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Lesson Plan: Newton's Cradle

Content	Audience	Method	Output/Products	Outcomes/Impact
Newton's Cradle is a science project demonstrating momentum and Newton's 3rd law of motion which states for every action there is an equal and opposite reaction. .	Ages 4rd-8th grade	1. Explain Newton's 3rd Law. 2. Facilitate brief discussion with students about Newton's Law, and ask questions. 3. Have the students hypothesize what they believe will happen. 4. Hands-on Activity	1. Brief discussion/info on Newton's 3rd Law and Newton's Cradle	1.Students will be able to work independently to create Newton's Cradle 2. Students will create their own cradle.

Supplies Needed

- Marbles
- String
- Beads
- Craft Sticks/Straws
- Hot Glue Gun and Glue

Prep

Optional: Have all supplies ready and waiting for group.

Method

- Give a brief introduction of the project.
- Facilitate brief discussion with students about Newton's Law, and ask questions.
- Have the students hypothesize what they believe will happen.

Background

Newton's Cradle is named after scientist a famous scientist, Sir Isaac Newton.

What is Newton's third law of motion? **Newton's third law of motion states that for every action there is an equal and opposite reaction.**

Newton's third law is also known as the law of action and reaction. This law is important in analyzing problems of static equilibrium, where all forces are balanced, but it also applies to bodies in uniform or accelerated motion. The forces it describes are real. For example, a book resting on a table applies a downward force equal to its weight on the table. According to the third law, the table applies an equal and opposite force to the book. This force occurs because the weight of the book causes the table to deform slightly so that it pushes back on the book like a coiled spring.[1]

Discussion/Questions

Have students give a hypothesis, an educated guess, on applying Newton's third law. What will happen after the cradle is created and you move one of the outer marbles? The force will travel through the marble it hits. Which marble will move? The marble on the opposite end.

Hands-on Activity: Newton's Cradle

1. Grab 4 craft sticks of equal length. Glue craft sticks together at the corners to make a square. Repeat process 3 more times. Let dry. This is your frame.
2. Cut string. Measure into 6 equal pieces 8" long
3. Hot glue a marble to the center of one of the pieces of string. Repeat to 6 separate marbles, each glued to the center of a string.
4. Make 6 marks along two craft sticks. Measure at ½". Make sure the marks are centered on each craft stick. Set aside.
5. Using hot glue, assemble the frame. Take the two sides and hot glue a craft stick perpendicular to each corner. The final frame will be a cube.
6. Glue the craft stick with the marks to one side of the frame.
7. Glue the second marked craft stick to the opposite side of the frame.
8. Hot glue the strings with a marble attached to them to the marked craft stick. Pull on the strings gently, if needed, to make sure the marbles align. The marbles must line up both horizontally and when viewed from the top.
9. Pull one of the end marbles up and let go.

[1] https://www.britannica.com/science/Newtons-laws-of-motion

The Science behind Newton's Cradle

Newton's Cradle demonstrates momentum. Momentum is an object (or mass) in motion. Momentum = mass * velocity

Swing one of the marbles on the end, it will collides with the marble next to it and the force of that collision travels through each of the other marbles until it reaches the last one, which swings outward. This marble swings back down and the force travels through the marbles again making the initial marble that was swung, swing out, and so on. This is also an example of, Conservation of momentum, which is when two objects meet at the same momentum they had before the impact and is equal to the momentum after the impact. In this experiment, Newton's Cradle demonstrates force of the impact traveling through each of the marbles until it reaches the last one, and that last marble swings out.

Resources:

https://www.indypl.org/blog/for-kids/science-experiment-newtons-third-law-of-motion
https://science.howstuffworks.com/innovation/inventions/newtons-cradle.htm
https://www.britannica.com/science/Newtons-laws-of-motion

Arkansas Education Standards

4th grade Science

4-PS4-1	Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

4th grade Math

AR.Math. Content.4 .MD.A.1	Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec; yd, ft, in; gal, qt, pt, c

5th Grade Science

5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

5th Grade Math

AR.Math. Content.5 .MD.A.1	Convert among different-sized standard measurement units within the metric system

6th Grade Science

6-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem

6th Grade Math

AR.Math. Content.6 .RP.A.3	Use and create tables to compare equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane

7th Grade Science

7-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

8th Grade Science

8-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

NGSS Cross-Cutting Concepts

- Cause-and-Effect
- Energy and matter
- Patterns
- Influence of Science, Engineering, and Technology on Society and the Natural World

NGSS Science and Engineering Practices

- Developing and Using Models
- Constructing Explanations and Designing Solutions