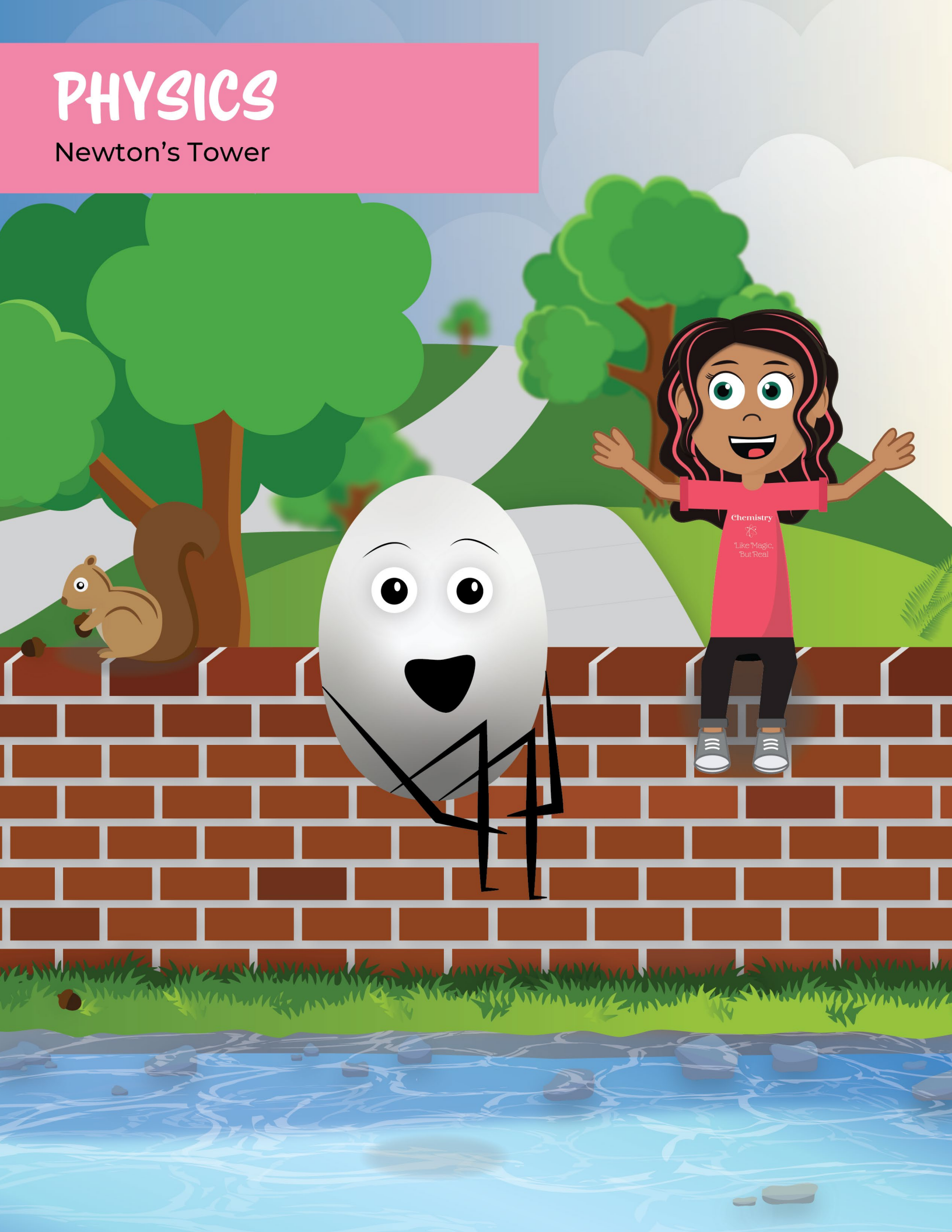
PHYSICS

Newton's Tower



Newton's Tower

NGSS

5-PS2-1; MS-PS2-1

Objective

The student will understand Newton's first and third laws of motion.

The student will be able to demonstrate Newton's first and third law by explaining the forces acting on the materials.

Vocabulary

Force: A push or pull upon an object resulting from the interaction of the object with another object.

Inertia: The resistance of any physical object to any change in speed, direction, or state of rest.

Newton's first law: An object at rest will remain at rest and an object in motion will remain in motion unless acted upon by an external force.

Newton's third law: For every action there is an equal and opposite reaction.

Background

While at rest, the egg/roll/pan complex you assemble during this experiment will experience the force of gravity and the normal force. The force of gravity pulls it downward while the normal force pushes up. By striking the pie pan, the horizontal force is transferred to the pie pan but not the egg. The only force acting on the egg is the force of gravity, which pulls it into the cup. The water then exerts buoyant force upon the egg, allowing it to rest safely in the cup.

The marbles are stationary on the floor (or table) until an outside force acts on them. The outside force will be another marble striking them. Notice that when a marble in motion strikes a stationary marble, the marbles bounce off each other

and then both are in motion. Why is it that the marbles stop moving on their own if we don't see an outside force stopping them? The force of friction between the marble and the floor causes the marble to stop. In a frictionless world, the marbles would continue on their trajectory until acted on by an external force.

When two marbles in motion strike each other head on, there is an equal and opposite reaction between them (if they are the same mass and traveling at the same speed). Changing the mass or speed of one of the marbles will have different effects on its inertia. Generally, an object with a larger mass and a greater velocity will have more inertia compared to an object with a smaller mass and a lower velocity. Experiment with these changes and observe the results; try to relate it back to Newton's Laws of motion.

Materials

Items needed per group (2-3 students)

- 2-3 pie pans
- 2-3 glass cups or beakers
- 2-3 toilet paper tubes
- 2-3 hardboiled eggs
- Water (to go into glass cup or beaker)
- Newspaper and paper towels (in case of spills)
- Small bag of marbles of various sizes

Procedure

http://www.youtube.com/watch?v=STQRUzalH2M (Watch this video prior to starting the experiment)

Experiment 1: The Tower

1. Do a whole-group demonstration and then have the students set up the experiment at each group. (For the demonstrations, follow steps 4-9).
2. Fill 3/4 of a clear glass cup with water.
3. Place a pie pan on top of the glass cup.

4. Place a toilet paper roll in the middle of the pie pan.
5. Place a hardboiled egg on top of the toilet paper tube.
6. Hit the pie pan with a horizontal sweeping motion! (Do not hit the egg).
7. Watch as the egg drops into the cup of water, even though the pie pan and toilet paper tube shoot off of the glass cup!
8. As you proceed through the experiment, relate what you are doing to Newton's Laws.
9. Encourage students to try!

Differentiation

- Have the students lead the experiment after you have done the main example. Let them explore different setups such as: stacking two toilet paper tubes, using two pie pans instead of one, hitting the pie pan slower versus faster. Instead of an egg, use a ball of paper or other small objects.
    - What happens to the objects?

Experiment 2: Marble collisions

Note: The following steps should be done at a constant velocity IF POSSIBLE: therefore, we can relate this to inertia.

1. Place a stationary marble on the floor, then roll another marble of the same size to collide with it.
2. What happens?
3. Place a larger stationary marble on the floor, then roll a small marble to collide with it.
4. Place a small stationary marble on the floor, then roll a larger marble to collide with it.
5. In which instance did the stationary marble move the most?
6. Why?
7. Which marble had more inertia?
8. Have students try out different settings with the marbles (example: line up two stationary marbles and roll a larger marble to collide into them).
9. Have students make observations, discuss the results, and reflect on the activities today.

Guiding Questions

- What will happen when we strike a stationary marble with a marble in motion?

- What will happen when two identical marbles rolling towards each other collide?
- Let's change the size of one of the marbles: what happens now?
- Does one have more inertia than the other?

Career/Future Application

Understanding all potential forces in a system is critical for designing structures. Physics is therefore highly relevant to engineering, construction, architecture, etc.

Sources

http://www.physicsclassroom.com/class/newtlaws/u2l2a.cfm