Program Description

Put students in the driver’s seat as they learn how to measure speed and distance. This humorous, high-energy road show highlights the conditions that affect speed, as well as the ways we use the forces of nature in our daily lives. This program includes four short segments:

- Forces and Motion (6 min.)
- The Physics of Falling (6 min.)
- Air Forces (10 min.)
- The Planet Electric (5 min.)

Onscreen Questions

- What is the relationship between distance, time, and speed?
- In what ways do air resistance and the shape of an object influence its acceleration and speed?

Lesson Plan

Student Objectives

- Review the various forces at work on a falling parachute.
- Demonstrate these forces by constructing and testing parachutes of different sizes.

Materials

- *Forces and Motion* video and VCR, or DVD and DVD player
- Lightweight, plastic kitchen garbage bags (depending on size, 1 or 2 per group)
- Scissors
- Rulers
- 20-inch lengths of light string (12 per group)
Forces and Motion: Teacher’s Guide

- Plastic sandwich bags (3 per group)
- Raw eggs (3 per group)

**Procedures**

1. Divide the class into several small groups, and distribute the materials. Tell students they are going to build and test three parachutes.

2. Give students these directions to build their egg parachutes:
   - From the garbage bags, cut out three squares: one 10-inch, one 20-inch, and one 30-inch square.
   - Make a parachute out of each square: tie a piece of string to each of the corners; attach the ends of the strings to a plastic sandwich bag.
   - Place a raw egg in each of the sandwich bag

3. Ask students to predict which egg has the best chance of surviving a 10-foot drop and to explain the reasoning behind their predictions.

4. Have the groups test their predictions by dropping all three of their parachutes from a height of 10 feet.

5. When the groups are finished with the experiment, ask students to describe the forces that acted on the parachutes as they fell and how these forces changed the parachutes’ motion. In what ways did the larger parachutes perform differently than the smaller ones?

6. Review the following with students: Gravity pulled the parachutes downward; air resistance worked as an opposing force to gravity; and the parachutes accelerated until the air resistance equaled the gravity, at which point the parachutes reached terminal speed. Because the parachutes with a larger area fronting the wind created more air resistance than the smaller parachutes, these larger parachutes reached terminal speed earlier.

**Assessment**

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

- **3 points:** Students made predictions based on sound reasoning; carefully performed their experiments; accurately and completely recorded results; presented clear and logical explanations.

- **2 points:** Students made predictions based on sound reasoning; performed their experiments with sufficient care; incompletely recorded results; presented acceptable explanations.

- **1 point:** Students made predictions based on guesswork; performed their experiments with insufficient care; incompletely or inaccurately recorded results; presented sketchy explanations.
**Vocabulary**

**accelerate**
*Definition:* To move faster or gain speed
*Context:* A car will accelerate when the forces propelling it forward are stronger than the forces attempting to slow it down.

**gradient**
*Definition:* Change in the value of a quantity (such as speed, temperature, or pressure) with change in a given variable, and especially per unit distance, in a specified direction
*Context:* On a distance-versus-time graph for a moving object, the gradient is equal to the speed of the object.

**graph**
*Definition:* A diagram that represents the variation of a variable in comparison with that of one or more other variables
*Context:* The motion of a car can be represented on a graph with position plotted on the y-axis and time on the x-axis.

**terminal speed**
*Definition:* The speed at which the downward pull of gravity is balanced by the equal and upward opposing force of air resistance for a falling object
*Context:* Not long after she jumped out of the airplane, the skydiver reached her terminal speed.

**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](http://books.nap.edu).

This lesson plan addresses the following science standard:

- Physical Science: Motions and forces

**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/](http://www.mcrel.org/).

This lesson plan addresses the following national standards:

- Science—Physical Sciences: Understands forces and motion
- Language Arts—Viewing: Uses viewing skills and strategies to understand and interpret visual media
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

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. Forces and Motion (6 min.)

Take a test drive in a Rolls Royce, a sports car, and on a motorcycle as we learn how to calculate and graph speed, acceleration, and stopping distance.
II. The Physics of Falling (6 min.)

What do height, speed, and air resistance have to do with one another when you are falling through the air? Go bungee jumping with Adrian Nicholas and find out!

III. Air Forces (10 min.)

Bicyclists, skydivers, and airplane pilots all rely on the same thing—forces of motion. Learn how friction, gravity, and other forces interact.

IV. The Planet Electric (5 min.)

Electrical energy is always around us, whether we see it or not. Discover some of the ways in which we harness this energy to use in our daily lives.

Curriculum Units

1. Graphing Speed

Pre-viewing question
Q: How do forces of nature affect you in your daily life?
A: Answers will vary.

Post-viewing question
Q: What is constant speed?
A: It’s when an object in motion continues to stay in motion without accelerating or decelerating. On a graph, constant speed appears as a straight line.

2. Acceleration and Deceleration

Pre-viewing question
Q: What is the connection between speed and acceleration?
A: Speed tells you how fast an object is traveling. Acceleration shows exactly how fast an object’s speed is changing.

Post-viewing question
Q: Which is more important to you, the ability to reach a faster speed or a higher rate of acceleration?
A: Answers will vary.

3. Measuring Jumps

Pre-viewing question
Q: What does falling feel like?
A: Answers will vary.

Post-viewing question
Q: What does the height of a jump have to do with the speed of a fall?
A: The greater the height, the more speed the falling object picks up. The top speed of someone falling from a height of five feet will be less than the top speed of someone falling from 10 feet.
4. Forward and Backward Forces

Pre-viewing question
Q: Approximately how fast can you ride a bicycle for a sustained amount of time?
A: Answers will vary.

Post-viewing question
Q: What are the counter forces that attempt to push a moving bicycle backwards?
A: Friction between the tires and the track, friction between moving parts on the bike, and air resistance as the cyclist continues to push along against the force of the air.

5. Changing Speeds

Pre-viewing question
Q: How do you maintain a steady speed when riding a bicycle?
A: You have to keep both forward and counter forces in balance. If you stop applying forward force your bike slows down; too much forward force and your bike speeds up.

Post-viewing question
Q: What happens to counter forces when greater forward force is applied?
A: The greater forward force overcomes the counter forces and acceleration occurs. As the forward force increases, the counter forces of friction and air resistance also increase, although at a lower rate. Eventually, the forces rebalance and a constant speed is again achieved.

6. Skydiving and Gravity

Pre-viewing question
Q: When do you most feel the effects of gravity?
A: Answers will vary.

Post-viewing question
Q: Why do skydivers use parachutes?
A: Parachutes provide greater air resistance. Skydivers use this air resistance to balance the force of gravity and slow their fall, allowing them to hit the ground at a reasonable speed.

7. Using Lift

Pre-viewing question
Q: Why don’t airplanes fall out of the sky?
A: Answers will vary.

Post-viewing question
Q: How does an airplane create lift?
A: Airplane wings are curved on top and flat on the bottom. Air traveling over the top of the wing moves faster, creating less pressure than the air below the wing. The difference in pressure lifts the plane from the ground.
8. Harnessing Electricity

*Pre-viewing question*
Q: In what ways do we use electricity?
A: Answers will vary.

*Post-viewing question*
Q: What are some ways to generate electrical energy?
A: Electricity can be generated from fossil fuels, moving water, solar power, wind power, nuclear power, and geothermal energy.