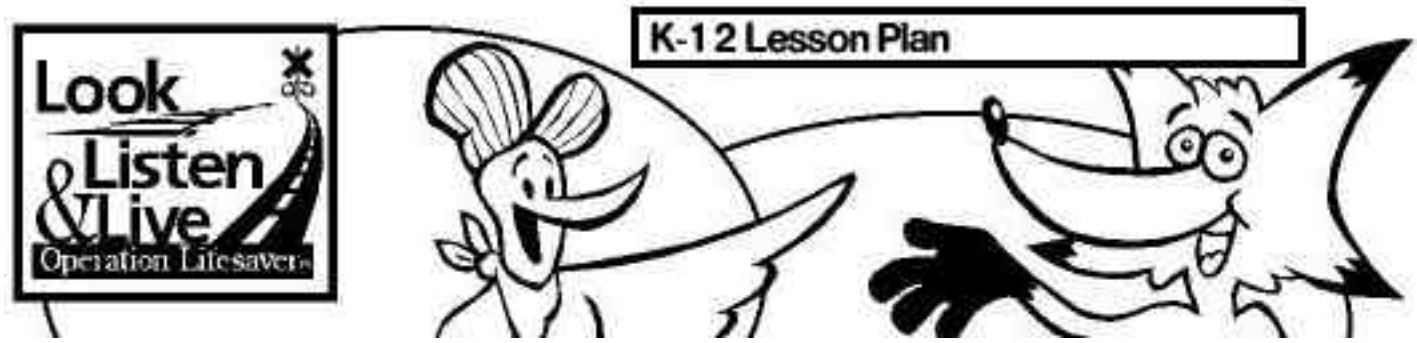

WHEN PUSH COMES TO CRUNCH

Grade: Eighth Grade

Subject:

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SAFETY MESSAGE:

- Trains can move at any time; never crawl under or between trains.

OVERVIEW

This lesson includes an experiment for the science class and can be expanded through optional graphing activities to include math. The experiment uses an inclined plane and balls of various masses to determine the effect a large object has on a small object, as well as the effect of different velocities. This experiment can be done to illustrate momentum, kinetic energy, acceleration due to gravity and forces.

SUGGESTED TIME ALLOWANCE

One or two 40-50 minute class periods (Data collected, graphs made, questions answered on day one; results discussed and optional video viewed on day two.)

OBJECTIVES

Students will be able to:

- Analyze the effect of mass of an object on the distance it travels.
- Analyze the effect of the height of the plane (velocity) on the

distance it travels.
- Describe how mass and velocity are interrelated.
- Graph data gathered during the experiment. (optional)
- Relate the experiment with real-world consequences that may happen at rail crossings if safety messages are not followed.

National Academic Content Standards addressed by this lesson.

MATERIALS

(Per student group of 2-4)

For science experiment:
- 1 inclined plane
- Scale (one per group or one per class)
- 3 balls of different masses
- 1-2 meter sticks (piece of wood or book may be substituted for second meter stick)
- 1 styrofoam cup

For optional math component:
- Graph paper or graphing technology (e.g., calculator or software)

Per student:
- Instruction sheet
- Data collection sheet

VOCABULARY

Inclined plane, mass, velocity, distance
Abbreviations: m = mass, v = velocity, d = distance

PROCEDURES

TEACHER PREPARATION:

Read general background information. Familiarize yourself with the content of the video, *Die Hard If You're Dumb*, if it is available for use with the students.

MOTIVATION:

If available, show a brief clip from the video *Die Hard If You're Dumb*, which shows a car being hit by an oncoming train (a staged accident with no one in car). Ask students: *What kinds of forces are involved in this collision?* Engage students in a discussion that gets them thinking about the effect of mass and velocity on each other: *How are these things related: the train hitting the car, a football player with a tackling dummy on the practice field, and starting the pinball in motion on a pinball machine?* (Use other examples from students' real life.) Lead into the overview of an experiment that students will conduct in class, using an inclined plane and balls of different masses.

ACTIVITY:

1. Divide students into lab groups. Pass out the student instruction and data sheets.
2. Discuss instructions with students, so they understand how to conduct the experiment. Tell students the purpose of the experiment is to observe and graph the effect of the mass of an object on the distance it travels and the effect of the height of the plane on the distance traveled.
3. They will find the mass of each ball and record it on their data sheet. (To save time, you can find the mass of each ball before class and give this information to the students.) Then they will set up the experiment with the inclined plane.
4. Tell them to be sure that their plane is secure. To form the barrier, students can use another meter, yardstick or piece of wood, as well as books or notebooks. They need to be sure the meter stick is always next to the bottom of the inclined plane and at the zero end.
5. Have students run three trials with each ball and record their data.
6. (Optional; for math classes) Have students plot their data on a graph. This can be done on graph paper or using a graphing calculator or software program. On graph paper, the following scale is recommended: 1 block = 5 g and 5 cm for distance. 1

block = 1 on the height of plane axis. Students make 2 graphs: graph 1 is the distance vs. mass; graph 2 is the distance vs. height of the plane.

7. Have students formulate their conclusions by answering the questions provided on their instruction sheet.

   The answers to the questions are:

   1. The larger the mass of the ball, the farther the cup moved.
   2. As the height of the plane increases, so does the velocity of the ball. Therefore, the cup will move farther as the plane height is raised.
   3. At the same height, the balls should travel at the same speed since acceleration is due solely to gravity, which is a constant value. There may be slight differences due to friction between the balls and the plane. As the height of the plane increases, so does the speed of the balls.
   4. A train has a mass about 4000 times that of a car. Since momentum of an object is mass x velocity, the larger the mass, the more momentum an object has. Therefore, a train of large mass would inflict considerable damage to a car.

CONCLUSION:

Discuss the conclusions. Students should have determined that the heavier the mass of the ball, the more force is exerted to move an object. The greater the velocity, the more force is exerted to move an object, also. Wrap up with this question: *From your observations, why would a train do considerable damage to a car in a collision?* Discuss safety messages. If time and resources permit, wrap up with an interactive viewing of *Die Hard If You're Dumb*.

HIGHER ORDER THINKING

To assure students are using critical thinking skills, expand discussion of the experiment to include kinetic and potential energy transfers and/or the momentum of objects. For example: *Why did the cup move? How did the collision affect the velocity of the ball and the cup? Why did the ball roll down the plane?*

ASSESSMENT

- Discussion and completion of data sheet and conclusion questions (Analyze effects of mass and velocity.)
- Discussion and description written on data sheet (Describe how mass and velocity are interrelated.)
- Completion of graphs on paper and/or software (Graph data gathered during the experiment.)
- Discussion of safety messages in relation to experiment (Relate the experiment with real-world consequences that may happen at rail crossings if safety messages are not followed.)

EXTENSIONS

Social Studies: Research accounts of train wrecks and investigate causes and effects.

Language Arts: Conduct a mock trial that places students in the position of determining the liability of the surviving driver of a passenger car that gets hit by an oncoming train. (Car stalled on tracks; occupants get away unharmed) *Should the owner of the car have to pay the railroad for damages to its equipment? Should the railroad have any liability?* Clips from *Die Hard if You're Dumb* may be helpful in initiating discussion.

TEACHER RESOURCES

Background Information
Die Hard If You're Dumb Video
Die Hard Video Clips (Quicktime Required):
    Vehicles Crash with Train
    Three Areas of Railroad Safety
    Trespassing Facts

Judging Train Speed

Video Utilization Tips for *Die Hard If You're Dumb*

NATIONAL ACADEMIC CONTENT STANDARDS

These standards are provided by the Mid-continent Regional Educational Laboratory (McREL) online publication, Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education. <http://www.mcrel.org/standards-benchmarks/>

The following standards are addressed by the activities of this lesson:

Mathematics
Level III: Middle (Gr. 6-8)
Standard 4: Understands and applies basic and advanced properties of the concepts of measurement
Benchmark: Selects and uses appropriate units and tools, depending on degree of accuracy required, to find measurements for real-world problems
Standard 6: Understands and applies basic and advanced concepts of statistics and data analysis
Benchmark: Organizes and displays data using tables, graphs (e.g., line, circle, bar), frequency distributions, and plots (e.g., stem-and-leaf, box-and-whiskers, scatter)

Science
Level III: Middle (Gr. 6-8)
Standard 12: Understands motion and the principles that explain it
Benchmark: Knows that an object's motion can be described and represented graphically according to its position, direction of motion and speed
Standard 15: Understands the nature of scientific inquiry
Benchmark: Designs and conducts a scientific investigation (e.g., formulates questions, designs and executes investigations, interprets data, synthesizes evidence into explanations, proposes alternative explanations for observations, critiques explanations and procedures)

To see related standards for your state, search Achieve's Clearinghouse: < http://www.achieve.org/achieve/achievestart.nsf/Search?OpenForm>
