Daily Planet: Science and the City
Gravity, Inertia, and Energy
Teacher's Guide

Grade Level: 6-12	**Curriculum Focus:** Physical Science	**Lesson Duration:** Four class periods

Program Description

Gravity — Explains gravitational force and how it affects objects here on Earth. ***Inertia*** — Demonstrates how inertia makes objects resist change in their motion. ***Energy*** — Illustrates the science of energy transfer and different energy forms. ***Magnetism*** — Discusses types of magnets and how they work.

Discussion Questions

- Why do objects move or remain still?
- What are forces and energy? What different kinds of forces and energy exist?
- How does energy change?

Video Index

Segment 1: Gravity

Description
Got questions about gravity? Let Alan Nursall bring you down to Earth with his probing look at this very interesting force.

Pre-viewing question
Q: What do you think gravity is?
A: Answers will vary. (Gravity is an attractive force between two bodies.)

Post-viewing question
Q: Why does the Earth have stronger gravity than a school bus?
A: The Earth has more mass than a school bus. The greater an object's mass, the more gravity it has.

Segment 2: Inertia

Description
Follow the on-the-street science lesson on inertia. Learn why objects at rest stay at rest — and what happens when Alan Nursall lets strangers hit him with a sledgehammer!

Pre-viewing question
Q: What is inertia?
A: Inertia is an object's resistance to change in its motion — that is, the tendency of an object at rest to stay at rest and of an object in motion to stay in motion.

Post-viewing question
Q: Why wasn't Alan injured when the participants hit the rock on his stomach with a sledgehammer?
A: The rock's inertia protected Alan. The rock, which had a large mass, absorbed the force of the sledgehammer blows. The sledgehammer's force was not enough to overcome the rock's inertia. Therefore, none of the force went through to Alan.

Segment 3. Energy

Description
They are chewy and fruity and come in cute shapes, so why on Earth is Alan Nursall burning gummy animals instead of eating them? He's doing it in the name of science, of course, as he takes to the streets to demonstrate some amazing experiments in energy.

Pre-viewing question
Q: What different types of energy can you think of?
A: Answers will vary.

Post-viewing question
Q: Can you trace the transfer and types of energy from the sun to the juggling balls?
A: Plants absorb energy from the sun (nuclear energy) through photosynthesis (chemical energy). We eat and digest those plants — or the animals that ate them (chemical energy) — which gives us energy to juggle the balls (kinetic energy).

Segment 4: Magnetism

Description
Alan Nursall hits the biggest mall in the world to show people the wonders of magnetism.

Pre-viewing question
Q: What do magnets do?
A: Magnets attract certain kinds of materials, such as iron and steel. Magnets move objects made of these materials without touching them. Magnets also repel or attract other magnets.

Post-viewing question
Q: What are the two types of magnets, and why are they magnetic?
A: The two types of magnets are permanent magnets and electromagnets. Permanent magnets are magnetic because their atoms are aligned in a certain direction. Electromagnets are magnetic because of the electric current running through them.

Lesson Plan

Student Objectives

- Develop knowledge of forces and motion, particularly of gravity, inertia, and energy
- Demonstrate understanding of forces and motion by constructing a catapult to launch objects
- Develop skills important to successful scientific inquiry, such as experimentation, design, communication, and collaboration

Materials

- *Science and the City: Gravity, Inertia, and Energy* video and VCR, DVD and DVD player, or CD-ROM and computer
- Computer(s) with Internet access (optional)
- Pictures of catapults
- Materials for students to construct catapults:
  - Cardboard shoe box (1 for each catapult)
  - Rubber bands (4 for each catapult)
  - Popsicle sticks (2 for each catapult)
  - Masking tape (two 6-inch pieces for each catapult, plus a 2-foot strip to mark the starting line)
  - Plastic spoon (1 for each catapult)
  - Rulers (1 per student group)
  - Scissors (1 per student group)
  - Marshmallows (2 per group)
- Object of your choice to serve as a target

Procedures

1. Watch the *Science and the City: Gravity, Inertia, and Energy* video segments (or any of the first three segments) and discuss them with the class. What are gravity, inertia, and energy? How do they affect the motion of objects? How do objects move? How do we calculate motion? What is acceleration? What is speed? What are some of the forces that act upon objects in motion?

2. Tell students they are going to apply their knowledge of forces and motion. They will work in groups to create catapults out of everyday objects. Explain that catapults were often used as weapons during the Middle Ages. Show students some pictures of catapults and discuss how they work, making sure that students understand catapult designs and uses. A good animated

illustration of a catapult can be found at http://www.bow.k12.nh.us/CyberBUS/armor and weapons/animated_catapult.htm.

3. Tell students that, after building their catapults, they will compete to see whose catapult can fling a marshmallow the farthest and whose catapult can fling an object closest to a target.

4. Divide students into groups of four, and give each group the supplies they will need to make their catapults (see materials list) as well as any other objects you wish to provide. Tell the groups that they can design their catapults however they please, but they may use only the materials you have provided (nothing extra). Give students time to design and build their catapults, and ask them to name their teams.

5. Once students have completed their catapults, clear an area in the classroom that can be used for the launching competition. Using masking tape, mark a starting line. Place the target object about 10 feet in front of the line.

6. One at a time, have the student teams place their catapults on the line and fling a marshmallow at the target. Their goal is to hit the target. Mark where each team's marshmallow landed with a piece of masking tape that has been labeled with the team's name.

7. As a class, determine which team was the most successful in accurately hitting (or coming the closest to hitting) the target with its marshmallow. Talk about the design of the winning catapults. Why did this design work the best?

8. Have students again place their catapults on the starting line and fire a second marshmallow. Their goal, this time, is to achieve the greatest distance. Again, mark where each marshmallow lands with a piece of labeled masking tape. Once all the catapults have been fired, have students measure the distance from the starting line to where their marshmallow landed.

9. As a class, determine which catapult was able to launch a marshmallow the greatest distance. Ask students: Why did this catapult work best? What element(s) of its design do you think helped propel the marshmallow farther than the others?

10. Have each student write a paragraph that answers the following questions.
    - What was your group attempting to achieve with its catapult design?
    - How did the catapult set the marshmallow in motion?
    - Which challenge did your catapult meet best, accuracy or distance? Why?
    - What could you have done to make the catapult better?
    - How did your knowledge of gravity, inertia, and energy help you to succeed in this activity?
    - What did this activity teach you about motion and forces?

11. Ask for volunteers to share their answers with the class. Discuss students' answers and what they have learned about forces and motion. What remaining questions do they have, and what experiment would they like to try next?

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Students actively participated in class discussions; worked cooperatively in their teams; successfully created a team catapult; actively participated in the catapult launch; and wrote a thoughtful paragraph that answered all six questions.
- 2 points: Students somewhat participated in class discussions; worked somewhat cooperatively in their teams; needed help to complete their catapult; did not actively participate in the catapult launch; and wrote an incomplete paragraph that answered only three or four of the six questions.
- 1 point: Students somewhat participated in class discussions; were unable to use catapult materials without teacher guidance; created unfinished catapults; did not actively participate in the catapult launch; and wrote an incomplete paragraph that answered only one or two of the questions.

Vocabulary

acceleration

Definition: The increase in speed over time

Context: You can calculate the acceleration of a falling object if you know the time and distance of the fall.

energy

Definition: The capacity to do work

Context: Energy transforms from one form to another when the gummy bear burns.

force

Definition: Strength or energy exerted, or a cause of motion or change

Context: The mechanical force of one object pushing against a second object can cause the second object to overcome its inertia and move.

gravity

Definition: An attractive force between two bodies that increases with greater mass

Context: The Earth has a lot of gravity because it has so much mass.

inertia

Definition: The tendency of an object to resist any change in its motion

Context: When Alan hits a rock with a hammer, inertia keeps the rock from moving.

mass

Definition: The amount of matter in a body, equal to the measure of its inertia (and not dependent upon gravity)

Context: The higher an object's mass, the more inertia it has.

Academic Standards

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp

This lesson plan addresses the following national standards:

- Physical Sciences: Understands forces and motion

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K-12 to promote scientific literacy. To view the standards, visit this Web site http://books.nap.edu/html/nses/html/overview.html#content

This lesson plan addresses the following national standards:

- Physical Science: Motions and forces

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html