

## Motion, Forces, Energy and Electricity: Teacher's Guide

**Grade Level:** 5-8

**Curriculum Focus:** Physical Science

**Lesson Duration:** Two or three class periods

### Program Description

Using examples that are familiar to young students, this feature illustrates the principles of physics. *Monster Masses in Motion*— Teaches students to find average speeds by comparing two teams racing to the finish. *Roller Coaster Physics*— Explains the importance of G-forces. *Bridges: A Heated Issue*— Examines why heat is vital to bridge building. *Exploring Lightning*— Sheds light on a striking natural phenomenon.

- I. Monster Masses in Motion (5 min.)
  - II. Roller Coaster Physics (4 min.)
  - III. Bridges: A Heated Issue (6 min.)
  - IV. Exploring Lightning (5 min.)
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### Onscreen Questions

#### Segments I

- What forces are involved in driving a vehicle up an incline?
- What is acceleration and how do you calculate it?

#### Segments II

- How do gravity, velocity, acceleration, and friction all play roles in making roller coaster rides both fun and safe?
- What are the main forces acting on passengers during a roller coaster ride?

#### Segments III

- What role does heat play in the design and construction of bridges?
- Why is knowledge of heat transfer important in the construction of bridges?

#### Segments IV

- What precautions can you take to avoid lightning strikes?
  - Describe how the top and bottom of a thundercloud become charged.
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## Lesson Plan

### Student Objectives

- Work in groups to build catapults out of everyday objects.
- Demonstrate understanding of motion and forces by using the catapults to launch objects.

### Materials

- *Motion, Forces, Energy and Electricity* video and VCR, or DVD and DVD player
- Pictures of catapults
- Computer with Internet access (optional)
- Cardboard shoe box (1 for each catapult)
- Rubber bands (4 for each catapult)
- Popsicle sticks (2 for each catapult)
- Masking tape (one 6-inch piece for each catapult)
- Plastic spoon (1 for each catapult)
- Rulers (1 per student group)
- Scissors (1 per student group)
- Marshmallows (2 per group)
- Masking tape (for launching competition)
- Object of your choice to serve as a target

### Procedures

1. Begin the lesson by discussing motion and energy. Ask students: 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? A good way to introduce this information is to view portions of the *Motion, Forces, Energy and Electricity* DVD.
2. Tell students they are going to work in groups to create catapults out of everyday objects. Explain that catapults were often used as weapons of war 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%20and%20weapons/animated\\_catapult.htm](http://www.bow.k12.nh.us/CyberBUS/armor%20and%20weapons/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 five, 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 can use only the



materials you have provided-nothing extra. Give students time to design and build their catapults, and ask them to name their team.

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?

## 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 launches; 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 launches; 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 launches; wrote an incomplete paragraph that answered only one or two of the questions.

## Vocabulary

### acceleration

*Definition:* The increased change in speed over time

*Context:* You can calculate the Pit Crew's acceleration during the first 10 seconds of the race with the information you have about their climb.



**force**

*Definition:* Strength or energy exerted; cause of motion or change

*Context:* Both teams know that getting their vehicle up the hill will require a great deal of force.

**inertia**

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

*Context:* It's not moving and, because of inertia, it will take an outside force to make it move.

**propel**

*Definition:* To push or drive forward or onward by means of a force that imparts motion

*Context:* If their vehicle weighs less than the other team's, the Jet Jocks' engine won't need to exert as much force to propel their buggy up the incline.

**reference point**

*Definition:* A fixed point of comparison

*Context:* Each vehicle will attempt the climb by itself, so the starting line serves as a reference point, or fixed point of comparison.

## Academic Standards

### National Academy of Sciences

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K-12. To view the standards, visit <http://books.nap.edu>.

This lesson plan addresses the following science standards:

- Earth and Space Science
- Physical Science
- Science as Inquiry
- Science and Technology

### 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 link: <http://www.mcrel.org/compendium/browse.asp>

This lesson plan addresses the following national standards:

- Language Arts – Viewing: Uses viewing skills and strategies to understand and interpret visual media; Writing: Uses the general skills and strategies of the writing process, Gathers and uses information for research purposes
- Technology – Understands the nature and uses of different forms of technology



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## 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>
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## DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

### *How To Use the DVD*

The DVD starting screen has the following options:

**Play Video** – This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

**Video Index** – Here the video is divided into four parts (see below), indicated by video thumbnail icons. Watching all parts in sequence is similar to watching the video from start to finish. Brief descriptions and total running times are noted for each part. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

**Curriculum Units** – These are specially edited video segments pulled from different sections of the video (see below). These nonlinear segments align with key ideas in the unit of instruction. They include onscreen pre- and post-viewing questions, reproduced below in this Teacher's Guide. Total running times for these segments are noted. To play a particular segment, press Enter on the TV remote or click once on the Curriculum Unit title on a computer.

**Standards Link** – Selecting this option displays a single screen that lists the national academic standards the video addresses.

**Teacher Resources** – This screen gives the technical support number and Web site address.

### *Video Index*

#### **I. Monster Masses in Motion (5 min.)**

Learn how to calculate speed and acceleration as the Pit Crew and the Jet Jocks race their monster vehicles up a steep track. Who will win? Watch and find out!



## II. Roller Coaster Physics (4 min.)

Like all things, thrill rides work within the boundaries of physics. See how precise applications of the laws of physics allow roller coasters to be both scary and safe.

## III. Bridges: A Heated Issue (6 min.)

Typically built of concrete and steel, modern bridges owe much of their strength and durability to heat. Learn about the role this energy plays in bridge construction.

## IV. Exploring Lightning (5 min.)

Lightning occurs when negatively charged electrons from a thundercloud connect with a stream of positive charges from the Earth. Explore the science behind lightning.

### Curriculum Units

#### 1. An Uphill Race

*Pre-viewing question*

Q: What are the benefits of a smaller, lighter vehicle versus a heavier, sturdier one?

A: Answers will vary.

*Post-viewing question*

Q: Which monster machine do you think will perform the best?

A: Answers will vary.

#### 2. Speed and Acceleration

*Pre-viewing question*

Q: Do you think speed or acceleration is more important in winning a race?

A: Answers will vary.

*Post-viewing question*

Q: Why did the Pit Crew win the race?

A: Answers will vary.

#### 3. Thrills, Chills, and Spills

*Pre-viewing question*

Q: Do you think all roller coasters are safe?

A: Answers will vary.

*Post-viewing question*

Q: What keeps a roller coaster train from falling towards the center of a loop?

A: The inertial tendency of an object to travel in a straight line pushes the roller coaster against the tracks while it is moving in a circular loop. There is also a three-wheel safety system that grabs onto the track.



#### 4. Heat and Steel

*Pre-viewing question*

Q: What do you think is the most difficult aspect of building a bridge?

A: Answers will vary.

*Post-viewing question*

Q: Why is steel heated before it's used to build bridges?

A: Heat strengthens steel by altering its molecular structure. However, hardened steel is brittle and less able to withstand or absorb shock, so engineers also use heat to lessen the brittleness.

#### 5. Heat, Stress, and Conduction

*Pre-viewing question*

Q: How does heat affect trees, buildings, and other structures in your area?

A: Answers will vary.

*Post-viewing question*

Q: Why does the surface of a bridge freeze quickly in cold temperatures?

A: Bridges do not have the ground to act as an insulator to keep in heat. Therefore, the surface of a bridge cools quicker than the road when air temperatures drop.

#### 6. Nature's Electricity

*Pre-viewing question*

Q: What do you know about lightning?

A: Answers will vary.

*Post-viewing question*

Q: How do thunderclouds form?

A: Thunderclouds form when warm, moist air rises from the Earth. As the air cools the moisture creates a cloud of condensation. Water droplets at the top of the cloud spread out creating the flat-angled shape typical of thunderclouds

#### 7. Studying Lightning

*Pre-viewing question*

Q: Why do you think we are unable to predict exactly where and when lightning will strike?

A: Answers will vary.

*Post-viewing question*

Q: How are lightning bolts created?

A: A bolt of lightning starts when the negatively charged underside of a thundercloud sends a stream of electrons downward in a jagged, stair-step path. As the negative stream approaches the ground, an upward, positive discharge starts from the Earth. As the two charged streams come together they create a path for a powerful electrical current, or lightning bolt, to begin flowing.

