

Investigation: Newton's Second Law Balloons

Standards:

- MS-PS2-2: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- NGSS Science Practices:
- NGSS Science Practices: Analyzing and Interpreting Data
- NGSS Science Practices: Mathematical and computational Thinking

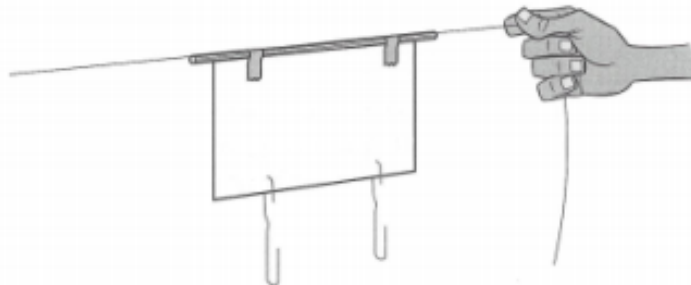
Purpose: You will work in teams of 3 to create a balloon rocket and collect data to investigate how force, mass, and acceleration are related. You will use this data to prove Newton's Second Law of Motion.

Materials:

- 4 balloons
- 2 paper clips
- 10 meters of fishing line (to add an extra challenge, use string)
- 1 straw
- 6 metal washers
- 5x7 index card
- Masking tape

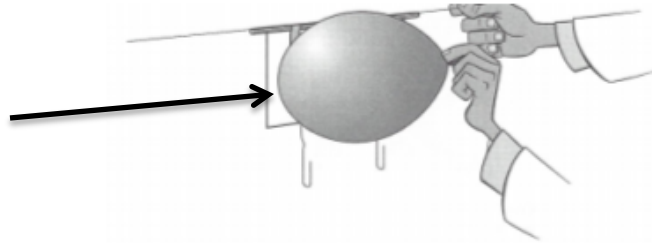
Procedure:

1. Bend 2 paper clips into hooks, on hook at the top of the paper clip and on at the bottom of the paper clip. Poke small holes toward the bottom of the index card and hang the paper clips from the holes.
2. String the fishing line or string through the straw.
3. Tape the straw to the top of the index card (the opposite side the hooks are on) with the masking tape.



4. Make a loop of masking tape, sticky side out that you will attach to the index card, to attach the balloon to the card.

5. Then blow up the balloon about $\frac{3}{4}$ full, DO NOT tie off then end, and stick it to the tape loop on the index card.



6. Two group members, one on each end of the fishing line or string, will hold the string or fishing line straight and *tightly* so there are no sags. Another member will hold the blown up balloon closed until the team is ready to test the rocket. (You may also tape the fishing line to a wall or windowsill on one side instead.)

7. When the group is ready, the member holding the blown up balloon closed will release the balloon and it should move quickly and smoothly along the line. If there is any spinning, check the alignment of the balloon on the card.

8. Once the team has made sure the rocket will work, it's time to test Newton's Law! Start by testing the effect of different masses on the rocket's acceleration by hanging different numbers of washers on the paper clip hooks and measuring the changes in acceleration by measuring DISTANCE traveled and TIME. Run 3 trials for *three different masses* of your choosing. (*Force must stay constant; so assure that you are filling the balloon equally for each trial!!!*)

9. Then test how changing the strength of the force exerted by the rocket by adding more balloons to the index card. Use more masking tape to attach the balloons. (*Force from each balloon and mass must stay constant; so assure that you are filling the balloon equally for each trial!!! Complete each trial with only 2 paperclips.*)

Data:

Effect of Mass on Acceleration

	Trial 1		Trial 2		Trial 3	
Mass	Distance	Time	Distance	Time	Distance	Time
2 Paperclips						

Effect of Force on Acceleration

	Trial 1		Trial 2		Trial 3	
Force	Distance	Time	Distance	Time	Distance	Time
2 Balloon						
3 Balloons						
4 Balloons *Challenge*						

Reflection Questions:

1. When changing the mass of the rocket, how was the acceleration of the rocket affected? Do your results support Newton's Second Law? Explain.

2. When changing the mass of the rocket, was the acceleration of the rocket affected? Do your results support Newton's Second Law?

Topic	Exceeding (4)	Proficient (3 target)	Approaching (2)	Developing (1)
<u>Experi- mentation</u>	Student collected and recorded precise and accurate data without teacher assistance	Student collected and recorded data without teacher assistance but may have errors	Student required teacher assistance OR errors in data are significant	Student did not collect or record data appropriately
Analyzing Data	Student correctly analyzes data AND can further utilize or apply data	Student correctly analyzes data	Student analyzes data with some mistakes	Student analyzes data with multiple mistakes