DAY 3
Rolling Along

CURRICULUM SAMPLE

SCHEDULE

1. Discussion	10 minutes
2. Challenge 1: Will They Stick?	13 minutes
3. Discussion	10 minutes
4. Challenge 2: One Shot	13 minutes
5. Challenge Yourself	6 minutes
6. Closing	8 minutes

OBJECTIVE

Students work in groups of 8:

- Complete two challenges that demonstrate the law of conservation of energy.
- Discuss how the law of conservation of energy.
- Continue working on their personal challenge.

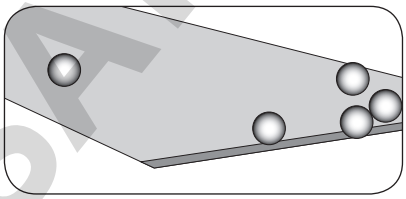
MATERIALS & INSTRUCTOR PREPARATION

- KWL Charts (1 per student)
- Pencils (1 per student)
- 8 Stopwatches (1 per group)

- 160 Marbles (20 per group)
- 8 Strips of Double Stick Tape 2' long (1 per group)
- 8 Unsharpened Pencils (1 per group)
- 8 Plastic Cups (1 per group)
- Masking Tape
- 8 Page Pockets (1 per group)
- 8 Dry Erase Markers (1 per group)
- 8 Day 3 Handouts (1 per group)
- Challenge Guides (1 per student)
- Group Assignment Signs A–H

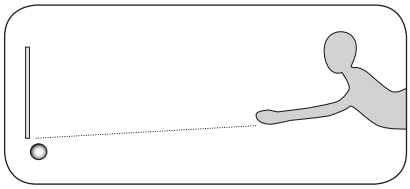
INSTRUCTOR PREPARATION

Challenge 1 (8 groups):



- Designate eight challenge areas at least 4' long and tape one Group Assignment Signs (A—H) at each challenge area.
- Affix a 2' strip of double-sided tape to one end of the challenge area.
- Place 20 marbles in a cup at the opposite end of the challenge area, 4' away.

Challenge 2 (8 groups):



- Place a single unsharpened pencil, standing on end, at one end of the table, or floor space.
- Place 20 marbles in a cup at the opposite end of the challenge area, 4' away.

SUGGESTED WEBSITE LINKS

http://www.phy.davidson.edu/fachome/dmb/PY430/Friction/rolling.html

http://examples.yourdictionary.com/examples/examples-of-rolling-friction.html

http://www.physicsclassroom.com/class/momentum/u4l1a.cfm

VOCABULARY & BACKGROUND INFORMATION FOR THE INSTRUCTOR

The Law of Conservation of Energy—the fundamental principle of physics that the total energy of an isolated system is constant.

STEM Topic: Law Of Conservation Of Energy

The following information can be expanded upon and incorporated at the instructor's discretion. It can also be used to help drive the group discussions.

Science

The law of conservation of energy is a fundamental concept of physics (along with The law of conservation of mass and momentum). The law of conservation of energy states that the amount of energy remains constant and potential and kinetic energy is neither created nor used. It is important to note that energy can be converted from potential to kinetic or transferred from one object to the other, but the total energy remains the same. Basically as kinetic energy increase there is a same amount of decrease in potential energy, and vise versa.

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Technology

Scientist have determined that energy in an isolated system is in a conserved quantity. An isolated system is one that neither matter nor energy can enter or exit. An example of an isolated system is a nuclear power plant. This "new" energy is emission-free energy, "easy" to produce, and, therefore, can provide energy to a large area with less effect.

Engineering

There are engineers for virtually everything and this includes one who studies the law of conservation of energy. A forensic engineer, for example, uses the principles of the law to recreate accidents on the road, in the workplace, etc. In addition, engineers refer to the law when working with energy, thermodynamics, structures, and more.

Math

To determine if the law of conservation of energy applies, one must calculate the amount of kinetic energy that is produced and the amount of potential energy that is used (or vice versa). Once the calculations are complete and the amounts of energy coming in and going out are determined to be the same, the law of conservation of energy is in effect.

DISCUSSION

1. Ask the student to describe a time they conserved energy. (Answers will vary)
2. With the show of hands, ask the students if they have ever been bowling or watched someone bowl?
3. Ask students to describe what happens when:
    - The bowling ball is released from the bowler hand.
    - Rolls down the lane.
    - Hits the pin.
4. Do you think during these three actions energy was conserved, created, or used? Crazy enough, energy in all three cases was conserved. However, it was transferred from one place to another.
5. Explain to students that the two challenges will provide real examples of the law of conservation of energy. Has anyone heard that term before and/or can anyone explain its meaning? Write their responses on the KWL chart.
6. Explain that after we complete the two challenges we will discuss the law of conservation of energy and see if we were correct.
7. Ask the students if their is anything they want to know about the law of conservation of energy. Write their responses in the "W" column.

CHALLENGE 1

Will They Stick?

Goal: Roll marbles across the challenge area, and have 5 of them stick to a piece of double-sided tape.

Rules: Player can only roll marbles one at a time, and can only use one hand. 5 marbles must be simultaneously stuck to the tape for 5 seconds to successfully complete the challenge.

1. Place students into 8 groups of 3 or 4 and assign them a challenge area A—H.

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2. Identify the jobs associated with the challenge:
   - **Player**—Will attempt to roll marbles across the challenge area, and have 5 of them stick to a piece of double-sided tape.
   - **Timer**—Starts and stops the challenge using a stopwatch.
   - **Recorder**—Records results.
   - **Materials Manager**—Collects, resets, and manages materials by collecting and returning them to the designated area.
3. Go over the format of the challenge area.
4. Send the Materials Manager to collect challenge materials and then on to the challenge area with the rest of their group.
5. Go over the instructions in the Day 3 Handout.
6. Tell the students they will have 10 minutes to complete the challenge.
7. After 10 minutes call the students back to a discussion area or their seats.

DISCUSSION

1. See STEM in the Vocabulary & Background Information section for more information and discussion points.
2. Ask the students to respond to the following questions:
   - What happened to the marble as it traveled down the table? Did you have to increase or decrease the speed on the marble to reach the tape?
   - Do you think the marble used, created, or conserved energy? Did the marble transfer energy? (The friction on the table slowed down the marble and it lost some kinetic energy. However, the ball gained the same amount of potential energy as well, so the marble conserved energy...what it lost, it gained.)
   - In the second challenge you will try to knock a pencil down with a marble. Predict how many marbles you will use to complete the task. What other science/physics topics do you think might apply to this challenge? (Momentum, mass, velocity)

CHALLENGE 2

One Shot

Goal: Player will attempt to knock over a standing pencil by rolling a marble from the opposite end of the challenge area.

Rules: Player can only roll marbles one at a time, and can only use one hand.

1. Place students into 8 groups of 3 or 4 and assign them a challenge area A—H.
2. Identify the jobs associated with the challenge:
   - **Player**—Player will attempt to knock over a standing pencil by rolling a marble 4' from the challenge area.
   - **Timer**—Starts and stops the challenge using a stopwatch.
   - **Recorder**—Records results.
   - **Materials Manager**—Collects, resets, and manages materials by collecting and returning them to the designated area (if 4 in a group).
3. Go over the format of the challenge area.
4. Send the Materials Manager to collect challenge materials and then on to the challenge area with the rest of their group.
5. Go over the instructions in the Day 3 Handout.

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6. Tell the students they will have 10 minutes to complete the challenge.
7. After 10 minutes call the students back to their seats and discuss their results.

CHALLENGE YOURSELF

Students will have six minutes to work on their personal challenge. Refer them to their challenge guide for support details and documentation requirement.

CLOSING

1. Invite students to discuss the two challenges and identify the following:
   - Which challenge proved to be most difficult? Why?
   - What strategies were most effective in Challenge 2?
2. Refer students the KWL Chart. Ask them to tell you what they learned today and write their responses in the "L" column.
3. Clean up supplies and collect page pockets, KWL charts, and Challenge Guides.

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