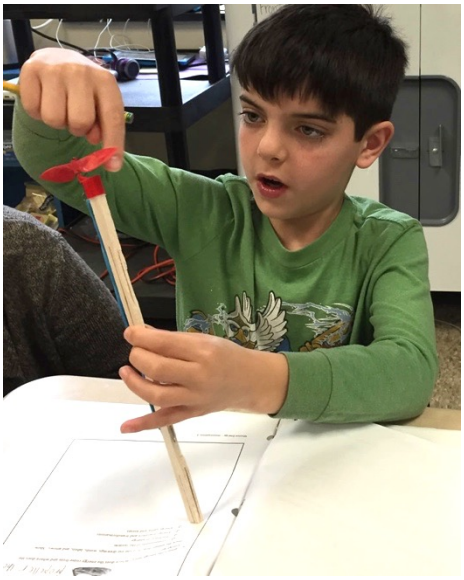
Motion Energy – Investigation 4

What's the energy story of the propeller?



A model airplane propeller attached to an elastic band is the system that students analyze with the Energy Tracking Lens. Students work with Energy Cubes to reason about transfer and transformation in this system and raise the question of where the energy goes after the elastic band unwinds and the propeller stops moving.

A focus of this investigation continues to be on asking where does the energy come from and where does the energy go to "tell the energy story." Students consolidate their learning about the use of energy bars and energy cubes to represent the flow of energy in a system.

Learning Targets Introduced in this Investigation

- The Energy Tracking Lens questions, "Where does the energy come from?" and "Where does the energy go?" provide a useful way of thinking about energy flow in any scenario.
- Drawings and representations help students reason about energy flow and transformation in a scenario.

Sequence of Experiences		
1. Introduction – Link to previous sessions	All Class	10 Minutes
2. Introduce the Question	All Class	10 Minutes
3. Explore the propeller and elastic band	Pairs	20 Minutes
4. Make Meaning	Discussion	20 Minutes
5. Wrap Up Probe	Individual	

Materials and Preparation

For the class:

- A large sheet of paper, approximately 18" x 24" or larger
- A felt tip pen
- 1 propeller-tube set-up (See Preparation)
- 1 springboard
- 1 pompom
- Set of 6 energy cubes

For each small group of 2:

- 1 propeller-elastic band system

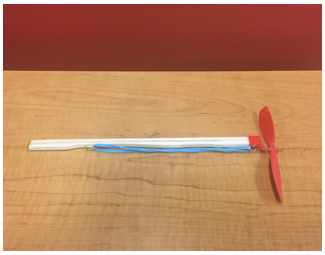
For each small group of 4:

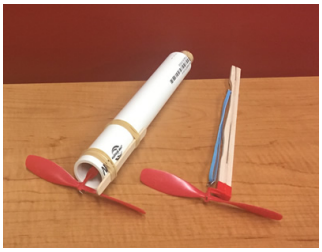
- White board or large sheet of paper
- Markers
- Set of 6 energy cubes

Materials for each group of students

Preparation:

- Propeller-elastic band system. See photos below. Attach the propeller and elastic band to the balsa sticks.
- Propeller-tube system: Insert a propeller-elastic band system into the tube. Push a cork into the end of the tube as shown in the image below, to press the balsa stick against the inside wall of the tube. This should be a snug enough fit to hold the balsa stick in place and prevent the cork from being accidently knocked out, yet not be so tight to make it difficult to remove the cork. The elastic band should remain hidden. Add the popsicle stick and the elastic bands, which act as a braking system. Prior to class, wind the propeller (25-30 rotations is adequate) and set the brake. The source of the energy should remain a mystery for students during the initial class demonstration.





- Watch the *Motion 4: Setting Up and Using Equipment video* available on the *Focus on Energy* website on the Curriculum -> Motion Energy -> Resource Quick Links page.

Motion 4: Setting Up and Using Equipment Video

- Be prepared to show the Unit Wrap Up video, *Giant Paint Paddle* (normal speed and slow motion), available in Motion Energy -> Resource Quick Links on the *Focus on Energy* website.

1. Introduction – Link to previous class sessions

All class – 10 Mins.

Review the following four points from previous classes:

1. In the first 2 classes we looked carefully at **motion energy**

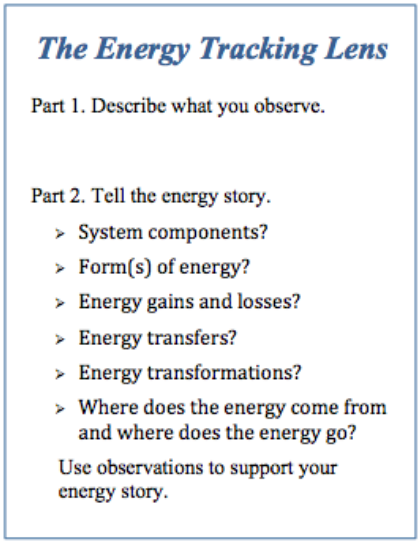
2. In Motion-3A, we looked at another kind of energy**, elastic energy.**

   - An elastic object can change its shape by stretching, bending, twisting, squeezing and then go back to its original shape on its own (spontaneously). Examples: springboard, elastic band.
   - Indicators of amount of elastic energy (amount the springboard is bent, amount the rubber band is stretched).
   - Elastic energy can be **transformed** into motion energy.

3. We learned to use Energy Cubes to tell the energy story of a pompom being flung into the air by a springboard.

4. Whether it's colliding balls or flying pompoms, we keep asking the same questions. Remember, we call this the Energy Tracking Lens:

   Part 1. Describe what you observe.
   Part 2. Tell the energy story.
   System components?
   Form(s) of energy?
   Energy gains and losses?
   Energy transfers?
   Energy transformations?
   Where does the energy come from and where does the energy go?



(The questions are listed at the front of the science notebook.)

Today we're going to look at another scenario that involves both motion and elastic energy.

2. Introduce the Question

All class – 10 Mins.

Today's question is:

What's the energy story of the propeller?

Show propeller in a tube.

Are there indicators of energy? [no motion, no stretching]

Slide the brake (popsicle stick) down, allowing the propeller to spin and then quickly raise it before the propeller stops spinning. Ask for observations.

What happened? Are there indicators of energy?

➔ The propeller moved, which indicates it gained motion energy.

If the propeller gained energy, where did the energy come from? If a gain in one place means a loss in another, what lost energy?

Collect ideas about what's in the tube [battery, twisted rubber band]. Remove tube and reveal propeller/elastic band system.)

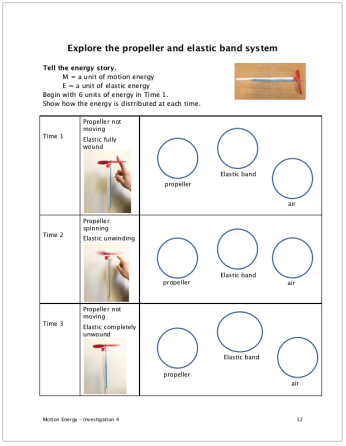
3. Explore the propeller and elastic band system

Pairs – 20 Mins.

Direct students' attention to Notebook p.12, *Explore the propeller and elastic band system*. Highlight directions that are on the notebook page.

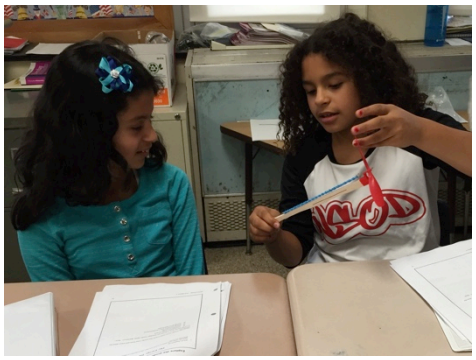
> *Your challenge is to make observations and to describe the energy of the red propeller and elastic band. Begin when the elastic is wound, and the propeller is not moving. Release the propeller and end when the elastic is completely unwound and the propeller is not moving.*

Explain that they have about 15 minutes to explore what happens and to complete the notebook page.



Notebook p.12

Distribute Materials



Give a propeller and elastic band systems to pairs of students.

Warning: *Please don't turn the propeller more than 25 times – We have found that the rubber band can break when twisted more than that.*

Optional: Give energy cubes, a white board or large piece of paper, and markers to groups of four students. This gives them an opportunity to use cubes to share ideas about the energy story and better prepare themselves for the group discussion.

Collect the materials before gathering in a circle for discussion and Energy Cubes.

Learn more about small group learning in *Focus on Energy* lessons.

Small Group Learning video available in Resource Quick Links on the Focus on Energy website

4. Make Meaning

Discussion – 20 Mins.

Form a discussion circle. Ask students to bring their notebooks, open to page 11.

The purpose of this discussion is to use evidence and reasoning to tell the energy story of the rubber band and propeller system and to use Energy Cubes to represent energy flow.

Place a large sheet of paper and a set of energy cubes in the center of the discussion circle.

Hold up a propeller/twisted elastic system.

- Make circles to show the components of the system (propeller, rubber band).

Ask students to use the cubes to tell the energy story, paying particular attention to showing where the energy is at:

- Time 1: When the propeller is not moving, and the elastic band is twisted
- Time 2: When the propeller is spinning and the elastic band is unwinding
- Time 3: When there is no more motion in the propeller or the elastic band

Remind students to check the Energy Tracking Lens as they tell the energy story.

Listen to students' ideas. (The energy cubes move from the rubber band to the propeller, the energy cubes are turned over to show transformation from elastic energy to motion energy.)

Wind and release the propeller again so that students can look for additional evidence. As the elastic unwinds, students may notice that there is both motion energy and stored elastic energy in the same object at the same time.

Ask students for ideas about what happens to the cubes after all motion stops.

- Cubes move out of (transfer from) the propeller circle somewhere else (another circle: "air," "the environment," etc.)

This is a good opportunity to introduce air as part of the system. Students may have felt the air moving. The propeller transferred motion energy to the air.

Optional: The movement of air can be highlighted by asking students what happens when the propeller is turned counterclockwise vs clockwise. What is different? (Air flow changes direction.) This can lead later on to more questions about air being part of the system.

> **Note**: What happened to the energy once the air stopped moving? This is a complex topic but it may come up. First, it's hard to tell when the air stopped moving because it spread out, so more particles of air may just be moving much more slowly. Also, the motion of air eventually transforms into thermal energy, warming the air a tiny, imperceptible amount. A way to acknowledge that the energy did not just disappear is to have another circle for "the environment", which is a way of saying, "We don't know exactly what happened to the energy but we know it went somewhere. It did not simply 'go away'."

Point out that when the cubes were moved from one component to another, this is called **energy transfer**. When the cubes were flipped from one for to another – Elas to M (elastic to motion energy), this is called **energy transformation.**

Ask students to remember the colliding balls.

Was there energy transfer?

➔ yes, from one ball to another

Was there transformation?

➔ no, it was motion energy to motion energy

What about the springboard and pompom?

➔ yes, transfer from the springboard to the pompom and transformation of elastic energy to motion energy of the springboard

Did the springboard or pompom have two forms of energy at the same time?

➔ yes, the springboard had elastic energy and motion energy as it moved back to the unbent position once it was released.

Add to the Model of Energy

What should we add?

➔ Motion energy can be transformed into elastic energy (twisting the rubber band) and vice versa (itself unwinding and spinning propeller)

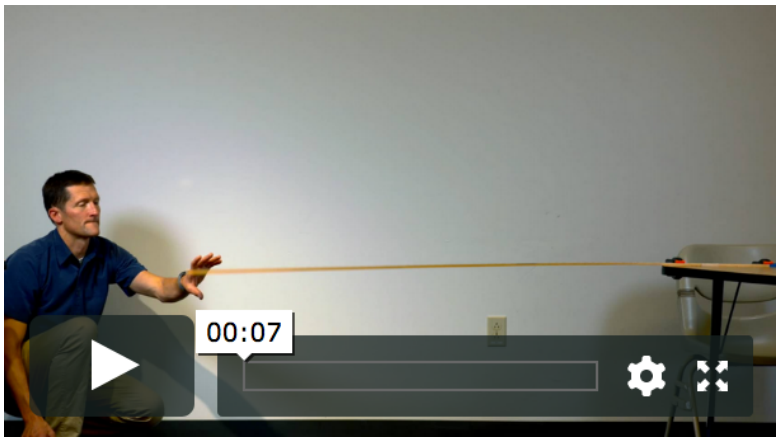
Time permitting, return to the introductory Video Montage. In the video clips, what does motion tell us about energy?

5. Wrap Up Probe

Individual

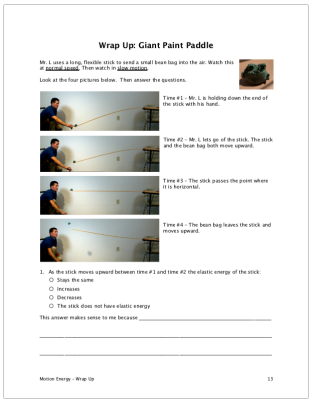
If you don't have time to implement the Unit Wrap Up Probe during this class period, find time to administer the probe prior to starting the next Unit:

- Ask students to turn to page 13 in the Student Notebook.
- Show students the short videos of the *Giant Paint Paddle*, first the normal speed version and then the slow motion version. Read the first question aloud and check that students understand the question. Show the videos one more time. Read the other questions aloud.



The link to the videos is on the Motion Energy Curriculum Resource Quick Links page.

- Allow 5-10 minutes for students to write their responses to the questions.



Wrap Up: Giant Paint Paddle

Mr. L uses a long, flexible stick to send a small bean bag into the air. Watch this at normal speed, then watch it in slow motion.

Look at the four pictures below. Then answer the questions.

Time #1 – Mr. L is holding down the end of the stick with his hand.

Time #2 – Mr. L lets go of the stick. The stick and the bean bag both move upward.

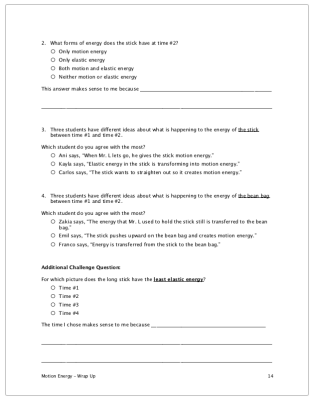
Time #3 – The stick passes the point where it is horizontal.

Time #4 – The bean bag leaves the stick and moves upward.

1. As the stick moves upward between time #1 and time #2 the elastic energy of the stick:
   - Stays the same
   - Increases
   - Decreases
   - The stick does not have elastic energy

This answer makes sense to me because _____

Motion Energy – Wrap Up 13



2. What forms of energy does the stick have at time #2?
   - Only motion energy
   - Only elastic energy
   - Both motion and elastic energy
   - Neither motion or elastic energy

This answer makes sense to me because _____

3. Three students have different ideas about what is happening to the energy of the stick between time #1 and time #2.

Which student do you agree with the most?
   - Ani says, "When Mr. L lets go, he gives the stick motion energy."
   - Kayla says, "Elastic energy in the stick is transforming into motion energy."
   - Carlos says, "The stick wants to straighten out so it creates motion energy."

4. Three students have different ideas about what is happening to the energy of the bean bag between time #1 and time #2.

Which student do you agree with the most?
   - Zahia says, "The energy that Mr. L used to hold the stick still is transferred to the bean bag."
   - Emil says, "The stick pushes upward on the bean bag and creates motion energy."
   - Francis says, "Energy is transferred from the stick to the bean bag."

Additional Challenge Question:

For which picture does the long stick have the least elastic energy?
   - Time #1
   - Time #2
   - Time #3
   - Time #4

The time I chose makes sense to me because _____

Motion Energy – Wrap Up 14

Notebook, p. 13 and 14

Wrap Up Probes are formative assessments. As such they are opportunities for both students and teacher to reflect on their learning. Plan time for students to discuss their responses to the probe, raise questions and clarify any area of confusion.

You might choose to collect students' notebooks before this discussion and project Wrap Up probe questions to guide the discussion. Or, you might have students keep their notebooks so they can refer to their responses during the discussion. At the conclusion of the discussion, you might provide time for students to revise their responses if they wish.

The interpretation guide (on the *Focus on Energy* website, in Curriculum Units -> Motion Energy -> Resource Quick Links) will help you interpret student multiple choice answers and open-ended explanations.