Optional Formative Assessment 4.3a


Image via iStock.com/Jag_cz

Anchoring Phenomenon

A Rube Goldberg® machine stalls.

Assessment Concept

Carry out an investigation that explores how energy can move from place to place and be transferred in various ways.

Investigative Phenomenon

Bowling pins can fall even if the ball doesn't touch them directly.

Standards

Refer to Appendix 4.3a for NGSS standards.

A project of CA NGSS K–8 Early Implementation Initiative.

TEACHER NOTE

Use this **optional assessment** if students need support to understand that observations can produce data as evidence, that within a system, moving objects contain energy, that the faster the object moves, the more energy it has, and that energy can be moved from place to place by moving objects. **Use student work from Steps 15 and 16 to see if students better understand the learning goals.**

Time

90 minutes

Part I

20 minutes

Part II

30 minutes

Part III

20 minutes

Part IV

20 minutes

Materials

Whole Class

- ❑ 4.2.C1: Energy Questions (from Lesson 2: Oops!)
- ❑ 4.3a.R1: Bowling Alley Picture
- ❑ *2 Kids, One Dream* video (https://www.youtube.com/watch?v=5Eb_NVjFah0)

Groups (Groups of 2)

(Note: These supplies are also used in Lesson 3: Collisions and Speed).

- ❑ 10 Marbles
- ❑ 20 Dominoes
- ❑ 2 Rulers with a center groove
- ❑ 4 Wooden blocks

Individual

- ❑ *Key Concepts: Energy Basics* by Glen Phelan

Advance Preparation

1. Gather materials from Lesson 3: Collisions and Speed.
2. Have available the **4.2.C1: Energy Questions** from Lesson 2: Oops!
3. Test the *2 Kids, One Dream* video to make sure it works.
4. Determine the number of copies of the book, *Key Concepts: Energy Basics* by Glen Phelan, that you will need.

Procedure

Part I

(20 minutes)

1. Play the *2 Kids, One Dream* video. Ask students to work in partners to generate questions about their observations. Chart their questions.
2. Conduct a brief discussion as to whether the bowling video is similar to the *Tom and Jerry* and *Audri's Rube Goldberg Machine*. If so, in what ways? Chart their ideas.
3. Display **4.3a.R1: Bowling Alley Picture**. Ask students to respond to the following prompt in their science notebook: "What are the components of the system?" *ESRs: The lane, the ball, the pins.* "How do these components interact with each other?" *ESRs: The ball rolls down the lane. The ball hits the pins. When the ball hits one pin, that pin hits others.*
4. Remind students of the questions on **4.2.C1: Energy Questions**. Ask them to think about these as you replay the *2 Kids, One Dream* video.
5. Ask students to discuss in partners, then do a class share:
   a. "What was the system of interest?" *ESR: The bowling alley*
   b. "What are the parts of the system?" *ESRs: The lane, the ball, and the pins*
   c. "What observable changes are taking place in the system?" *ESR: The contact force of the ball rolling down the lane moves to the first pin it hits. When the ball hits one pin, that pin hits other pins and applies a contact force.*
   d. "How is the energy transferred?" *ESR: Each time a contact force is applied, energy transfers from one object to another.*
      - "Where did the energy come from?" *ESR: A person had to transfer energy to the system by picking up the bowling ball and rolling it down the lane.*
      - "What did the energy do?" *ESR: When the ball hits the pin, energy transferred from the ball to the pin, and the energy transfers from that pin to the next pin.*
      - "Where did the energy go?" *ESR: The last pin moves further than the others because all of its energy moves to the air instead of some energy moving to another pin.*

Part II

(30 minutes)

6. Have students recall what they learned in Lesson 3: Collisions and Speed when they explored using marbles, dominoes. and blocks.
7. Explain that students will continue to explore the transfer of energy by creating their own mini-bowling alley chain reaction system using the materials from Lesson 3: Collisions and Speed (marbles, dominoes, and rulers).

TEACHER NOTE

The chain reaction must contain two contact forces. A simple example is a marble hits a domino that hits another domino. A marble hits (energy transfer) a marble and then hits a domino. Encourage students to be as complex as they want!

8. Provide students with the following prompt: "Design a chain reaction mini-bowling alley system using these materials: marbles, dominoes, and rulers. Your system must include at least two contact forces (energy transfers)."

9. Ask students to draw a picture of their system (setup). "What components are in the chain reaction system? How many marbles, how many dominoes, and what other components are in the system?"

10. Ask students to answer these questions on their drawing: "How do the components interact? How does the chain reaction start? What is the observable evidence that energy transfers? Where does the energy go at the end of the reaction?"

TEACHER NOTE

Use students' answers to Steps 9 and 10 to look for gaps in understanding. Ask probing questions during Part III to help students refine their thinking.

Part III

(20 minutes)

11. At the end of about 20 minutes, ask students to conduct a data discussion. (See Teacher Note for more details.) Use **4.2.C1: Energy Questions** to help students share their ideas. Ask several students to share their observations. During the discussion, have students state how similar or different their answers were for how energy transferred into the chain reaction systems they created.

TEACHER NOTE

Data discussions are held after students have an opportunity to collect data. These discussions connect the investigation question with data. In this lesson, most of the student data will be qualitative. In data discussions, students grapple with discrepant or anomalous data, identify data that can serve as evidence to support a claim, and link data to a representation. During this discussion, students compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.

For more information about Talk Science and the discussion types, visit
https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf
https://inquiryproject.terc.edu/shared/pd/cc/DiscussionTypes.pdf

12. At the end of the discussion, ask students what was the same about all of the chain reaction systems. *ESR: The components used; the energy transferred in all of them when objects touched/contacted another object.* Then ask, "What was different about the chain reaction systems?"

13. Allow time for students to record any new ideas that they would like to apply to their chain reactions and anything they are still wondering about.

> **TEACHER NOTE**
>
> At this point in the lesson, content reading should be embedded. If you do not have access to the recommended book, a different book or article that contains pictures with examples of energy transfer (moving from one place to another or moving from one object to another) can be used instead.

14. Have students read Chapter 1 of *Key Concepts: Energy Basics* by Glen Phelan. Let students know that after reading, they will discuss the images using the following prompt with an elbow partner:

    a. Go back through Chapter 1 and look at each picture. "What changes are happening in each drawing or photo? What contact forces do you see being applied? How is energy being transferred?" *ESRs: Page 6: The dog has jumped in the air and stopped the motion of the Frisbee™. Page 7: The train is moving, shaking the tracks, and making noise. Page 9: The girl is diving and making a splash and noise as she enters the water.*

    b. What do you think causes that change? *ESR: Energy causes all of these changes.*

Part IV
(20 minutes)

15. ▶ Have students respond to the following prompt in their science notebook. "Using evidence from your science notebook and the reading, explain how we know that energy is transferred between the components within a system and between systems. What observable evidence do we have?" *ESRs: When things in a system move, we know that energy transferred. When the bowling ball was rolled down the lane, the person transferred energy to the ball to make it move. The ball hit the pin and energy transferred from the ball to the pin. When things are moving, it is evidence that energy transfers. In the* Tom and Jerry *video, energy transfers each time a new thing moves. When we set up our mini-bowling alley, energy transferred from the moving marble to the first domino, and then from the first domino the next domino.*

> **TEACHER NOTE**
>
> ▶ Use student answers to assess understanding.

16. ▶ Have students respond to the following prompt in their science notebook. Students can use data from their science notebook to respond. "Describe a series of actions you did in our lessons or saw happen in your life that involved energy transferring at least three times. Describe how you know energy transferred in the system. What was your observable evidence?"

    ESRs:
    Energy transfers between objects. I can observe changes in the system as evidence that energy was transferred.

    This morning when I walked to school, I opened the door and closed the door. When I got to the corner, I pressed the button for the walk light, and the walk light changed to green.

    In the video we watched (Audri's Rube Goldberg Monster Trap)*, the boy pushed the dominoes, which made the bowling pin fall, pushing the gyroscope to make the marker top push the marble down the spiral tube, into the straight tube. When the marble hit the toaster switch the energy was moved by electrical current to heat which pushed the lever up.*

References

Blayze, J. (2013, May 4). *2 Kids, One Dream: The PBA Tour 3 & 7 Year Old Bowling Prodigy DJ aka Little Norm Duke & JEM*. Retrieved from https://www.youtube.com/watch?v=5Eb_NVjFah0

Phelan, G. *Key Concepts: Energy Basics* (2014 ed.). Sally Ride Science.

TERC. (n.d.). *Four Discussion Types*. Retrieved from https://inquiryproject.terc.edu/shared/pd/cc/DiscussionTypes.pdf

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Toolbox Table of Contents

Bowling Alley Picture

Image by Skitterphoto via pexels.com

Appendix 4.3a

Optional Formative Assessment

Next Generation Science Standards (NGSS)

This lesson is building toward:

SCIENCE AND ENGINEERING PRACTICES (SEP)
Planning and Carrying Out Investigations
• Make observations ~~and/or measurements~~ to produce data to serve as the basis for evidence for an explanation of a phenomenon ~~or test a design solution~~.

DISCIPLINARY CORE IDEAS (DCI)
PS3.B Conservation of Energy and Energy Transfer
• Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects~~, or through sound, light, or electrical currents. Energy can be converted from one form to another form~~.

CROSSCUTTING CONCEPTS (CCC)
Systems and System Models
• A system can be described in terms of its components and their interactions.