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## Anchoring Phenomenon

A Rube Goldberg® machine stalls.



## Lesson Concept

Ask questions about the contact forces and energy used to cause chain reactions.



## Investigative Phenomenon

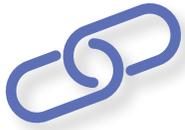
In a Tom and Jerry cartoon, objects in a chain reaction move with one initial contact.



## Standards

Refer to Appendix 4.1 for NGSS, CCSS (ELA), and California ELD standards.

## 4.1 What's Going On?



### Storyline Link

This is the first lesson of this learning sequence and introduces the students to a phenomenon (chain reactions in a cartoon) to which they can initiate their learning. The lesson provides a common experience for students to learn what a Rube Goldberg® machine is. Students use their prior knowledge from kindergarten through grade 3 about force and motion to observe and describe chain reactions in terms of action (movement) and how the action occurred (forces). They explain their observations in terms of their prior knowledge about energy (DCI and CCC), cause and effect (CCC), and by asking questions (SEP).

In the next lessons, students compare and contrast observations from a Rube Goldberg® machine that works but then fails.

Throughout the unit, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

#### TEACHER NOTE

The concept of energy is difficult for fourth graders to construct intuitively. Most can describe that they need energy to ride their bike or that they eat to get energy to do other things.

The unit is designed for students to describe chain reactions as something that happens because of forces (from grade 3) while starting to make connections to the word *energy*. In Lessons 1–2, it is okay if student thinking about energy is tentative; by Lesson 3: Collisions and Speed students should be using the concept to describe what they are observing.

Try to provide opportunities for students to mention energy. Here is one example of an exchange between student and teacher:

**Student:** The ball was moving because a contact force made it move.

**Teacher:** How did the force cause it to move?

**Student:** Somebody pushed it.

**Teacher:** How did the person get the motion to push it?

Students discuss possible ways that happen; they might use the word *energy*.

**Teacher:** (if students didn't mention energy): Describe a time when you didn't feel like moving.

**Student:** When I was tired; I had no energy

**Teacher:** Was there energy in the Rube Goldberg machine? How do you know?

**Student:** Yes, things moved in the Rube Goldberg machine, so there was energy.

Whenever students mention energy, conduct a discussion with probing questions about what they mean by the word, trying to tie it to their everyday life. *Expected Student Responses (ESRs): I need energy to ride my bike; my baby brother runs out of energy and falls on the floor; when our car runs out of gas, we need to get some to make the car go.*

## 4.1 What's Going On?



### Time

110 minutes

Part I

20 minutes Engage

Part II

45 minutes Engage

Part III

45 minutes Engage



### Materials

Whole Class

- Tom and Jerry* video (<https://www.youtube.com/watch?v=GvnEBX9aedY&feature=youtu.be>)

Groups (Groups of 4)

- Sentence strips
- Chart paper (or large whiteboards)
- Markers

Individual

- Science notebook



### Advance Preparation

1. Gather supplies.
2. Prepare two charts: **Our Questions** and **Our Thinking So Far**. Both charts will be referred to throughout the learning sequence.
2. Test the *Tom and Jerry* video (<https://www.youtube.com/watch?v=GvnEBX9aedY&feature=youtu.be>) to make sure it works.

## 4.1 What's Going On?



### Procedure

#### TEACHER NOTE

This entire lesson is an Engage phase of the 5Es. The lesson is about:

1. uncovering students' prior knowledge and experience,
2. increasing students' awareness of their own relevant ideas and experiences, and
3. expanding and broadening their ideas by hearing others' ideas.

Because there are no right or wrong answers in these initial discussions, it's a good time to encourage every student to add his or her voice.

Accept answers as students provide them. It is okay to ask questions to help students clarify their thinking, but do not at this point try to change student ideas. As students move through the next lessons, there will be opportunities for them to revisit their initial thoughts and build on or modify them.

At the end of the lesson, the class will create the **Our Thinking So Far** chart. This chart will be modified as students go through the learning sequence. In some cases, thinking will be revised, changed completely, or added to.

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/TalkScience_Primer.pdf)

### Part I

#### Engage (20 minutes)

*Ask questions about patterns and cause and effect observations of a chain reaction.*

1. Introduce the lesson with this scenario: "Jenny went to the pantry to get a bag of chips. She noticed a hole in the bottom of the bag and showed it to her mom, who exclaimed, 'We've got mice! We need to get rid of them.' What do you think they might do?" Ask students to think-pair-share some ideas.
2. Ask students to discuss what criteria would make a good mousetrap and chart their ideas.  
*Expected Student Responses (ESRs): One that catches the mouse without harming it; doesn't use chemicals; kills the mouse; kills quickly so the animal doesn't suffer, is small enough to fit in the cabinet, etc.)*
3. Continue the scenario: "Jenny's family looked online to find some solutions and came across this video. They decided to watch it to see if it meets their criteria."
4. Play the *Tom and Jerry* video and tell students to just observe. Then replay the *Tom and Jerry* video and ask students to think about their criteria and record their observations in their science notebook.

## 4.1 What's Going On?

5. ► (Pre-assessment of using criteria to solve problems). Ask table groups to share their observations and conduct a discussion as to whether the mousetrap met the criteria.

*Expected Student Responses (ESRs): It wasn't very efficient; in the end the mouse got away; there were no chemicals; it had too many parts, etc.*

Ask students what questions they have and what are they wondering about. Chart their responses.

### Part II

#### Engage (45 minutes)

*Ask questions about patterns and cause and effect observations of a chain reaction*

6. Ask students to consider what happened and if they could make the trap better. Then replay the *Tom and Jerry* video again, asking students to carefully observe the sequence and write their observations in their science notebook. It may be helpful to pause the video, showing "chunks" to facilitate note taking.
7. Ask students to briefly share their observations with their table group by stating what they observed happening and what caused it. Encourage students to use their notes to help with their sharing.
8. Distribute sentence strips and markers to each group. Ask the groups to record actions that they agreed they observed, using cause and effect words. *ESRs: The fan caused the boat to move across the water; the cuckoo bird sawed the rope, causing it to break and make the safe fall.*
9. After the groups have recorded the actions they observed, replay the *Tom and Jerry* video again and ask if students want to add any additional actions. Provide additional sentence strips if necessary.
10. Replay the *Tom and Jerry* video one more time, and ask table groups to arrange their sentence strips in the order of the actions.
11. Call on several groups to share the order of the actions, so that the class has a sense of how others viewed the actions. It is okay if the groups don't agree.
12. Have several students share how the order of actions represents *cause and effect relationships*. For example identify a cause (fan blows) and the effect (boat moves) as well as the change: the boat was sitting in the water and did not move until the fan created the wind to make it move.

#### TEACHER NOTE

Reflect on students' prior knowledge about cause and effect relationships (from K–2) and how these relationships are used to explain the change. Later in the learning sequence students will test their ideas about cause and effect relationships.

## 4.1 What's Going On?

### Part III

#### Engage (45 minutes)

*Ask questions about patterns and cause and effect observations of a chain reaction.*

13. ► Provide chart paper and markers to each group and ask them to create a model of one section of the mousetrap that involves at least 3 changes. Ask them to describe how the mousetrap works in their section.

#### TEACHER NOTE

► Look for their models to include a drawing of the mousetrap sections and labels for the parts. Look for some explanation of the cause and effect relationships including forces can change object speed or direction of motion (grade 3).

14. Select several groups to share their models. Ask the class to identify patterns in the models (e.g., there is always a cause and effect; there is always motion, and it changes direction and speed).
15. Ask students to individually think about any questions they have about the mousetrap. Have them share their ideas with a partner. Then ask the class to share aloud, charting their questions.

*Expected Student Responses: What is the fewest number of chain reactions you could use to make a mousetrap? What else besides forces makes a mousetrap work? How fast does a chain reaction have to be to move things? Can a chain reaction be slow? In the video, how did the windshield wipers turn on after the banana hits them? Does the mousetrap always work?*

16. Using the **Our Questions** chart made in Advance Preparation, briefly discuss, using testable/non-testable criteria, which of the questions *might lead to an investigation* that would help students to understand their observations.

#### TEACHER NOTE

Reflect on the student's prior knowledge about how to generate questions based on their observations, a K–2 grade band element of asking questions.

Then assess how students are thinking about questions that might lead to an investigation, a 3–5 grade band element of asking questions. The remainder of this 3–5 grade band element of asking questions (which states that students predict reasonable outcomes based on patterns such as cause and effect relationships) is NOT part of this prior knowledge prompt, but it is a skill that will be developed in this learning sequence.

## 4.1 What's Going On?

### TEACHER NOTE

It is okay at this point in the learning sequence if this energy discussion is tentative. Students will strengthen their ideas in the next lessons.

If the students don't mention energy, it is okay to skip Steps 17 and 18; energy will begin to be addressed in Lesson 2: Oops!

17. Build on any questions that ask about what else might be involved in the chain reaction or any question that asks about energy. Conduct a class discussion about energy by first having students talk about the word with a partner, then as a table group. Select several table groups to share their ideas about energy and chart them.
18. Ask probing questions about how they think energy might be involved in the mousetrap. Ask them to return to their models and add any ideas about energy.
19. Have students share and add their input to the **Our Thinking So Far** chart. Record how students are describing their observations based on their concepts about energy.

### TEACHER NOTE

The **Our Thinking So Far** chart will be modified as students go through the learning sequence. Thinking will be revised, changed completely, or added to.

Reflect on the student ideas and take note of IF and HOW the ideas below are shared in the student models. Do not expect this language on the models at this point! Students will build their academic language over the course of the learning sequence. If these ideas are expressed in the student models, or the class chart, consider how to build on them as you facilitate the next lessons.

- Forces can change an objects speed or direction of motion (from grade 3)
- A force started the motion; contact force transfers energy.....(PS3.C)
- Energy can be moved from place to place by moving objects or through sound..... electrical currents (PS3.A)
- Energy is present whenever there are moving objects, sound... (PS3.B)
- When objects collide, energy can be transferred from one object to another (PS3.B)
- Energy can be transferred from place to place by electrical currents which can then be used locally to produce motion.....the currents may have been produced to begin with by transforming the energy of motion into electrical energy (PS3.B)

## 4.1 What's Going On?

### TEACHER NOTE (continued)

Also, take note of students' prior knowledge about the science and engineering practices and crosscutting concepts. Be sure to reflect on student knowledge and understanding of these elements that will be:

- asking questions that can be investigated
- using patterns to make predictions
- identifying cause and effect relationships to explain change

These will be more fully developed in the learning sequence.

## References

Stem Teaching Tools. (n.d.). Talk Science Printable. Retrieved from <http://stemteachingtools.org/assets/landscapes/TalkSciencePrintable.pdf>

TNTuxedoBlog. (March 10, 2012). *Tom and Jerry—Rube Goldberg Fail*. Retrieved from <https://www.youtube.com/watch?v=GvnEBX9aedY&feature=youtu.be>

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# Appendix 4.1

What's Going On?

## Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object. <i>[Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]</i>
4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. <i>[Assessment Boundary: Assessment does not include quantitative measurements of energy.]</i>
4-PS3-3	Ask questions and predict outcomes about the changes in energy that occur when objects collide. <i>[Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]</i>
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* <i>[Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]</i>

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

### SCIENCE AND ENGINEERING PRACTICES (SEP)

#### Asking Questions and Defining Problems

- K–2: Ask questions based on observations to find more information about the natural and/or designed world(s).
- 3–5: Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

#### Developing and Using Models

- Develop and/or use models to describe and/or predict phenomena.

### DISCIPLINARY CORE IDEAS (DCI)

*(Note: Energy is not introduced until fourth grade, so this prior knowledge might be expressed from a student's life experiences or if they have already experienced other learning sequences in fourth grade that address energy DCIs.)*

#### PS3.A Definitions of Energy

- Energy can be moved from place to place by moving objects or through sound, light, or electrical currents.

## Appendix 4.1

### DISCIPLINARY CORE IDEAS (DCI) (continued)

#### PS3.B Conservation of Energy and Energy Transfer

- Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion.
- Energy can also be transferred from place to place by electrical currents, which can then be used locally to produce motion, sound, heat, or light.

#### PS3.C Relationships Between Energy and Forces

- When objects collide, the contact forces transfer energy so as to change the objects' motion.

### CROSCUTTING CONCEPTS (CCC)

#### Cause and Effect

- Cause and effect relationships are routinely identified, tested, and used to explain change.

#### Energy and Matter

- Matter is made of particles.
- Energy can be transferred in various ways and between objects.

#### Patterns

- K–2: Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

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## Common Core State Standards (CCSS)

### CCSS ELA WRITING

#### CCSS.ELA-LITERACY.W.4.8

Recall relevant information from experiences or gather relevant information from print and digital sources; take notes, paraphrase, and categorize information.

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## Appendix 4.1

### California English Language Development (ELD) Standards

CA ELD		
<b>Part 1.4.1</b> Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics		
EMERGING	EXPANDING	BRIDGING
Contribute to conversations and express ideas by asking and answering <i>yes-no</i> and <i>wh-</i> questions and responding using short phrases.	Contribute to class, group, and partner discussions, including sustained dialogue, by following turn-taking rules, asking relevant questions, affirming others, and adding relevant information.	Contribute to class, group, and partner discussions, including sustained dialogue, by following turn taking rules, asking relevant questions, affirming others, adding relevant information, building on responses, and providing useful feedback.
In addition to the standard above, you may find that you touch on the following standard as well:		
<b>P1.4.9</b> Expressing information and ideas in formal oral presentations on academic topics		

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