Name _____ Period _____ Date _____

Force on a Free Body Lab 6.01

Purpose

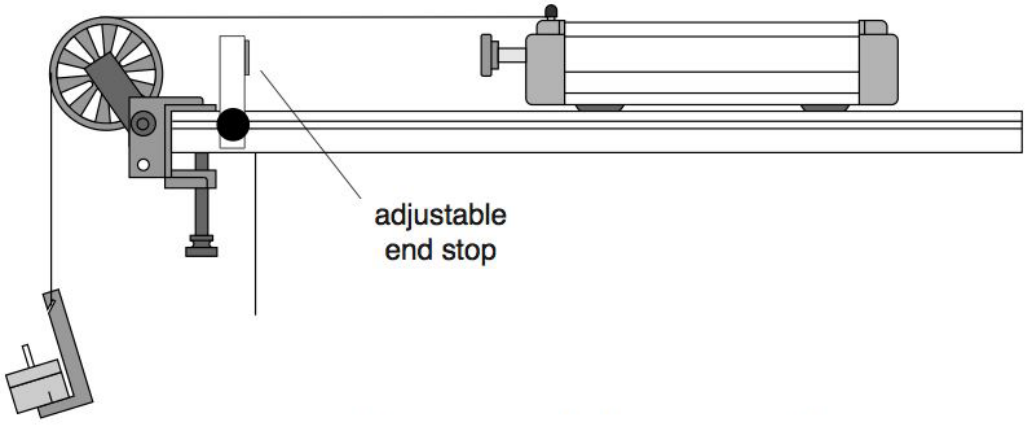
To investigate the relationship among mass, force, and acceleration

Required Equipment

- Meter stick or meter tape
- Masking tape
- Timer

Discussion

In this experiment, you will investigate how increasing the applied force on a cart-and-falling-weight system affects its acceleration while keeping the mass of the system constant. The applied force is increased without changing the mass by removing mass from the cart and placing it on the hanging weight.

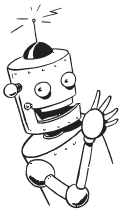


Total Mass of System: Part A

1. Set up a pulley and cart system as instructed by your teacher and get the following masses from your instructor: one large black bar, one 0.01 kg, two 0.02 kg masses.
2. Find the mass of your cart using a triple beam balance and record the mass of the cart bellow in kilograms.

   Mass of Cart (kg): _____

3. Find the mass of the large black bar #1 using a triple beam balance and record the mass of the large black bar bellow in kilograms.



   Mass of Black Bar #1 (kg): _____

4. Add up the total the mass of the weights and the hanger and record bellow.

   Mass of Weights and Hanger (kg): _____

5. Calculate the total mass of your system and record bellow as **Total Mass Part A**.

   Total Mass A = mass of cart + mass of black bar #1 + mass of weights and hanger

   Show your work:

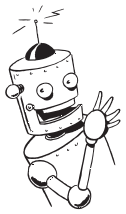
Total Mass Part A (kg): _____

Data Table A

Timing Distance (m)	Mass on Hanger (kg)	Unbalanced Force (N)	Time (s)				Final Velocity (m/s)	Acceleration (m/s/s)
			trial #1	trial #2	trial #3	Ave Time		

Timing the Cart

6. Start by placing all of the masses including the large black bar on the cart then remove the 0.01 kg mass from the cart and place it on the hanger.
7. If you are using a stopwatch for your timings, select someone in your group to be the timer. This person must also be the same person releasing your object from the directed starting point in order to eliminate error. Do several practice runs in order to minimize error.
8. Pull the cart back to the start line. Release the cart and carefully time its travel between the start and the finish lines using a stopwatch or computer. Repeat three times and record each trial in **Data Table A**.
9. Keep repeat the steps above by increasing the mass on the hanger each time by 0.01 kgto the hanger, taken from the cart, until no mass remains on the cart and all the mass is on the hanger.



Calculating the Unbalanced Force

10. The unbalanced force is the weight of the mass hanging on the end of the string. Use the equation for weight to calculate the unbalanced force for each timing and record in **Data Table A**.

$$W = mg \longrightarrow W = F \longrightarrow \boxed{F = mg}$$

Calculating Final Velocity

11. Calculate the final velocity (v_f) of your object for each trial and record in **Data Table A**. The starting velocity (v_o) for all distances will be 0 m/s.

$$\Delta d = \frac{(v_o + v_f)}{2}\Delta t \longrightarrow v_f = \left(\frac{2d}{t}\right) - v_o \longrightarrow \boxed{v_f = \frac{2d}{t_{ave}}}$$

Calculating Acceleration

12. Calculate the average acceleration for each trial and record in **Data Table A**. The starting velocity (v_o) for all distances will be 0 m/s.

$$\bar{a} = \frac{\Delta v}{\Delta t} \longrightarrow \bar{a} = \frac{v_f - v_o}{t} \longrightarrow \boxed{\bar{a} = \frac{v_f}{t_{ave}}}$$

Total Mass of System: Part B

13. Obtain another large black mass from your instructor.

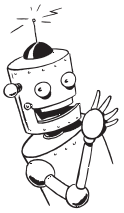
14. Find the mass of the large black bar #2 using a triple beam balance and record the mass of the large black bar bellow in kilograms.

Mass of Black Bar #2 (kg): _____

15. Calculate the total mass of your system and record bellow as **Total Mass Part B**.

Total Mass Part B = Total Mass Part A + mass of black bar #2

Show your work:



Total Mass Part A (kg): _____

Data Table B

Timing Distance (m)	Mass on Hanger (kg)	Unbalanced Force (N)	Time (s)				Final Velocity (m/s)	Acceleration (m/s/s)
			trial #1	trial #2	trial #3	Ave Time		

Graph The Results

16. Graph your data for force and acceleration for **Data Table A** and **Data Table B**.

17. Draw a best line fit through the scattering of points that you have plotted for each set of data. Your line should start at zero and be a straight line. Label the lines as **Data Table A** and **Data Table B**.

18. The slope of your best fit line represents the mass of your system, pick a point that falls on the line and find the slope of your best fit line for both data tables.

Slope of best fit line (part A): _____ kg

Slope of best fit line (part B): _____ kg

Percent Error

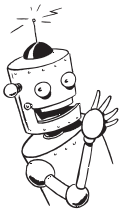
19. Using the actual mass for the system in part A and then in part B calculate the percent error using the percent error formula.

$$\%\ error = \left(\frac{slope - actual\ mass}{actual\ mass} \right) x\ 100$$

Show your work:

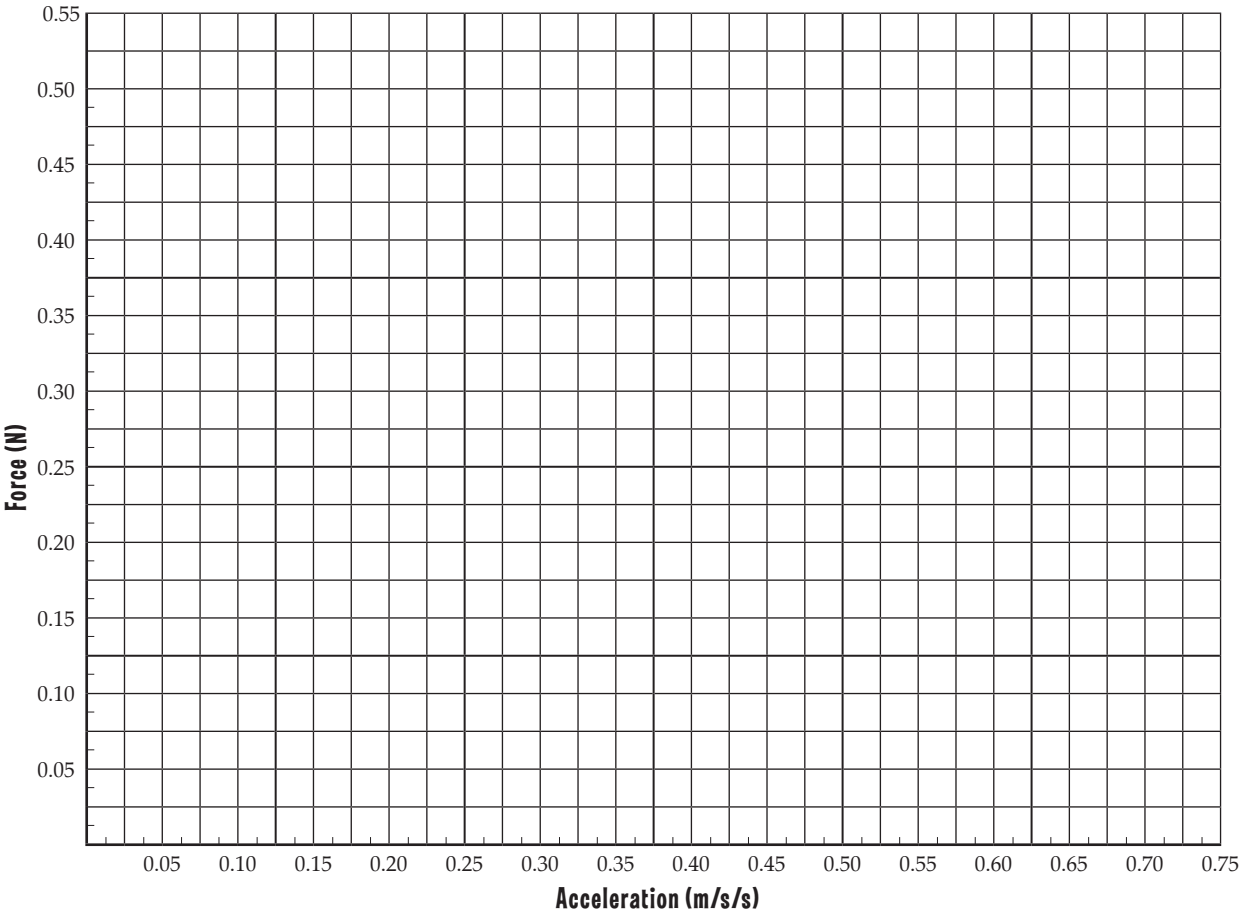
Percent Error (part A): _____

Percent Error (part B): _____



Name _____ Period _____ Date _____

Force vs Acceleration



Extension

1. From your instructor, obtain an unknown mass and remove all other mass from your cart except the unknown mass. Using a 0.02 kg mass find the acceleration of the system.

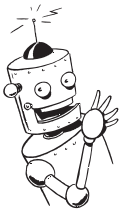
Timing Distance (m)	Mass on Hanger (kg)	Unbalanced Force (N)	Time (s)				Final Velocity (m/s)	Acceleration (m/s/s)
			trial #1	trial #2	trial #3	Ave Time		

2. Use Newton's second law of motion to solve for the unknown mass.

$$F_{net} = ma \longrightarrow m_{total} = \frac{F_{net}}{a} \longrightarrow \boxed{m_{uknown} = \left(\frac{F_{hanging\ weight}}{a}\right) - m_{cart\ +\ hanging\ mass}}$$

3. Calculate the percent error.

$$\%\ error = \left(\frac{calculated\ mass\ -\ actual\ mass}{actual\ mass}\right) x\ 100$$



Percent Error (unknown mass): _____