Balloons in Motion:
Exploring Newton's Three Laws

VIDEO: https://youtu.be/G6_0fGcaFGU

INTRODUCTION:

Sir Isaac Newton, as all scientists should be, was a very curious man. The things around him were more than what they appeared to be, and he began investigating what made objects move. Eventually, Newton compiled his findings into three laws that describe the relationship between an object's motion and the forces that make it move or stop. These three laws of motion have laid the foundation for understanding how and WHY objects move the ways that they do!

NEWTON'S THREE LAWS OF MOTION:

1. Objects at rest will remain at rest and objects in motion will remain in motion at the same speed and direction unless acted upon by an unbalanced force.
2. The mass of an object is inversely related to its acceleration, but directly related to net force on the object. There is an equation: *Force = mass x acceleration or F=ma*
3. Every force has an equal and opposite force. These forces occur in action-reaction pairs.

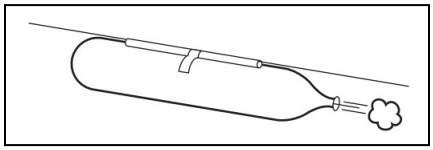
In this lab, you will construct a balloon vehicle carrying cups that will move along a string. This simple vehicle will allow you to prove each of Newton's three laws of motion in real time. As you conduct the lab, think about how each of Newton's laws is being applied. This will help you with the analysis questions!

PURPOSE:

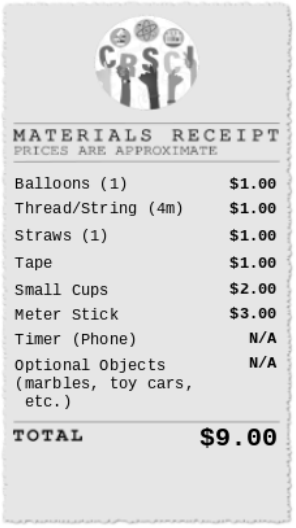
Use inquiry, engineering, and computational skills to collect evidence that proves Newton's three laws of motion in real time.

PROCEDURE:

1. Cut a length of thread/string ~4m long. Record the length in the data table, under displacement.
2. Pull the thread/string through a straw and secure each end between two posts (or hold).
3. Blow up a balloon to its maximum volume and clip the open end with fingers.
4. Hold the balloon horizontally and tape the balloon to the bottom of the straw. *(See image below.)*



5. Securely tape a small cup to the bottom of the balloon.
6. Move the straw to one end of the thread/string.
7. Release the clipped end of the balloon and time how long it takes the balloon to travel the entire length of thread/string. Record it in the data table.
8. Calculate the object's velocity ($v = \Delta d/\Delta t$) and acceleration ($a = \Delta v/\Delta t$).
9. Repeat steps 3-8 three more times, adding additional cups (or other objects), increasing mass each time.



MATERIALS RECEIPT
PRICES ARE APPROXIMATE

Balloons (1)	$1.00
Thread/String (4m)	$1.00
Straws (1)	$1.00
Tape	$1.00
Small Cups	$2.00
Meter Stick	$3.00
Timer (Phone)	N/A
Optional Objects (marbles, toy cars, etc.)	N/A
TOTAL	$9.00

DATA:

Trial (↑mass)	Displacement (m)	Time (s)	Velocity (m/s)	Acceleration (m/s^2)
1				
2				
3				
4				

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ANALYSIS QUESTIONS:

1. How did this lab demonstrate Newton's first law of motion? **Justify** your answer by describing what you observed in the lab.

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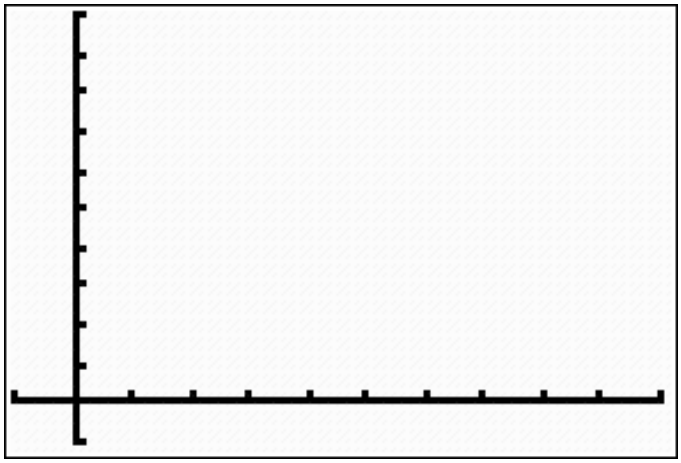
2. **Sketch** a line graph of your mass vs acceleration below.



   a. **Describe** the relationship between mass and acceleration. (Positive, negative, have no effect?)

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   b. Does this align with what Newton's Second Law states? **Explain** why or why not.

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3. The balloon accelerates based on propulsion, meaning the air releasing out of the balloon pushes the balloon forward. *(See image below.)*

   a. Which of Newton's three laws does this describe? Provide reasoning to **justify** your answer.

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b. Are there any examples in real life where objects move similar to the balloon in this lab? **Explain** your answer.

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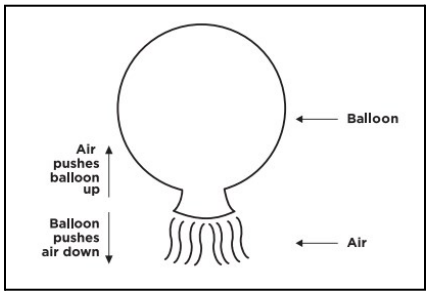

4. The balloon eventually slows down.
   a. What causes this? **Explain.**

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   b. What would happen if this force were not present? **Cite** one of Newton's Three Laws to explain your reasoning.

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5. Assume Jasmine blew up a different balloon for each trial. This procedure would lead to wildly inaccurate data. Use Newton's second law of motion to **justify** why Jasmine's data would turn out inaccurate.

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