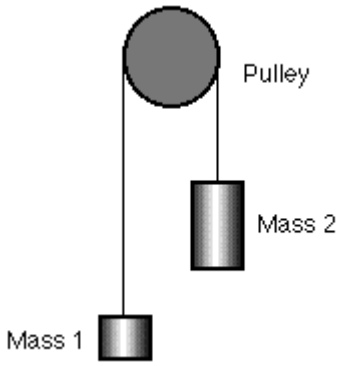
AP Physics: Newton's Second Law and the Atwood's Machine

Purpose: To graphically determine the total mass of a system.
Materials: Atwood's machine, string, stopwatch, paperclips, known masses



An Atwood's machine is a device where two masses, m_2 and m_1, are connected by a string passing over a pulley.
Prelab:

1. Assume $m_2 > m_1$. Start with a good free-body diagram. Two, in fact, one for each mass. Assume the pulley is frictionless and massless, which means the tension is the same everywhere in the string.
2. Write the EQUATIONS OF MOTION for each mass if m_2 accelerated downward:
   If the TENSION is the same in EACH string what can we do to the two equations above?
3. Show ONE complete formula below with "g" terms on the left and "a" terms on the right.
4. Simplify the equation
5. Now show your equation using the following model: In other words, your equation should look similar to what is shown.

$$X(Y-Z) = (A+B)C$$

We are now going to use this model and compare it to another MODEL you are already familiar with: Place your equation in the last set of boxes.

X(Y-Z)=	(A+B)	C	
y=	m	x +	b
			N/A

Procedure:

1) Set up the Atwood's Machine as shown in the diagram seen earlier.
2) Place a large mass on BOTH ends of the machine. Make sure the masses are equal.
3) Acquire 20 large paper clips. MEASURE and RECORD the MASS of all 20, convert to kg. The paper clips will represent the masses being transferred between sides. Start with 15 on one side and 5 on the other. (Adjustments can be made depending on the masses used; be sure the machine moves smoothly but not too fast).
4) Measure and record the MASS DIFFERENCE (kg) between the two sides.
5) Hold the larger mass at the top of the Atwood's Machine.
6) Measure and record the vertical displacement (m) this mass is going to travel when released.
7) Release the mass.
8) Measure and record the time it takes for this mass to reach the ground. (be sure you get a good trial.
9) Repeat TWO extra times to get an average TIME.
10) Repeat the ENTIRE experiment again with paper clip differences on the data table.

Measurement Data Table

M_1 = _____ M_2 = _____

Mass of 20 paperclips_____ Total mass of system _____

Vertical Displacement = _____

Paper Clip Combo	Mass Difference	Time		
15/5		Trial 1	Trial 2	Trial 3
		Average =		
16/4		Trial 1	Trial 2	Trial 3
		Average =		
17/3		Trial 1	Trial 2	Trial 3
		Average =		
18/2		Trial 1	Trial 2	Trial 3
		Average =		
19/1		Trial 1	Trial 2	Trial 3
		Average =		
20/0		Trial 1	Trial 2	Trial 3
		Average =		

Using the AVERAGE Time and the vertical displacement, calculate the ACCELERATION (using kinematics) for EACH trial. Show all work and formula used.

Calculation Data table

Paper Clip Combo	"g" times Mass Difference $kgm/_{s^2}$	Acceleration $m/_{s^2}$
15/5		
16/4		
17/3		
18/2		
19/1		
20/0		

- Make the appropriate graph as mentioned earlier and find the slope. The slope will equal the total mass of the system.

- Using the actual value for the total mass (Paper Clips + hanging masses) as measured from the balance, calculate a % error.

- What are some factors, which have caused error in this experiment?