



Minor Challenge Set #2

STEM Field: Physics

Level: Intermediate / Senior

Challenge Name: Pinwheel Rocket

Project Cost: 0-20 USD

Materials Required:

- 1 wooden pencil with an eraser on one end
- 1 sewing pin
- 1 balloon
- 1 flexible straw
- Tape

Safety:

- Adult assistance may be needed when using sewing pin
- Be careful when using sewing pin

Duration:

- The challenge takes approximately 1 hour to finish, however, the time guideline is an estimation only, and students and mentors can complete the tasks around their schedules.

Introduction:

Sir Isaac Newton made many great contributions to mathematics and science. Perhaps the most well known story is that Newton formulated a theory on gravity after watching an apple fall and asked why the apple fell downwards, rather than sideways or even upwards. Following this observation, Newton developed the three laws of motion: Law of Inertia, Law of Acceleration, and Law of Action and Reaction.

In this challenge, we will explore Newton's third law: Law of Action and Reaction. It states, in his own words, "for every action, there is an equal and opposite reaction". This means that if you push an object, that object pushes back in the opposite direction with the same force.

For example, if you bounce a ball, the ball is exerting a downward force on the ground. Here, the ground also exerts an equal upward force on the ball and makes it bounce. Or if you do play soccer / football, when you kick a ball, you are applying a force to the ball to move it. The ball reacts by pushing back against you, and you can feel this reaction force as pressure on your foot as you kick the ball.

Instructions:

- 1) Inflate the balloon to stretch it out a bit.
- 2) Identify the end of the straw that is furthest away from the flexible end. Attach the nozzle end of the balloon over this end of the straw.
- 3) Use a short piece of plastic tape to seal the balloon to the straw. The balloon should inflate when you blow through the straw.
- 4) Bend the opposite end of the straw at a right angle.
- 5) Lay the straw and the balloon on the eraser of the pencil. Find the balance point by balancing the end of the straw with no balloon using your finger. Once you have found the balance point, push the pin through the straw into the eraser.



Figure 1 - Balance the straw with the balloon on the eraser of the wooden pencil

- 6) Spin the straw a few times to loosen up the hole the pin has made.
- 7) Blow in the straw to inflate the balloon, then let go of the straw. Watch the balloon spins and write down your observations of the speed of the spin and the size of the balloon.
- 8) Inflate the balloon to different sizes and let go of the straw. Does the balloon and straw spin faster when the balloon's size is bigger?

So, what happened?

The balloon-powered pinwheel spins because of the Law of Action and Reaction described by Newton. The balloon produces an action by squeezing on the inside, causing this air to rush out of the straw. The air exerts a reaction force at a right angle to the straw. The result is that the balloon and straw spins around the pin.

Extension

Modify the experiment by taping some weight to the balloon, for example, coins. Observe what happens to the speed of the spin when you add more weight.

Reflection Questions:

- Are there any improvements you would make to this challenge?
- Can you list 2 examples in real life that demonstrate Newton's Third Law?
- Write your observations from the experiment. Did the balloon's size have an effect on the speed of the spin?

Submission Guidelines:

- Submit a photo of the experiment setup. Include a short summary that addresses the reflection questions.

Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your parent or guardian first.

- The submission form is on the Minor Challenges page:
<https://sciencechallenge.org.au/index.php/minor-challenges/>
Fill out the details and make sure you upload your submission.

Learn More! Resources:

- Isaac Newton: Who he was, why apples are falling - <https://education.nationalgeographic.org/resource/isaac-newton-who-he-was-why-apples-are-falling/>

Bibliography:

- Dees, S. (2016) *Make a balloon pinwheel science demonstration, Frugal Fun For Boys and Girls*. Available at: <https://frugalfun4boys.com/balloon-pinwheel-science-demonstration/> (Accessed: April 10, 2023).
- Hartsfield, J. (no date) *Rocket Pinwheel*, NASA. NASA. Available at: https://www.grc.nasa.gov/www/k-12/TRC/Rockets/rocket_pinwheel (Accessed: April 10, 2023).
- *Isaac Newton: Who he was, why apples are falling* (2022) Education. National Geographic. Available at: <https://education.nationalgeographic.org/resource/isaac-newton-who-he-was-why-apples-are-falling/> (Accessed: April 10, 2023).