Throughout the guide teaching tips are in red.

Activity Description and Estimated Class Time

In this activity, students measure the transformation of potential energy into kinetic energy. The activity consists of three parts. In part one, students experience how the height of a ramp affects the distance a marble will travel across a surface. In part two, students vary the mass of balls rolling down a ramp to experience changes in the distance the ball travels. In part three, students use information gathered in the first two parts to solve an engineering challenge. Each part requires one class period.

Objectives

Students will develop an understanding of the following ideas and content:

- Potential and kinetic energy
- Factors that affect potential and kinetic energy

Correlations to North Carolina Science Standards

7.P.2.1 Explain how kinetic and potential energy contribute to the mechanical energy of an object.

Brief Science Baground

To lift a marble above the floor, you have to do work on the marble against the force of gravity. The work done on the marble is stored as a form of energy called "potential energy." This is a form of energy associated with position. As long as the marble remains at a certain height above the floor (above the Earth) the stored potential energy is constant. When we drop the marble, the potential energy transforms into the energy of motion, which we call "kinetic energy."

The amount of potential energy stored and the amount of kinetic energy released are directly related. In this investigation, students store potential energy by raising a marble a measured distance above the floor. When the marble is released, it rolls down the ramp to push a folded index card across the floor. The distance the card slides serves as a way to measure the amount of energy released by the marble. Students find a relationship between the height of the ramp and the distance the card slides: the higher the ramp, the farther the card slides. The more potential energy in the marble, the more kinetic energy it releases. Potential energy is also related to mass. Objects of different mass raised to the same height have different amounts of potential energy. Those with more mass have more, and they release more kinetic energy. Part two gives students experience with balls of different mass.

Part 1 – How does height affect kinetic energy? (55 minutes)

Materials and Procedures

Materials for the whole class

- Masking tape

Materials for groups of 2 students

- Marble
- 2 rulers
- One 4"x6" index card
- Tape measure

- 1 copy of Support Document 1 (SD-1), Potential and Kinetic Energy (height)
- Student notebook*

* supplied by the teacher

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Procedure

Exploration – 5 minutes

1. Ask students to share examples of energy and to explain what they think about it. **Accept all answers without correction.**
2. Hold a book a few feet above a table, as still as possible. Ask the class if the book has energy? **Again, accept all answers.**

   Drop the book and repeat the question.
3. Introduce a working definition of energy: "Energy is what makes things move or change." Explain that we will explore energy during the next several activities.

Explorations are intended for students to engage with materials and concepts, ask questions, and share what they notice. Avoid teaching content in an exploration, even during discussions.

Activity – 40 minutes

1. Inform students that we will begin to explore some factors that affect energy and hand each pair of students these materials:
   - A copy of SD-1
   - A marble
   - A 4"X6" index card
   - Two rulers
   - A tape measure

   Students also need access to masking tape to complete the set-up.
3. Walk the students through the preparation section of SD-1 to ensure their set-up is correct.
4. Allow students time to complete the instructions on SD-1.

Content Wrap-Up – 10 minutes

1. Ask students to share their results and discuss the questions in the analysis section of SD-1.
2. Share the following definition with the class:

   Potential energy is energy that is stored in an object. An object that is not in motion can have potential energy.

   Ask students to write the definition in their notebook and provide an example of potential energy from the activity. Also, ask students to record factors that can affect potential energy.

At this point students should be able to explain that a marble sitting on the ramp has potential energy, and that its height is a factor that affects its potential energy. Students will see the effect of mass on potential energy in Part 2.

3. Share the following definition with the class:

   Kinetic energy is the energy that an object possesses due to its motion.

   Ask students to write the definition in their notebook and provide an example of kinetic energy from the activity. Also, ask students to record factors that can affect kinetic energy.

   For example, faster or slower. At this point, they are unlikely to think of mass.

4. Explain that both potential and kinetic are forms of mechanical energy that involve motion.

Part 2 – How does mass affect kinetic energy? (55 minutes)

Materials and Procedures

Materials for the whole class

- Masking tape

Materials for groups of 2 students

- Marble
- Steel ball
- Wooden ball
- 2 rulers
- One 4”x6” index card
- Tape measure
- 1 copy of Support Document 2 (SD-2), Potential and Kinetic Energy (mass)
- Student notebook*

*Item supplied by the teacher

Procedure

Exploration – 5 minutes

1. Ask students to share what they have learned about potential and kinetic energy, including how height affected their results.
2. Ask students to speculate how the mass of the ball might affect potential and kinetic energy.

Explorations are intended for students to engage with materials and concepts, ask questions, and share what they notice. Avoid teaching content in an exploration, even during discussions.

Activity – 40 minutes

1. Explain that we will explore how mass affects potential and kinetic energy.

2. Give each pair of students:
   - A copy of SD-2
   - A marble
   - A wooden ball
   - A steel ball
   - A 4”X6” index card
   - Two rulers
   - A tape measure

   Students also need masking tape to complete the set-up.
3. Allow students time to complete the instructions on SD-2.

Content Wrap-Up – 10 minutes

1. Ask students to share their results and discuss the questions in the analysis section of SD-2.
2. Have students add information about how mass can affect potential and kinetic energy to their notebook entries from Part 1.

Part 3 – Hit Your Mark (50 minutes)

Materials and Procedures

Materials for the whole class

- Masking tape

Materials for groups of 2 students

- Marble
- Steel ball
- Wooden ball
- 2 rulers
- One 4”x6” index card
- Tape measure
- Student notebook* with data from part 1 and part 2 of this lesson

*Item supplied by the teacher

Procedure (challenge)

1. Explain that the class will use the set up and materials from the previous two parts of this activity.
2. Their goal is to solve the challenge in as few trials as possible. Students are encouraged to use all data they have previously collected.

Challenge 1:

Using the steel ball, what ramp height will cause the folded index card to travel 58cm? (Allow a range of 57-59 cm).

Encourage students to use data collected from part 1 and 2 of this activity. Ask them to record in their notebooks the height they predict the steel ball should be released from, and give reasons for the prediction. After they test, let them predict again for each trial until they succeed. Repeat this with all three challenges.

Challenge 2:

Using the marble, what ramp height will cause the folded index card to travel 25cm? (Allow a range of 24-26cm).

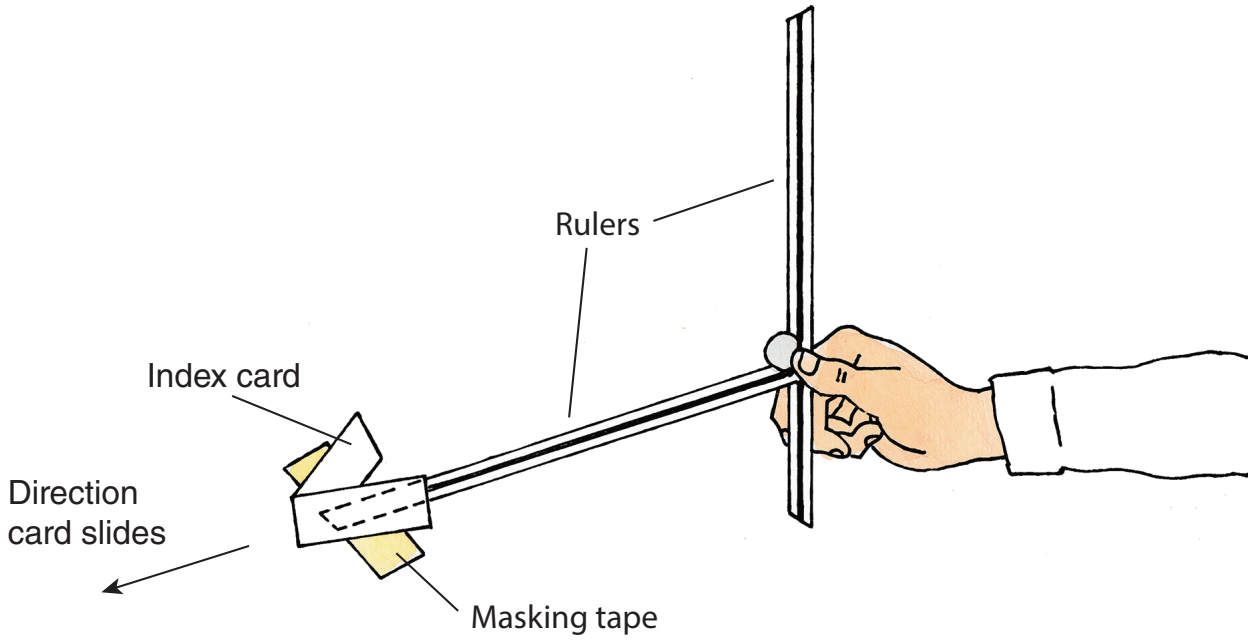
Challenge 3:

Using the wooden ball, what ramp height will cause the folded index card to travel 15cm? (Allow a range of 14-16cm).

Wrap-Up – 10 minutes

At this point students should be able to describe potential and kinetic energy and explain factors that affect them. Lead a class discussion about these topics, related to the activity.

Support Document - 1, Potential and Kinetic Energy (height)



Preparation

1. Place about 3 inches of masking tape on the floor perpendicular to the direction your index card will slide. Allow about a meter of room beyond the tape to measure the distance that the index card slides.
2. Fold an index card in half, lengthwise, then once again in the middle to make a "V."
3. Set up 2 rulers and a folded index card on the floor as shown in the figure so that the bottom of the ramp touches the far side of the masking tape and the index card is at the bottom of the ramp.
4. Practice releasing the marble at different heights and measuring the distance the card travels.

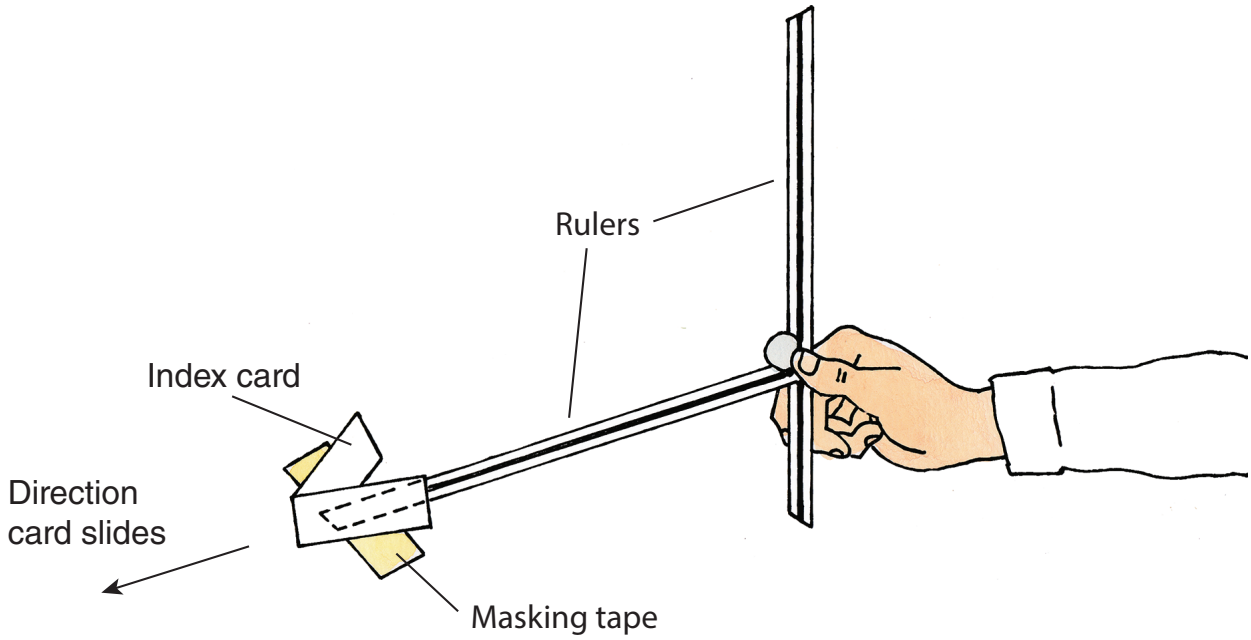
Experiment:

5. Choose 3 heights from which to roll the marble. You will roll 3 times from each height and record the results. Then you will choose the median distance the card traveled for the 3 trials at each height. Test heights may range from 3-15 cm.
6. Before you begin, create a data table in your notebook to collect all of your data.
7. Test, collect and record data. Choose the median distance for each height.

Analysis:

8. How did the height of the marble affect the distance the card traveled?
9. What other factors may have affected the results?

Support Document - 2, Potential and Kinetic Energy (mass)



Preparation

1. Place about 3 inches of masking tape on the floor perpendicular to the direction your index card will slide. Allow about a meter of room beyond the tape to measure the distance that the index card slides.
2. Fold an index card in half, lengthwise, then once again in the middle to make a "V."
3. Set up 2 rulers and a folded index card on the floor as shown in the figure so that the bottom of the ramp touches the far side of the masking tape and the index card is at the bottom of the ramp. Set the ramp ruler at 10cm.

Predictions (record in your notebook):

- Which ball will push the card farthest? How far do you expect it to go?
- Which ball will push the card the shortest distance? How far do you expect it to go?

Experiment

4. Release all three balls—glass, wood, and steel—from 10cm. Roll each ball 3 times and record the results. Choose the median distance for each ball.
5. Before you begin, create a table in your notebook to collect and organize your data.
6. Test, collect and record data. Choose the median distance for each ball.

Analysis:

7. How did the mass of the ball affect the distance the card traveled?
8. What other factors may have affected the results?