Experiment 5: Atwood's Machine

In 1784, George Atwood created a device to calculate force and tension and to verify the laws of motion of objects under constant acceleration. His device, now known as an Atwood's Machine, consisted of two masses, m_1 and m_2, connected by a tight string that passes over a pulley, as seen in Figure 1. When the masses are equal, the pulley system is in equilibrium, i.e. balanced. When the masses are not equal, both

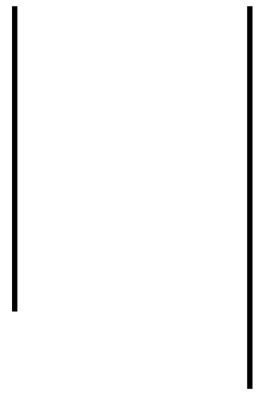

Figure 2: Free body diagrams for the masses of the Atwood Machine. The tension T is shown in blue and

Devise an experimental procedure to measure the acceleration of the masses on the Atwood's machine for 5 different mass combinations of m_1 and m_2, but keeping the sum of the masses $m_1 + m_2$ constant. That is, if you decrease m_1 by a set amount, increase the other mass (m_2) so that the total mass is always the same. You should compare the measured accelerations with those calculated from Eq. 3.

Verify that a plot of **F** vs **a** will give you a straight line with a slope equal to the total mass (see Eq. 4). Don't forget to include error bars on your graph.

Devise an experiment to measure the gravitational acceleration constant g. Do at least 6 different runs where one mass is held constant while the other mass increases by 10 g increments.

Make a plot of **a** vs $(m_1 - m_2)/(m_1 + m_2)$ in your lab report. Explain what the slope of this graph represents.

Questions

Answer these questions in your lab report. Show all work.

1. Calculate the tensions in the string for the second experiment.
2. What is the relationship between the acceleration and the total mass when the force is held constant?
3. How do these measurements compare with calculations using equation 3? What sources of error are most likely the cause of the discrepancies between your experimental data and your theoretical calculations? How well does the "ideal pulley" scenario hold? Explain.