NEWTON'S NOTIONS

STUDENT WORKBOOK

LAUNCH

INERTIA DROP

ACTIVITY 2

Have you ever seen a magician pull a tablecloth out from under a set of dishes? That "magic" trick actually works because of science, and it has something in common with the spinning water tube. It also has a lot to do with Isaac Newton and the work he did in discovering the basic laws of physics.

LEARNING GOALS:

I can use mathematical models to show that the total momentum of a system of two objects moving in one dimension stays the same unless there is a net force.

GET TO KNOW NEWTON

To understand the spinning water tube, we can study the work of Isaac Newton.

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THE FATHER OF MODERN PHYSICS

Imagine this scene: Isaac Newton sits under an apple tree, furiously scribbling equations onto a piece of parchment, when suddenly, an apple falls on his head. He declares he has just discovered gravity. **Gravity** is the force of attraction between two objects.

The scenario above is what many people think of when they call Newton to mind. While the apple tale has never been confirmed, Newton was the first person to develop a functional theory of gravity. He played a major role in developing the basic laws that describe force and motion in our universe. He is often called "the father of modern physics." **Physics** is the study of matter, energy, and the interactions between them.

Newton was born in England in 1643. He was interested in physics from an early age, building sundials and toy windmills.[1] While he attended Trinity College (Cambridge), he developed the precursor to modern calculus.

While studying for his Master of Arts degree (around the time the apple may have fallen on his head), Newton worked extensively on gravitational theory and optics, the study of light, lenses, and mirrors. In fact, his primary focus in his early professional years was optics. He frequently gave lectures on the topic as a professor, and he even designed and built a reflecting telescope, the first of its kind.

This portrait of Newton at 46 years old was completed by Godfrey Kneller, who often painted British royals, in 1689.

found: https://en.wikipedia.org/wiki/Isaac_Newton

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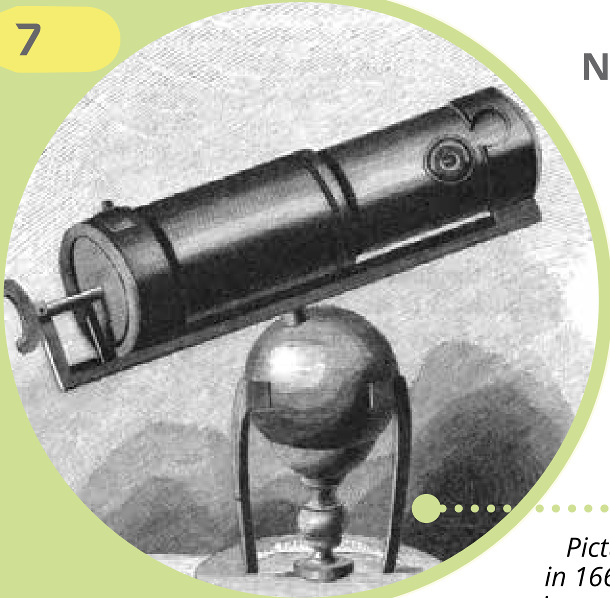


NEWTON'S GREATEST CONTRIBUTIONS

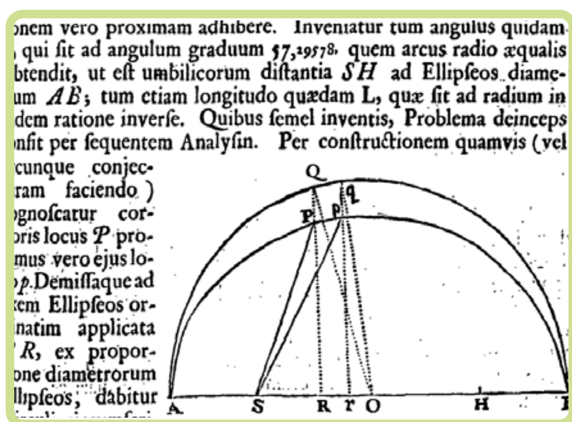
In 1687, Newton published the book ***"Philosophiæ Naturalis Principia Mathematica,"*** translated as ***"Mathematical Principles of Natural Philosophy"*** and often shortened to ***"the Principia."*** It details Newton's ideas about how gravity and other fundamental forces of nature affect the motion of planets and other objects. Many of the physics equations and concepts we use today are similar or identical to those Newton outlined in the ***Principia.***

Pictured here is a drawing of the reflecting telescope Newton built in 1668. It was made mostly of wood and metal, and it used two mirrors. The basic design is still used in telescopes today.

THINK ABOUT IT!

Newton was not concerned with educating the average person about physics, instead writing his works for mathematicians and scientists. Do you think this approach is acceptable? Why or why not?

The ***Principia*** represents the decades of work Newton did in searching for explanations for perplexing observations, including why people don't fly off the Earth as it spins around, and how a projectile keeps moving after it is no longer being thrown. Newton's explanation for these occurrences builds off both his work and the thinking of many thinkers before him. It is summarized by **Newton's First Law.**



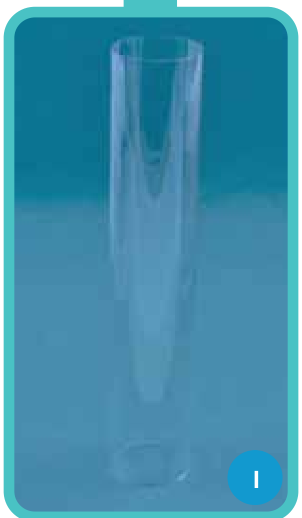
ɔnem vero proximam adhibere. Inveniatur tum angulus quidam , qui ſit ad angulum graduum 57,29578. quem arcus radio æqualis btendit, ut eſt umbilicorum diſtantia *SH* ad Ellipſeos diame- um *AB*; tum etiam longitudo quædam L, quæ ſit ad radium in dem ratione inverſe. Quibus ſemel inventis, Problema deinceps nſit per ſequentem Analyſin. Per conſtructionem quamvis (vel cunque conjec- ram faciendo) ɔgnoſcatur cor- ɔris locus *P* pro- mus vero ejus lo- ɔ *p*. Demiſſaque ad cem Ellipſeos or- natim applicata *R*, ex propor- one diametrorum llipſeos, dabitur

This is a photo of the first edition of the Principia, showing an explanation for the motion of a pendulum. Notice how it was written in Latin, the common language of scientists in the 17th century. Image credit: Leeds University Library.

located at https://explore.library.leeds.ac.uk/special-collections-explore/271274

PUT INERTIA TO THE TEST

You can observe inertia at work with this hands-on activity in which you will apply a pulling force.



WHAT YOU NEED:

FROM THE KIT:

- Cardstock
- Large steel ball
- One cork
- One small steel ball
- Ping-pong ball
- Plastic tube
- OTHER: Scissors

WHAT TO DO:

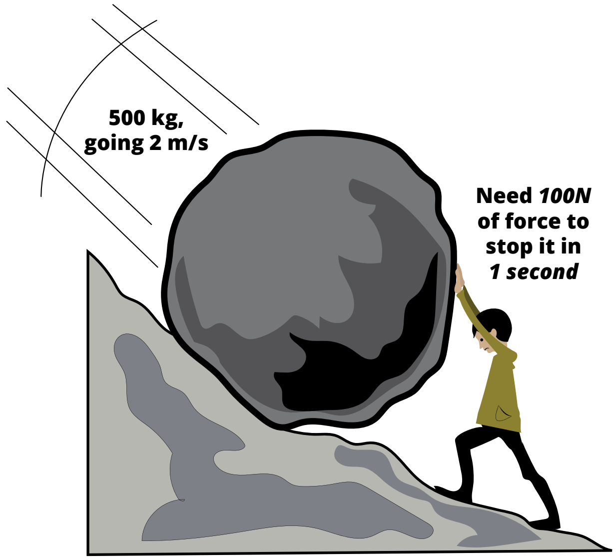
1. Stand up the tube so the open end is on top.

2. Fold the cardstock in fourths (horizontal and then vertical folds) and cut out one of the fourths along the fold.

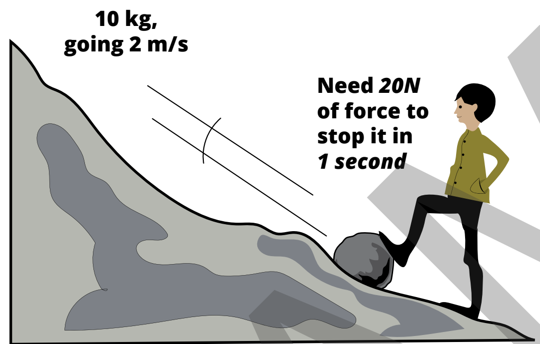
3. Place the cardstock piece over the top of the tube, covering the opening of the tube.

4. For each of the objects in the table on the next page, place the item on top of the cardstock, centered over the opening of the tube.

5. On the chart on the following page, record what happens to the object as you very quickly pull the cardstock straight out from under the object (make sure you pull across, not up or down). Repeat with each object two more times for a total of three trials for each object. (You might need to hold the tube when you're pulling so it doesn't fall over.)



SITUATION 1



SITUATION 2

It can be easier to predict and describe the amount of energy transferred by calculating the momentum of an object. **Momentum** is the quantity of motion of an object based on its mass and velocity. It is sometimes called "mass in motion." **Velocity** is the change in position of an object over time.

You can calculate momentum using this equation: **p = m x v**

where **p** is ***momentum***, **m** is ***mass***, and **v** is ***velocity.***

An easy way to understand momentum is by thinking about how difficult it would be to stop an object in motion: objects with more mass and objects that are moving faster take more force to stop.

As it turns out, there is a real connection between force and momentum: force is equal to the change in momentum in a given period of time. This relationship can be shown as an equation,

$$F = \frac{\Delta p}{\Delta t}$$

where F is force in Newtons, Δp is the change in momentum in kg-meters per second, and Δt is the change in time in seconds. (As you might have guessed, the delta symbol, Δ, means "change in.")

To figure out how much force it will take to change the motion of an object, all you need to know is what its momentum is before and after the force, and how much time it took to apply the force.

In the diagram shown, there are two situations. Both involve applying a force to stop a boulder that is traveling 2 m/s toward a person. But, the boulder in Situation 2 is much smaller.Up next, see the step-by-step problem solving for how the size of the boulders affects the force required to stop them.

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Kit	SU-NEWTON
Instructions	IN-NEWTONS
Revision Date	3/2021