwood machine, you will need to allow room for the mass to descend. Cut enough string that one hanger rests on the table when the other is as high as it can go.

Turn on the LabQuest and connect the photogate to Digital 1. Press Sensors ➔ Sensor Setup and choose "Photogate" for Dig 1. Press OK. On the main screen, press on "Photogate mode" and select "Pulley". (See next page for screenshot.) Press OK.



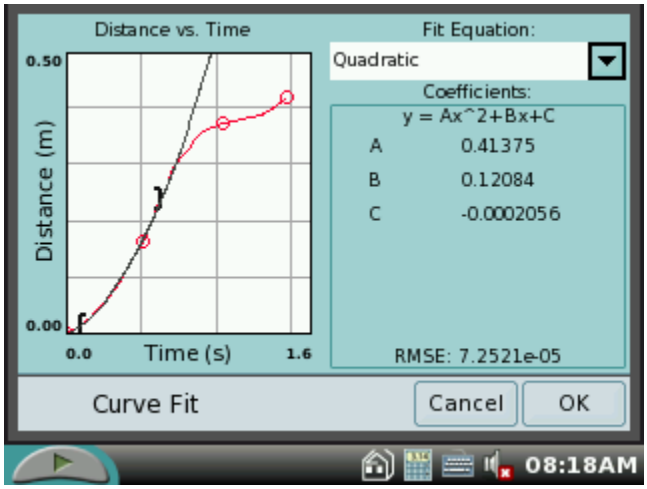
Photogate setup



A good run

Put the appropriate masses on the two hangers, supporting them with your hands. Keep in mind that the hangers also have a mass (50 grams). When ready, have one partner press the Play button and, when the LabQuest is ready, release the hangers. When the heavy hanger hits the table, you might have to press Stop on the LabQuest.

What comes out should look like the screen shot above. Fit to the parabolic-looking region (like the one highlighted). Select Analyze ➔ Curve Fit ➔ Distance, then fit a parabola. Remember that the acceleration is twice the value of **A** listed. In the given example, the acceleration would be 0.8275 m/s^2.



Record this value and conduct a new run. Do three runs for each mass. If there is time, go back and conduct a fourth and fifth run for each mass.

Analysis

Important: Remember that the hangers themselves mass 50 grams.

- Compute the mean acceleration and the error bar.
- Produce a plot of a v. δm and include the error bars.
- Fit a line to this data. The slope of the line is related to the value of g. Find the slope and then find g from it.
- Compute a percentage difference between "your" g and the accepted value, 9.8 m/s^2.
- Is your value acceptably close to the standard value?
- Address what might have made your value differ.