It's All Downhill From Here

Create the fastest rolling object with a 5" diameter that will travel down a 6' incline.

Subjects and Skills

- Geometry of circles and cylinders
- Calculating surface area
- Kinetic energy, velocity, acceleration
- Mass, law of gravity

Materials

- Paper
- Straws
- Tape
- Rulers
- Timers with stop/start buttons
- Incline of 6' (e.g., a plank leaned against a desk, a slide)
- Rubber band

Vocabulary

- Circumference
- Pi
- Cylinder
- Surface area
- Kinetic energy
- Velocity
- Acceleration
- Inclined plane
- Mass
- Gravity

Purpose

An understanding of the core concepts of mechanical energy, either as kinetic energy (energy of motion) or potential energy (stored energy of position), is the foundation of mechanical engineering. The physics of mechanical energy play a significant role in everything we do.

Objectives

Students will:

- understand how kinetic energy and potential energy relate to motion;

- apply previously learned mathematic concepts, such as circumference and area of circles, as they learn how mass and speed play an important role in the movement of an object;
- discover how kinetic energy can be transferred in different ways; and
- understand how kinetic energy can be transformed into electricity.

Activity Preparation

1. Run off activity sheets.
2. Gather materials and place them in two separate areas of the room. Be sure that you have an incline that will work for all students to use, such as a plank propped against a desk. This incline should be around 6' long.
3. Bookmark websites to be used in class.
   a. http://www.teachertube.com/viewVideo.php?video_id=127812
   b. http://tinyurl.com/28mxzf6
   c. http://www.teachertube.com/viewVideo.php?video_id=53066

Activity Procedure

1. Write "Kinetic Energy" and "Potential Energy" on the board. Ask students to share what they know about both types of energy.
2. Stretch a rubber band and hold it in the "ready" position, but do not let go. The stretch demonstrates potential energy. Aim the rubber band at a wall, and discuss how potential energy is converted to kinetic energy as you launch it at the wall.
3. Drop an object from the top of a desk. Throw an object across the room. Ask, "What types of energy were being used in these objects' movements?"
4. Discuss that the amount of kinetic energy depends upon the mass and speed of the object. Mass refers to how much matter is within an object. All objects and materials have mass.
5. Allow 5 minutes for students to work with a partner to explain their understanding of mass and the differences between kinetic and potential energy.
6. Share the video (3:55) on kinetic and potential energy found at Link a.
7. Pass out the activity sheet, and explain that students will be applying their understanding of energy in today's challenge.
8. Play the energy song at Link b. or show the video with lyrics (01:59) at Link c.
9. Have students complete the individual portion of the activity sheet. Divide students into small groups of two or three students each, and assign a number to each team.

10. Review the challenge with students and answer any questions they may have.
11. Conduct the challenge. If possible, you may choose to have teams race their rollers two at a time, rather than timing the rollers on an individual basis. This makes things a bit more exciting, as the students are watching the rollers compete one on one. The number of timers you use, as well as who does the timing, are up to you—things can get a bit contentious if more than one person is timing a race, but if somebody is timing and makes an error, the students may get upset. Thus, it may be best if you time all of the races or if there are designated timers.
12. After the challenge, discuss the results with students and have them complete their activity sheets.
13. If you wish, assign one of the activities suggested in Extend the Learning With Kinetic Energy: Online Resources and Activities.

Name: _____ Date: _____

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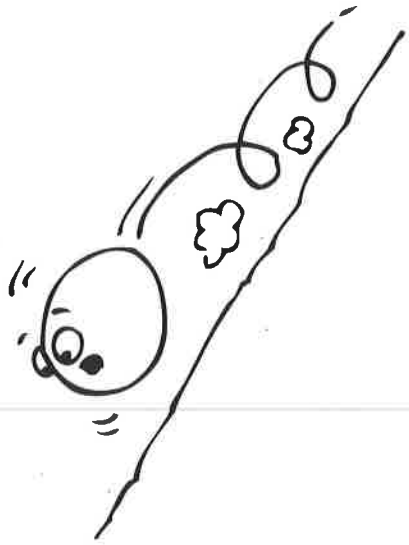


GOAL

- Create the fastest rolling object with a 5" diameter that will travel down a 6' incline.

MATERIALS

- Paper
- Straws
- Tape
- Rulers

TIME TO CREATE

- 15 minutes

INDIVIDUAL ACTIVITY

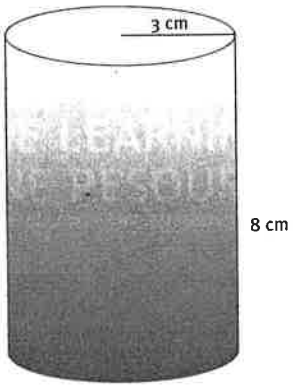
Read the following information and respond to the questions.

When you ride your bike down a hill, it's easy to go fast. Gravity is handling the work, so you don't have to exert much energy. The length and steepness of the hill can increase your speed—the steeper and longer the hill, the faster you go. The distribution of your mass and the incline of the slope will also affect the speed of movement.

When describing the motion of objects, we're actually describing kinetic energy, energy characterized by the movement of an object. Understanding kinetic energy helps us to use natural forces and/or create machines to improve the quality of our lives.

You will apply your understanding of kinetic energy in today's team challenge. However, before you begin the challenge, you'll need to refresh your memory on some geometric principles.

1. Define circumference. _____
2. What is half of a diameter called? _____
3. What is the value of pi? _____
4. To find the circumference of a circle, multiply pi by the: _____
5. What is the formula to find the area of a circle? _____
6. Find the circumference and area of a circle with a 3-inch radius. _____
7. Define surface area. _____
8. What is the formula for finding the surface area of a cylinder? _____
9. Imagine taking apart the cylinder on the following page. You would have the top, bottom, and middle. This is called a net. Think about the shapes of each part. Draw the net and include the measurements for the radius on the top and bottom, and the length and width of the middle.



10. Find the area of the: top: _____ bottom: _____ middle: _____
11. What is the surface area of this cylinder? _____
12. What is the formula for finding the volume (inside area) of a cylinder? _____
13. Use this formula to find the volume of the cylinder in Question 9. _____

TEAM CHALLENGE

Participants will work in teams of two or three to create a rolling object with a 5" diameter within an allotted time of 15 minutes. A 6' slope of approximately 45 degrees will be provided by the teacher, and all of the teams will use this slope. The goal is to have the roller that travels the fastest down this slope.

Start Time _____: _____ + 15 Minutes = _____:_____ End Time

1. For each race, record the times of each team's rollers. Find the sum of each column.

Roller #1: _____ : _____	Roller #2: _____ : _____	Roller #3: _____ : _____
Roller #4: _____ : _____	Roller #5: _____ : _____	Roller #6: _____ : _____
Roller #7: _____ : _____	Roller #8: _____ : _____	Roller #9: _____ : _____
Roller #10: _____ : _____	Roller #11: _____ : _____	Roller #12: _____ : _____
Roller #13: _____ : _____	Roller #14: _____ : _____	Roller #15: _____ : _____
Column sums: _____ : _____	_____ : _____	_____ : _____

2. Using the column sums, compute the average of all rollers. Show your work.

Average time: _____ : _____

3. What do you think contributed to one roller being faster than another? Support your ideas.

4. If you were to create the roller again, what would you do differently and why?

5. In what real-life situations might this information be useful?

EXTEND THE LEARNING WITH KINETIC ENERGY: ONLINE RESOURCES AND ACTIVITIES

1. **Design a roller coaster.** Visit one of the following sites to design your own roller coaster:
   - http://www.learner.org/interactives/parkphysics/coaster
   - http://dsc.discovery.com/games/coasters/interactive.html
   - http://sci-quest.org/learn/just-for-kids/build-roller-coaster
   - http://www.questacon.edu.au/indepth/maketracks/maketracks.html
   - http://www.funderstanding.com/coaster
   - http://puzzling.caret.cam.ac.uk/game.php?game=roller
   - http://www.dgp.toronto.edu/~lockwood/coaster/coaster.htm

2. **EdHeads resources.** Visit the EdHeads glossary and complete the lever lesson, and then play the game and go on the WebQuest.
   - Glossary: http://www.edheads.org/activities/simple-machines/glossary.htm
   - Lever lesson: http://www.edheads.org/activities/lesson_plans/pdf/sm_03.pdf
   - Game: http://www.edheads.org/activities/simple-machines/index.htm
   - WebQuest: http://www.edheads.org/activities/lesson_plans/pdf/sm_04.pdf

3. **Review games.** Visit the following Disney sites to play games that review kinetic and potential energy:
   - Rat 'n' Roll Pinball: http://www.disney--games.com/rat_n_roll_pinball_63.html
   - Disney Friends Golf: http://www.disney--games.com/disney_friends_golf_145.html
   - Disney Baseball: http://www.disney--games.com/disney_baseball_197.html