FOCUS ON ENERGY
IMPLEMENTATION WORKSHOP GUIDE

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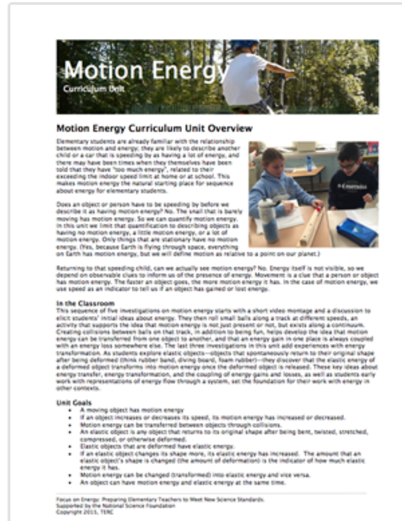
Motion Energy
Curriculum Unit
Motion Energy Curriculum Unit Overview

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LETTER TO THE WORKSHOP LEADER

Dear Workshop Leader

These materials will help you get ready to lead an Implementation Workshop for the *Focus on Energy* curriculum. This curriculum is a carefully crafted, research-based progression about Energy for grades 3-5. The curriculum includes a detailed *Teacher's Guide* and additional resources for teachers. Why hold an implementation workshop? A teacher who is about to use the *Focus on Energy* curriculum for the first time has a lot to think about and will have many questions:

- big picture questions about the key science ideas, science practices, and crosscutting concepts,
- logistical questions about using and managing materials,
- pedagogical questions about how students collect and use evidence or learn to reason scientifically.

This workshop

- helps teachers answer some of these questions
- illuminates the organization of the *Focus on Energy* website
- facilitates teachers' own firsthand experience of key investigations, using the student notebook and materials from the classroom kit
- models ways to ask and answer questions, use evidence to argue, explain or support a claim, and lead discussions
- highlights resources available for teachers when they want to know more about science content, using practices, in particular, developing and using models, arguing from evidence and developing explanations.

In our experience, teachers like to be active explorers. They like experiencing investigations firsthand. They like the combination of theoretical and the practical information and the tight connection between the workshop content and what they are about to teach.

The workshop requires 6-hours. The time could be organized as a full day workshop, two three-hour, or three two-hour workshops. You can use these materials as is or modify them to meet the needs of your group of participants. It is essential that you become very familiar with the (i) Focus on Energy website, (ii) curriculum, (iii) organization and contents of the *Teacher Guide* and *Student Notebook*, plus, (iv) video and print resources.

Be sure to try the classroom activities yourself before you ask participants to experience them in the workshop. As you begin planning, print out this *Focus on Energy Implementation Workshop Guide* (pdf).

We want teachers to leave the workshop knowing how to navigate the website. For this reason, we ask them to bring laptops or tablets to the workshop and we project pages from the website and illustrate how to move among the various resources. You should not plan on projecting slides or presentation tools. Rather, we suggest you annotate or tab the print leader guide, use the Workshop Outline, or prepare notes of your own to structure your facilitation of the workshop activities.

If you have not taught or observed *Focus on Energy* in the classroom yourself, it's important to become very familiar with the contents of the 5 Motion Energy lessons and resources. If possible, ask teachers who have taught *Focus on Energy* to co-lead workshop activities. Participants will appreciate their perspectives from feet-on-the - ground experience. Finally, the energy ideas, science practices, modeling, Energy Tracking Lens and representations introduced in the Motion Unit are the foundation for the Thermal and Electrical Energy units that follow. Use the Teacher Guides to see how these units unfold.

BEFORE THE WORKSHOP

WELCOME LETTER TO PARTICIPANTS

Send a friendly letter of welcome to workshop participants. A sample letter is available in the Appendices to this Guide.

In addition to logistics such as the date, time and location, the letter should ask participants to prepare for the workshop:

1. Find the *Focus on Energy* Website
   URL: https://focusonenergy.terc.edu
2. Watch *the Introduction to the Focus on Energy Project* video (found on the home page of the *Focus on Energy* website)

PLANNING THE WORKSHOP SPACE

1. Set up tables so groups of 3-4 participants can gather for firsthand explorations and investigations using materials.
2. Plan seats and space so all participants can form a discussion circle. Whole group meaning making discussions are key elements of classroom lessons and need to be modeled and practiced in the workshop.
3. Provide copies of the Motion Energy *Student Notebook*, one per participant.
4. Provide name tags or name cards.
5. Post a sheet of chart paper titled: Questions.
6. Optional: You may provide print copies of the Motion Energy Unit Teacher Guide, however, we suggest you distribute these at the end of the workshop.

HANDOUTS

One copy for each table and one posted where it's visible to all

1. Workshop goals (see Appendices)
2. 8 Practices of Science and Engineering (see Appendices)
3. Energy Tracking Lens (The Energy Tracking Lens is found on page 2 of the Motion Energy Student Notebook)
4. Energy Cube Rules (see Appendices or

For each participant

1. Motion Energy Student Notebook (see above)
2. Sparklz worksheet if you will include this optional pre-post assessment activity

3. Transcript of a Classroom Discussion of video montage. (Click Professional Learning tab in the top nav bar-> Resources ->videos -> Classroom Discussion Video Elicitation Discussion: Motion Energy, Investigation 1. A link to a pdf of the transcript is at the bottom of the page.)

ONE-DAY WORKSHOP OUTLINE

Welcome and Introduction

Welcome Introductions Logistics Goals (have a handout on each table and post a copy in a visible spot). Review goals. WATCH INTRODUCTORY VIDEO	Name tags or cards Goals handout on each table

Motion 1 Elicitation: What are our initial ideas about energy?

Sparklz pre-assesssment (optional) **Video Montage Activity** **Eliciting ideas about energy and piquing curiosity: Montage activity,** Model elicitation discussion and introduce students initial ideas about energy using transcript from classroom discussion of montage	Sparklz toys on tables and a worksheet for each participant Student Notebook activity page Transcript of student discussion of montage activity

Motion Investigation 1: Firsthand Investigation - What can motion tell us about energy?

Activity	Energy ideas	FoE highlights	Workshop Materials
Explore Motion by rolling single ball on track/cards Begin Model of Energy Introduce term "motion energy"	**Forms: motion energy** Ideas for Model of Energy • Energy can't be seen (teacher tells) • Indicators (evidence) used to infer energy • If it's moving, it has energy • Speed indicator of motion energy • An object can have different amounts of energy (not all or none)	**Model of Energy** (how to introduce Model of Energy) where to find resources **Energy story** (of one ball on track) **Make Meaning Discussion Circle** (Make Meaning: supports in TG, purpose, lead off question, etc.)	Tracks, ball, cards, Plasticene for leveling track ETL poster Student NB copy Chart paper for Model of Energy. markers How to Start a Model of Energy Where to find resource Quick links/Library

Motion 2. Can a ball cause another ball to move and not lose any of its own energy?

Observe collision of 2 balls demo Introduce Energy Bars	**Energy gains/losses** **Transfer** Need to represent energy we cannot see	**Energy bars** **Curriculum:** • **Lesson format (organization)**	Track, 2 balls, plasticene Big energy bar poster on chart paper to post

Participants explore collisions in pairs Make prediction in student NB leader demos collisions and participants record data Discuss results in circle Make claims Introduce term "transfer" Optional activities 1. Name organizational structure of an investigation 2. What "practices" have you experienced? Formative assessment Quick Check		• **3-D, use practices to learn energy ideas and crosscutting concept** Term: transfer **Quick Check** (block push, hot links in TG and Quick links)	Post ETL Energy Bars intro (video resource) Resource: Reading: "Teaching Framework to reflect new vision" Reading: "What's Important About the Energy Tracking Lens?"
Motion 3A. Can a paint paddle gain and lose energy?			
Launcher and pompom Explore materials Introduce new form of energy (elastic) Discuss results and representation	**Forms: Elastic energy** How do we know there's a new form of energy? If a there's a form we recognize, use model to infer there must be another (the pompom gained motion, where did that energy come from?) Energy = all the same stuff manifest in different forms Elastic objects **Transformation or change of form)** (elastic to motion)	Elastic energy 2 forms of energy in the same object at same time Term: Transformation at end of investigation	Launcher, pompom Whiteboard, markers Reproduction of Student NB pp. 9 & 10
Motion 3B. What's the energy story of the paint paddle and pompom?			
Launcher, pompom		**Energy Cubes** Demo cubing using collision as example	Energy cubes White boards, markers, erasers

Introduction to energy cubes using collisions as example Participants in small groups use energy cubes to "tell the energy story" of the springboard and pompom Make Meaning Update Model of energy		Participants in groups of 3-4 "cube" paint paddle and pompom Small group work (figuring out) and full class (communicating) **Point to ETL poster**	Refer to these video resources, show if there's time: How to introduce Energy Cubes Small Group Work
Motion 4. What's the energy story of the propeller?			
Propeller system Formative assessment	**Energy Tracking Lens Questions**	Energy Tracking Lens Sketches (in NB) Assessments in this curriculum **Wrap Up Probe** (in NB, Giant Paint Paddle)	Setting up and using equipment Propeller in case Propeller system for each pair Energy cubes Whiteboards, markers, erasers

What's Next?

If time permits, provide a preview of the investigations
Thermal Energy unit (show equipment, reference TG and online resources and experienced teacher colleagues)
Electrical Energy Unit (ditto)

Wrap up the curriculum activity (under Curriculum Tab)

Sparklz. In table groups, have participants "tell the Sparklz energy story" using whiteboards. Ask participants to notice what's different between their initial energy story and this one. Share responses as time permits.

PLCs

Feedback/Exit ticket

Unit/Activity	Energy ideas	FoE Highlights	Workshop Materials
Thermal 1		Pop the stopper	Video pop the stopper

	Thermal Energy is another form TE energy gain or loss may be too small to measure given our instruments Build on Motion content new form (TE) and indicator (temperature) Use energy bars or cubes to represent transfers	Temperature changes indicate gains or losses of thermal energy (TE) TE can transfer from warm rock to cooler surrounding air Where did the TE go? The temperature is not the thermal energy.	Rock, hot water, thermometer
Thermal 2	A mini-room can be used to answer the question Where did the thermal energy go?	A smaller volume of air can test the idea of transfer of TE when the rock cools in classroom air	Foam box (mini-room) Cup of hot water with lid Slab thermometer Digital probe thermometer.
Thermal 3			Samples of student posters
Electrical 1			Hand crank generator (HCG) Motor/propeller
Electrical 2			HCG Capacitor Motor/propeller
Electrical 3			

THE WORKSHOP

WELCOME AND INTRODUCTION

- Welcome
- Introduce workshop staff
- Logistics: e.g., sign-in sheets, rest room locations, breaks, lunch, etc.)
- Ask participants to introduce selves (name, school), and describe a hope for the workshop.

GOALS

Share workshop goals (print outs are on tables and a copy posted). (See Appendices)

Goals

By the end of the workshop, participants will:

- be familiar with a framework and language for reasoning about the flow of energy in everyday phenomena;
- become fluent navigating the *Focus on Energy* curriculum website and resources for teachers;
- experience a coherent set of classroom activities designed for learning about Energy forms, transfer, transformation, and tools for reasoning and communicating ideas about energy flow including:
    - the Energy Tracking Lens
    - representations: Energy bars, cubes, sketches, flow diagrams,
    - developing and using a Model of Energy;
- be ready to teach the *Focus on Energy* curriculum units in your classrooms.

ADDITIONAL POINTS FOR THE LEADER TO MAKE

You (participants) are adult learners. During this workshop you will experience firsthand energy activities developed for Grade 4 or 5 in order to prepare you to introduce these lessons in your classrooms. However, throughout the day, we will discuss, question and go deeper into the science content and practices and classroom pedagogy as your interest and curiosity lead us. And we will move faster than you will in the classroom! We (I) want you to write in your copy of the Student Notebook to become familiar with what you will ask your students to do.

There will be times when you ask a good question and I'll ask that we put it aside for now and address it later; we'll record those questions on the Questions Chart. We will try to get to these questions by the end of the day or during follow up PLCs or in an online resource!

Explain that today everyone will go through the Motion Energy Unit, the first of three linked pieces of the curriculum.

1. The Motion unit is designed for students to use some important practices of science as pathways to learning a set of core ideas about the nature of energy, energy transfer and energy transformation. Many teachers tell us

that *Focus on Energy* requires a major shift in their science teaching practice: where once they saw their role as ensuring students get correct information, now they understand their role is to help students figure things out for themselves, using evidence gathered during classroom activities and reasoning.

2. The **Framework for Science K-12** and the **NGSS** identify 8 key practices of science (handout and/or posted). In this curriculum students use seven of the eight but primarily:

- Practice 3: Developing and using models and representational tools
- Practice 6: Engaging in argument from evidence
- Practice 7: Constructing explanations

3. There are 5 lessons, called investigations, in the Motion Energy unit. In the classroom, each takes at least 45-60 minutes - more likely an hour.

Each investigation is explicitly linked to the previous one and the one that follows; that is, the *Focus on Energy* curriculum is “coherent.”

THE MOTION UNIT IS THE FOUNDATION FOR THE THERMAL AND ELECTRICAL ENERGY UNITS THAT FOLLOW

Explain that the *Motion Unit* you’ll experience today introduces all the essential ideas, practices, habits of mind, routines and tools that make up the full curriculum. Students will solidify and deepen their learning as they put their Motion Energy experiences to work in new and increasingly complex contexts involving thermal and electrical energy.

Participants will leave the workshop having been introduced to all the key ingredients of the units. They will have access to a detailed teacher guide (which was classroom tested over 3 years by 6 groups of pilot teachers in the Boston area and Seattle) and video resources to support the teaching of all three units.

Show the **Introduction to the Focus on Energy Project** video available on the *Focus on Energy* website home page – (repeat if they have viewed it ahead of time) for an overview of the unit. Do not discuss – move ahead.

BEFORE YOU START

Project the *Focus on Energy* website on a screen or whiteboard.

Demonstrate typing in the URL https://focusonenergy.terc.edu and point to the “curriculum” tab on the nav bar at the top of the page as well as the Curriculum circle. Ask participants to follow along on their laptops or tablets, reminding them that you hope they will leave the workshop able to confidently navigate the website!

Overview.

Encourage everyone to read the **Overview** on their own after the workshop. Refer to the Kit and explain what you know about how teachers will obtain the materials (schools or districts may have ordered or provided classroom kits).

Sparklz, an optional pre- post-assessment activity has successfully set the stage for learning about the *Focus on Energy* approach in other workshops. Ideally, you'll have Sparklz toys for every pair or for every table. Provide enough time for each person to explore firsthand.

Show how to find directions for the Sparklz activity. From the top nav bar, click Curriculum -> Get Ready ->Optional Sparklz Assessment. There's also a link to a pdf of the student worksheet to print classroom copies (print back to back).

Explain that this is an optional activity for students and requires Sparklz toys for students to observe and explore, Ideally, there will be one Sparklz for each group of 4 students. The purpose of this activity is two-fold: it's fun and as such piques students' interest and curiosity. It also can serve as a pre-post assessment.

If you are using Sparklz in this workshop, distribute the toys, 1 per pair or table group if possible, and a copy of the Sparklz worksheet for each participant. Be sure participants write names on their papers and keep them to use at the conclusion of the workshop or PLCs.

Teachers can decide whether or not to include Sparklz in their classrooms. (One Sparklz toy comes in the kit. Teachers can pool their toys and make a class set to share.)

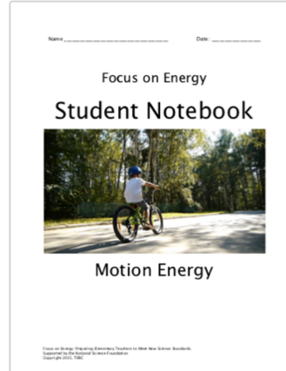
MOTION INVESTIGATION 1: WHAT ARE OUR INITIAL IDEAS ABOUT ENERGY? ~10 MIN

LEARNING TARGETS INTRODUCED IN MOTION 1

- Energy cannot be seen or directly measured.
- All moving objects have motion energy.
- Speed is the indicator of how much motion energy an object has. If an object's speed increases or decreases, its motion energy has increased or decreased.

PREPARATION AND MATERIALS

Motion Energy Student Notebooks for each participant



Motion Energy Teacher Guide https://focusonenergy.terc.edu; Motion Unit, Motion 1 that you project. You may decide to hand out a print copy for each participant at the end of the workshop.

Handout: transcript of 4th graders discussing the video montage. (Library of Resources)

VIDEO MONTAGE ACTIVITY (INITIAL ACTIVITY OF MOTION 1)

Explain that "lessons" are called "investigations" to reflect the understanding that science is about asking and answering questions about the natural world. Each investigation is guided by a question. There are two parts to Motion Investigation 1: the Video Montage activity and the firsthand investigation of a ball on a wooden track that launches the development of a Model of Energy.

Remind participants that the third goal of the workshop is to become familiar with the classroom activities by experiencing them as they will unfold in the classroom and discussing the experiences as adults.

Show participants where to find the montage on the Website.
https://focusonenergy.terc.edu/curriculum/motion/montage.html

PURPOSE: This activity kicks off the Motion Unit and is designed to elicit viewers' initial ideas about energy and pique their curiosity about what's to follow. It also sets the stage for a discussion of the abstract, unobservable nature of energy, of what constitutes evidence of energy and of the distinctions between observation vs. inference

INSTRUCTIONS FOR VIEWING THE MONTAGE

- Find page 3 in the Student Notebook (NB), including a set of 12 thumbnail images.
- The Montage is a collection of scenes from everyday life. It serves as the "anchor" for what follows. The same activity kicks off the *Focus on Energy Motion Unit* for students. The montage will be revisited in the curriculum wrap up.
- As you watch the montage, ask yourself, "Do I think that energy is present in this scenario?" "What do I actually see that makes me think that energy is present?"

Show montage

- Now watch the montage a second time. Ask participants to put an "E" next to the thumbnail on student NB page if they think there is evidence of energy in this scenario.

SHARE IDEAS WITH A PARTNER (2-3 MINUTES).

With a partner, share what you observed in video clips that made you think energy was present in the scenario.

ASK FOR PARTICIPANTS' IDEAS

- Share out some initial ideas, contributing one idea at a time until all ideas are shared. "Does everyone agree? Other ideas?"

> **Note**: There are **NO WRONG ANSWERS HERE – JUST IDEAS**- this is an elicitation activity, designed to make participants aware that we all have ideas about energy to build on. This is not a time to teach or clarify misunderstandings.

ANTICIPATING STUDENTS' IDEAS?

What do you think you might hear from your students? What might be one or two of their energy ideas?

Ask participants to discuss this question with a partner for a few minutes.

Point out that an important aspect of teaching is to be aware of students' initial ideas about energy. Explain that you are going to play a recording of a group of 4th graders discussing why they thought a scene from the video montage should "get an E" or not. It's hard to hear their voices so ask participants to follow along using a transcript found on their tables.

You can find the recording and pdf of the transcript of the discussion by going to the top nav bar on the home page and choosing Professional Learning-> videos -> Classroom Discussion Videos -> Elicitation Discussion: Motion Energy, Investigation 1. There is a link to a pdf of the transcript at the bottom of the page.

Ask participants to mark or annotate their transcripts to answer these questions they'll discuss briefly:

- What are some ideas 4th graders have about energy?
- Did anything surprise you?

Provide 3-5 minutes for discussions at tables and ask for a few people to share out.

The people who developed *Focus on Energy* interviewed students in grades 3-5 to find out more about their energy ideas. They also observed students doing the *Focus on Energy* activities and looked at their notebook entries. They looked at journal literature to see what other researchers had found out. Here are some findings:

Children may

- Think that living things have energy but inanimate objects do not;
- Associate energy with motion and with batteries and sometimes with sound;
- Think that energy is an "all or none" thing – you have it or you don't.

⇒ Emphasize that elicitation requires careful <u>listening</u> for students' energy ideas. Not a time to judge or teach.
⇒ When a student offers an idea, probe deeper by asking, can you say what makes you think that?
⇒ Push students to distinguish between an observation and an inference:

When you said the train had energy, what did you observe that made you think it had energy? When you talked about a motor or the fuel, did you observe a motor or fuel? If you couldn't see it, what made you think it might be inside the train? We call this inference or reasoning based on prior knowledge or experience.

When you said the bird had energy, what did you observe (wings moving) that made you decide the bird had energy?

When you said the kettle on the stove had energy, what did you see that gave you a clue that there was energy in this scene? [red ring burner. Heat; bubbles, motion; whistle, sound]

MOTION INVESTIGATION 1 FIRSTHAND INVESTIGATION – WHAT CAN MOTION TELL US ABOUT ENERGY? (~45 MINUTES)

Project the Teacher Guide Motion 1 Step 3 Investigate the motion energy of balls

1. PARTICIPANTS EXPLORE THE MOTION OF A BALL ON A TRACK AND MATCH MOTION WITH MOTION CARDS.

This simple activity will provide evidence to support an answer to the Investigation question and to start a list of statements about energy that we will call our Model of Energy.

- Hand out tracks, plasticine (for leveling the track), one ball; demonstrate leveling the track and fixing it with a small blob of plasticene.
- Have participants explore pushing the ball in various ways so it rolls along the track
- Distribute Motion cards and have participants match the description on the card with the motion of the ball. Call attention to the "speed lines" on the image of the ball on each card. (pdf print out of cards Motion 2, Quick Links)
- Ask participants to fill in table at the bottom of page 3 of Student Notebook (NB).
- Collect the materials.

Note that this is a very simple activity. Teachers tell us they are amazed by how many important ideas and practices can be launched from something so simple! If you're tempted to skip it, don't!

2. MODEL A FULL CLASS MAKE MEANING DISCUSSION.

In Focus on Energy *lessons, before the class moves on to the next lesson, there's always a chance to process the firsthand and other activities. Making Meaning discussions provide time to raise questions, revisit part of a lesson, and see if the group thinks they have enough evidence to answer the investigation question.*

Note: A set of norms and expectations

Group discussions benefit from an explicit set of norms and guidelines that are understood and accepted by all. In some schools, norms and expectations are established for discussions in all subjects. If norms don't exist, teachers need to create them. Students benefit when they can participate in developing a class list of agreed-upon behaviors for discussions. While a list of norms may vary from class to class, most lists will include listening to others, speaking so others can hear you, "sharing the air," responding to ideas and not a person, disagreeing respectfully.

These skills are not automatic and need to be reinforced and practiced. Norms should encourage full participation and a classroom environment where it's okay to offer a partially formed idea or to ask a question.

Participants gather in circle. Put a track and ball in the center of the circle. Point out the importance of having the equipment or materials visible during the discussion.
Emphasize the "power of the circle:" When students sit in a circle, facing each other, everyone can focus on the speaker and listen to their ideas. No one talks to a classmate's back or can hide at the back of the class; this arrangement discourages side conversations. In a circle, everyone is on an equal plane and this invites everyone to take part in discussion. The circle encourages students to talk to each other, not just the teacher. When teachers

join the circle, it's easier for them to facilitate peer-to-peer discussions rather than dominate the conversation. The few minutes spent forming the circle signal it's time to processing or making meaning of classroom work.

a. Describe the purpose of the discussion:

> *The purpose of this discussion is to see how we can answer the question: what can motion tell us about energy?*
>
> *You will find the Teacher Guide helps you plan and lead discussions by providing the purpose of the discussion, a lead-off question, and examples of follow-up questions. Often the lead-off question is the investigation question.*

B. INTRODUCE WHAT'S MEANT BY "THE ENERGY STORY."

⇒ *You have all had a chance to roll the ball at different speeds: no motion, slow motion, and fast motion.*

⇒ *What did you decide about the motion energy (that you couldn't see) of the ball when it was rolling at different speeds or not moving at all?*

⇒ *One of the motion cards reads No Motion and this ball matches the card* (place a ball so it's motionless on the track*). Tell me the **energy story** of that ball. What did you observe and what did that tell you about energy?*

⇒ The ball has no energy. I think so because it isn't moving.

Repeat with the two other motion cards, each time asking for the "energy story" of the ball and emphasizing what is observable and what is inferred (the energy). Remind the group that they and their students will use evidence to figure out, infer, a story about energy flow in other more complex systems. This is a warm up! Reiterate that no one saw the energy increase or decrease but found convincing evidence to think that's what happened.

⇒ The ball was motionless so it had no motion energy. I pushed it and it began to move so that told me it had some energy. It slowed down and then stopped so that told me the ball had less and less energy until it had none!

C. INTRODUCE THE MODEL OF ENERGY.

Based on our experience with the montage and rolling a ball at different speeds along a track, we're going to start making a list of statements about energy (that we can't see!) that we'll call the Model of Energy.

Key ideas that may emerge. Stick to what participants actually say – right or wrong - statements can be corrected later.

- energy cannot be seen, felt, or measured directly (it's abstract),
- if it's moving, it has energy
- motion energy can be present along a continuum of magnitudes (an object can have different amounts of energy – it's not just all or nothing). Speed is an indicator of magnitude of motion energy

Note: You may point out a Teacher Resource "How to Start the Model of Energy" in Curriculum tab ->Library of Resources.

D. INTRODUCE THE TERM MOTION ENERGY, THE NAME OF THIS FORM OF ENERGY.

It seems that when an object is moving, its speed provides evidence of energy of the object. Let's call the energy of the moving ball ***motion energy****.* (You could prepare on a card with "motion energy" to put on the board, or simply write it on the white board).

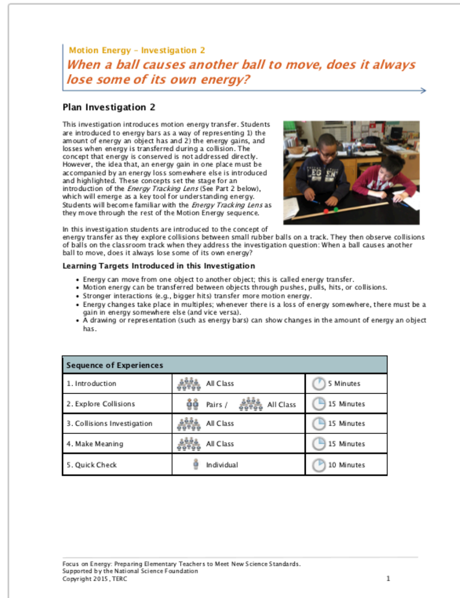
Note: Ask participants to listen for the way you describe the energy of an object: the energy **of** the ball. Try to avoid energy "in the ball" – may imply matter that is poured in and can be used up!

Think back to the video montage: were there clips with examples of motion energy?

MOTION ENERGY INVESTIGATION 2: WHEN A BALL CAUSES ANOTHER BALL TO MOVE, DOES IT ALWAYS LOSE SOME OF ITS OWN ENERGY?

A. WHERE WE'VE COME FROM AND WHERE WE'RE GOING

In Motion 1, we established that we can't see energy, energy is abstract, but that we can use evidence to infer the presence and behavior of energy, we've established that motion which observable is evidence of energy which is not observable; we call that form "motion energy", an object can have different amounts of energy.



Motion Energy – Investigation 2

When a ball causes another ball to move, does it always lose some of its own energy?

Plan Investigation 2

This investigation introduces motion energy transfer. Students are introduced to energy bars as a way of representing 1) the amount of energy an object has and 2) the energy gains, and losses when energy is transferred during a collision. The concept that energy is conserved is not addressed directly. However, the idea that, an energy gain in one place must be accompanied by an energy loss somewhere else is introduced and highlighted. These concepts set the stage for an introduction of the *Energy Tracking Lens* (See Part 2 below), which will emerge as a key tool for understanding energy. Students will become familiar with the *Energy Tracking Lens* as they move through the rest of the Motion Energy sequence.

In this investigation students are introduced to the concept of energy transfer as they explore collisions between small rubber balls on a track. They then observe collisions of balls on the classroom track when they address the investigation question: When a ball causes another ball to move, does it always lose some of its own energy?

Learning Targets Introduced in this Investigation

- Energy can move from one object to another object; this is called energy transfer.
- Motion energy can be transferred between objects through pushes, pulls, hits, or collisions.
- Stronger interactions (e.g., bigger hits) transfer more motion energy.
- Energy changes take place in multiples; whenever there is a loss of energy somewhere, there must be a gain in energy somewhere else (and vice versa).
- A drawing or representation (such as energy bars) can show changes in the amount of energy an object has.

Sequence of Experiences		
1. Introduction	All Class	5 Minutes
2. Explore Collisions	Pairs / All Class	15 Minutes
3. Collisions Investigation	All Class	15 Minutes
4. Make Meaning	All Class	15 Minutes
5. Quick Check	Individual	10 Minutes

Focus on Energy: Preparing Elementary Teachers to Meet New Science Standards.
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LEARNING TARGETS INTRODUCED IN **MOTION 2**

- Energy can move from one object to another; this is called energy transfer
- Motion energy can be transferred through pushes, pulls, hits or collisions
- Stronger interactions transfer more motion energy
- When there is an energy gain in one object there is a loss somewhere else and vice versa.
- Representation such as energy bars can show changes in energy and help tell an energy flow story

FEATURES OF FOCUS ON ENERGY CURRICULUM TO HIGHLIGHT IN THE CONTEXT OF MOTION 2 INVESTIGATIONS

- Characteristics of a "3-D" curriculum (Library of Resources)
- The class continues to add to or refine the list of statements in their Model of Energy
- What we mean by "telling the energy story." (What is an Energy Story? Resource Quick Links)
- Facilitating full class Make Meaning discussions
- Quick Checks: formative assessments, one in each unit.

PREPARATION AND MATERIALS

- The Setting Up and Using Equipment Video is the same as Motion 1 (You can introduce these resources now or in the context of one of the next investigations).
- Read "A Teaching Framework to Reflect a New Vision" (Professional Learning Resources ->Readings)
- Read [What's Important about the Energy Tracking Lens?](#) (Professional Learning Resources ->Readings) You may decide to include this as a handout.

FOR THE CLASS:

- A wooden track and modeling clay to level it
- 2 rubber balls (1¼ in. diameter, different colors)

- A large drawing of 3 energy bars (see Teacher Guide Motion 2)

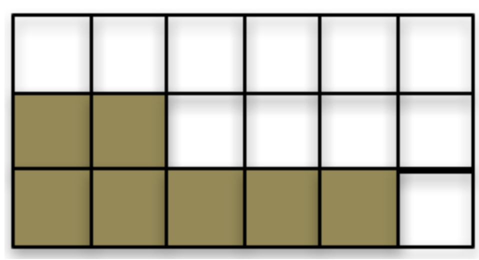
Materials for each pair of students

FOR EACH SMALL GROUP OF 2 STUDENTS:

- A set of 3 notecards with "No motion," "Slow motion," and "Fast motion"
- A wooden track and modeling clay to level it
- 2 rubber balls (1¼ in. diameter, different colors)

PREPARATION

- Set up and level the track on a table where participants can gather around and observe.
- Make a large drawing of 3 energy bars on the white board or large piece of paper.



A: no energy – all squares empty

B: some energy – fill in 1 to 3 squares

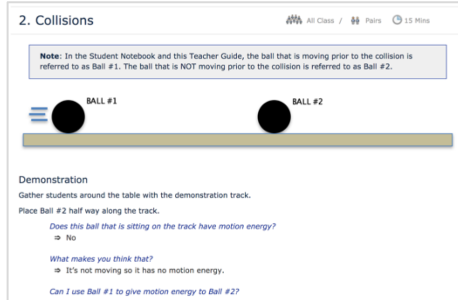
C: lots of energy - fill in 4 to 6 squares

- Place the Model of Energy poster where all can see
- Make preparations to show the short video Quick Check: Block Push Probe to the class after the Make Meaning discussion.
- Read What's Important About the Energy Tracking Lens? (see Motion Energy, Resource Quick Links)

B. ACTIVITY: COLLISIONS

The **Teacher Guide Motion 2, Step 2. Collisions** describes the activity in detail.

As you facilitate Motion 2, point out that this investigation


2. Collisions
All Class / Pairs 15 Mins

Note: In the Student Notebook and this Teacher Guide, the ball that is moving prior to the collision is referred to as Ball #1. The ball that is NOT moving prior to the collision is referred to as Ball #2.

Demonstration

Gather students around the table with the demonstration track.

Place Ball #2 half way along the track.

Does this ball that is sitting on the track have motion energy?
⇒ No

What makes you think that?
⇒ It's not moving so it has no motion energy.

Can I use Ball #1 to give motion energy to Ball #2?

- Begins with an **anchoring phenomenon**: a collision between ball moving along the track (Ball 1) and a stationary ball (Ball 2).
- Provides time to **explore** collisions
- Introduces the concept of "**representations"** in particular, **Energy Bars**
- Poses an investigation question and asks students make a prediction (with rationale for their prediction) before they collect data.
- Asks participants to collect evidence that will tell them if Ball 1 always slows down after a collision – evidence that it has lost energy – and Ball 2 speeds up – evidence is has gained energy.
- Is the place in the curriculum to introduce the term **"transfer" of energy**
- Provides content to add to the Model of Energy

Ask a question: *Can a ball cause another ball to move and not lose any of its own energy?*

Gather the group around a demonstration track.

Place one ball (Ball #2) near the middle of the track and roll another ball (Ball #1) toward Ball #2.

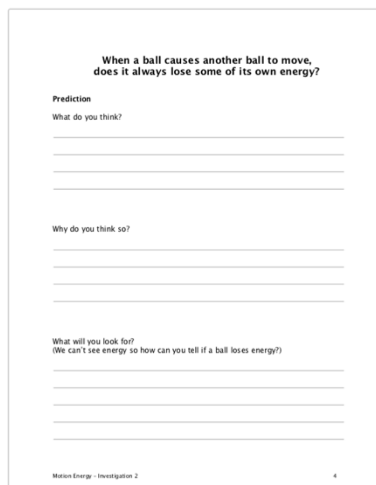
Does this ball that is sitting on the track have motion energy?

What makes you think that?

How about Ball #1?

How could I give Ball #1 more energy?

What do you think you would observe if I give Ball #1 more energy before the collision?


When a ball causes another ball to move, does it always lose some of its own energy?

Prediction

What do you think?

Why do you think so?

What will you look for?
(We can't see energy so how can you tell if a ball loses energy?)

Motion Energy - Investigation 2 4

Notebook Page 4

Repeat the collision.

Reinforce the idea that changes in speed are what tell you about changes in motion energy.

Leader tip: the following provides practice "telling the energy story."

Think about what you just observed; describe changes in the motion energy of Ball #1.

Use the terms:

- No motion energy
- Some motion energy
- Lots of motion energy

Start by saying "before the collision …" and then "after the collision …"

- Before the collision, Ball #1 had lots of motion energy. After the collision, Ball #1 first had some motion energy-although less than before the collision- and then it had no motion energy.

How did you decide that Ball #1 had lots of motion energy before the collision and no motion energy at the end?

- Before the collision, the ball was moving fast so it had a lot of motion energy and after the collision, when it had stopped, it didn't have any motion energy.

What about Ball #2?

- Before the collision, Ball #2 had no motion energy. After the collision, Ball #2 had lots of motion energy.

EXPLORE COLLISIONS IN PAIRS

Have participants return to their tables to work in pairs.

Give each pair:

- a piece of track
- some modeling clay to level the track
- two balls
- a set of 3 motion cards

Remind participants to level the track using modeling clay and give them 5 minutes to explore collisions, working in pairs. One student places cards, one at a time, on the table and the other rolls Ball #1 at different speeds (matching the description on the card) to cause a collision with Ball #2. After 2 minutes, switch roles.

Reminder: we can't see energy so we're going to pay attention to the indicator, something we can see: changes in how fast or slow the ball is moving that we call speed.

Collect the balls, tracks, cards, and modeling clay before moving on to the next part of the investigation.

INTRODUCE "ENERGY BARS" REPRESENTATION

Use the large chart you have prepared to demonstrate how to represent No motion energy, some motion energy, lots of motion energy.

Refer to the video resource "Energy Bars" (show it if you have time). Explain that this shows a teacher introducing this representation to her class. It is found in Motion 2 Quick Links.

PROVIDE TIME TO EXPLORE

Give participants 5 minutes or so to explore collisions.

Ask them to turn to page 4 in the Student Notebook and write responses to the three questions.

Note: Remind participants that students won't necessarily know that a prediction is based on prior experience or knowledge (a prediction is not just a guess!), teachers should be sure to ask students to explain the rationale or basis for their prediction.

COLLECT DATA

Gather around the demonstration track with notebooks and a pencil in hand.

Use the demonstration track to show a collision.

Have participants record a description of the collision in their notebooks.

Remind participants that "speed or zoom lines" describe what they observed, while Energy Bars describe what you can infer from observations.

Note: in the classroom students often forget to draw speed/zoom lines and may need a reminder!

- **Data collection:** "Can a ball cause another ball to move AND not lose any of its own energy?"
  - Explain that in the classroom, you will do a few more examples of a collisions while students observe and record energy bars on NB pages. Students are actively observing and recording data.

- F**orm a discussion circle and model a Make Meaning discussion.**

  The purpose of the discussion is to use observations (data) as evidence to support a claim that answers the investigation question. A secondary purpose is to introduce some common language to describe energy flow.

  The Make Meaning discussion in the TG may look less like a discussion as the teacher introduces new content (transfer, gains, losses). Emphasis in this discussion is reiterating that energy can't be sensed or measured directly, yet people seem pretty confident they can fill in the energy bars for each collision! Ask if the evidence was observable or did it need to be inferred?

  Ask participants to put into their own words what evidence they think can support a claim that motion energy from Ball #1 is transferred to Ball #2?

  How would you now respond to the investigation question?

  What evidence do you have to support your answer?

  The filled in energy bars are a kind of semi-quantitative data – not actual measurements but expressions of more or less.

- Introduce the term **transfer** to describe the flow of energy from one object to another. "What happens to the energy in a *transfer*?" Encourage participants to articulate the idea that *transfer* involves an energy gain in one object and energy loss in another – where it's lost, it is no longer present!

  Note: We have found that students use the word transfer readily but when probed often do not really understand transfer. You might take time to have them develop an analogy. Classroom example:

  "*If I have $100 and I transfer $50 to you, I don't have that money any more I only have $50. The rest is yours now*."

- Ask, *How did you represent this energy story? Take a few minutes to jot down anything you've added to your understanding of energy and also what questions you have.*

- Ask participants if they have questions at this point in the workshop. Record questions that may need to be put aside until another time on the Questions chart and respond to questions can be answered at this time.

OPTIONAL ACTIVITIES FOR NOW OR FOR LATER.

Activity: focus on organization of the Teacher Guide.

At some point in the workshop, you will want to point out the way information for the teacher is organized in the Teacher Guide. You describe this to the group or make it an activity: In pairs, ask participants to look at any one of the Motion Investigations and identify the organization or structure. The key headings are:

Plan

Overview

- Preparation
- NB pages
- Learning Goals
- Time chart
- Setting up and Using Materials Video

Each investigation follows the same steps.

- Ask a question
- Explore and/or collect data
- Make Meaning

Information to help the teacher plan and lead a make meaning discussion

- Lead-off question, often the investigation question
- Purpose of the Discussion
- Follow up questions
- Discussion wrap up or summary

Activity: focus on the 8 Practices.

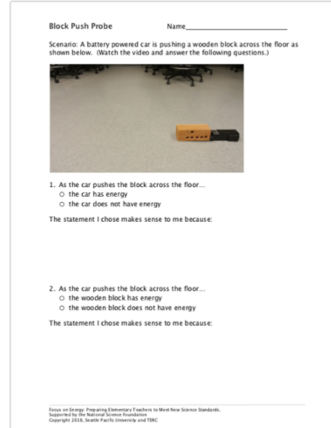
We've said that *Focus on Energy* students will be using science practices to learn key energy ideas and cross-cutting concepts. Ask participants to keep an eye on the 8 Practices handout and see if they can spot which practices they have experienced so far.

C. QUICK CHECK

Have participants find the Quick Check Block Push Probe on page 8 in the student notebook.

Show the 10 second video. (demonstrate there are several ways to get to this video: a hotlink embedded in Motion 2 on the online Teacher Guide or Resource Quick Links)
Emphasize the importance of reading the scenario and prompts out loud so ALL students understand the questions.

This is a formative assessment. Take class time as needed to discuss the responses to this item. The "big idea" is expressed in the Model of Energy: if it's moving, it has motion energy."


Block Push Probe Name______________________

Scenario: A battery powered car is pushing a wooden block across the floor as shown below. (Watch the video and answer the following questions.)

1. As the car pushes the block across the floor...
   - the car has energy
   - the car does not have energy

The statement I chose makes sense to me because:

2. As the car pushes the block across the floor...
   - the wooden block has energy
   - the wooden block does not have energy

The statement I chose makes sense to me because:

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Note to Leader: This typically provokes a lively discussion in teacher workshops! And a lot of reflection and learning. We hope the same will be true for students.

Note that the multiple choice items help students zoom in on the important idea that this item assesses: motion is a sign (speed in the indicator) that an object has energy or, put another way, objects in motion have energy. The open response below gives the teacher insight into a student's thinking or reasoning.

It is not unusual for a student to think that only objects with a built-in energy sources (a car with a battery or a motor, a person with muscles) have energy and that an object "going along for a ride" or being pushed does not have energy.

If students agree that an object has to have energy to give energy (Ball 1 had to have motion energy to give to Ball 2), you might ask what people think would happen if the block being pushed along the floor bumped into a stationary ball. Or, if we took away the block, what do you think would happen to the motion of the car? Explain why you think so.

It's important to note that ideas related to motion energy, gains and losses, and transfer will be revisited many times as students experience the three units so if a student's understanding is shaky after only 2 lessons (!) there's ample opportunity to solidify understanding in the investigations that follow.

MOTION ENERGY INVESTIGATION 3A: CAN A PAINT PADDLE GAIN AND LOSE ENERGY?

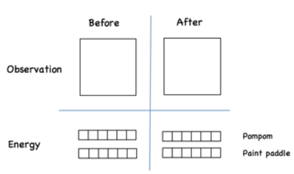
A. WHERE WE'VE COME FROM AND WHERE WE'RE GOING

In Motion 2, we extended the exploration of motion energy in the context of collisions, adding the concept of energy gains and losses and energy transfer. In addition to "telling the energy story" in words, we introduced a representation called Energy Bars. We used the Block Push assessment to make sure participants understand that motion is evidence that an object has energy. This is a formative assessment: based on responses, the teacher or leader decides whether to spend more time with the concepts introduced so far or to move on.

LEARNING INTRODUCED IN MOTION 3A

- An introduction to elastic objects
- A new form of energy, elastic energy, and the evidence we can use to tell if an object has elastic energy and how much
- An important new idea: energy transformation (the term isn't introduced until the Make Meaning Discussion)
- Specifically, we learn that Elastic energy can be transformed to motion energy and vice versa

PREPARATION AND MATERIALS

- Motion Energy Teacher Guide https://focusonenergy.terc.edu; motion unit
- Collect a few elastic objects (rubber bands, Theraband, squishy ball, spring)
- Make a large reproduction of Student Notebook pages 9 and 10 (see Teacher Guide)
- 

Materials for each pair of students

FEATURES OF FOE CURRICULUM TO HIGHLIGHT IN THE CONTEXT OF INVESTIGATION 3A

- How we can use the Model of Energy, in particular the concept of energy gains and losses, to introduce a new (to participants) form of energy, elastic energy? If the bent paint paddle can give energy to the pompom it must have energy to give energy – the paint paddles wasn't moving so there must be a new form (which teacher names).
- Introduction of the concept and term "energy transformation"

B. ACTIVITY: CAN A PAINT PADDLE GAIN AND LOSE ENERGY?

1. Introduce the investigation (Motion 3A, Step 2, introduction) and let participants explore the materials (Step 3, Explore)

   Keep this introduction short!

Identifying a new energy form

Hold up a demo springboard device with the paint paddle in a bent and locked position. Place a pompom on the end of the paint paddle. Ask if the paint paddle has energy. [No motion, no motion energy]

Release the latch and watch the pompom fly into the air.

Use the Model of energy to tell the energy story:

The pompom *began to move so we know it gained motion energy*.

Where there's an energy gain in one object, there must be a loss somewhere else so we ask what gave energy to the pompom? [The paint paddle.]

An object has to have energy to give energy. The bent and latched paint paddle wasn't moving so it must have had another form of energy. We call this elastic energy.

- This investigation (3A) introduces elastic objects, objects made of materials that when *deformed* (bent, twisted, compressed, stretched), return to their original shape by themselves. Show some of the elastic objects you have collected (spring, elastic band, binder clip, Nerf ball, etc)

- Motion 3A introduces another form of energy, elastic energy. Elastic objects that are deformed have elastic energy – a kind of stored energy.
- The materials participants will use are a paint paddle/pompom system (hold up the objects)
- Driving question is Can a paint paddle gain and lose energy? What's the evidence?
- Provide about 2 minutes to explore the paint paddle and pompom and another 3-4 minutes to complete pages 9 and 10 in notebooks.

3. Make Meaning (10 min)

   To preserve time, have participants stay at their tables.

   Refer to the simplified version of the notebook pages you have posted on chart paper or whiteboard.

   The purpose of this discussion is to reach consensus around using drawings and energy bars to tell the energy story.

   Ask the group to share the number of energy bars they filled in and explain how they decided what that number should be. Emphasize that there is no "right" number of bars and that the reasoning is what's important. Highlight the idea that the bars are a tool (1) for reasoning or "figuring out" and (2) communicating your ideas.

   You are trying to represent something that's your head (your mental model) in some way. What's important is that whatever you are trying to represent obeys some rules (A student might say, "I gave the pompom zero bars because it wasn't moving, I gave the paint paddle 3 bars because it was bent so it had elastic energy but it could have been bent further.")

If the group decides the pompom has 5 energy bars after release and the paint paddle had only 3 to begin with, you might ask how many bars of energy the paint paddle had available transfer initially. This may turn into a good discussion. When we tell an energy story, we are accounting for energy gains and losses. This idea will become more clear using energy cubes. Accounting for the energy available in the system to begin with and at the end foreshadows the important concept of energy conservation that students will work with extensively in middle school.

MOTION ENERGY INVESTIGATION 3B: WHATS THE ENERGY STORY OF THE PAINT PADDLE AND POMPOM?

A. WHERE WE'VE COME FROM AND WHERE WE'RE GOING

In Motion 3A, we introduced elastic objects and a new form of energy, elastic energy, in the context of a springboard and pompom system. We learn that the amount of deformation, in this case bending, is evidence we can use to decide if an object has elastic energy and if so, how much. We added a term, energy **transformation** and, specifically that elastic energy can be transformed to motion energy and vice versa. We introduced a tool to represent energy changes in the case of the springboard and pompom.

LEARNING INTRODUCED IN MOTION 3B

- An introduction to a representation called Energy Cubes.

FEATURES OF FOE CURRICULUM TO HIGHLIGHT IN THE CONTEXT OF INVESTIGATION 3A

- Energy Cube rules, and modeling use of energy cubes
- Whiteboards, markers, erasers

PREPARATION AND MATERIALS

- Motion Energy Teacher Guide https://focusonenergy.terc.edu; Investigation 3B.
- Watch "Introducing Energy Cubes "(Resource Quick Links)
- For each group of 4, provide a whiteboard, dry erase markers, eraser and set of 6 energy cubes with M and Elas stickers attached.
- Watch Small Group work (Resource Quick Links)
- Post a copy of Energy cube rules so it's visible to all and/or prepare handouts.

Video Resources referenced in Investigations are available on the Focus on Energy Website in Curriculum -> Library of Resources or Resource Quick Links

B. ACTIVITY: WHAT'S THE ENERGY STORY OF THE PAINT PADDLE AND POMPOM?

You are going to use the now-familiar ball collisions scenario to introduce energy cubes. Then participants will figure out a "cube" story of the paint paddle and pompom in small group

1. Gather the group around a demo track and two balls (the materials they used in Inv. 2)

2. Introduce the **Energy Cube** rules using the ball collisions as an example. (Use directions in the TG and Introducing Energy Cubes video.)

3. After the introduction, give the small group assignment.

- Ask participants to work in groups of 4. Provide each group with a whiteboard, dry erase marker, eraser, set of 6 cubes and a paint paddle and pompom.
- Describe the small group challenge:
    - Use the energy Cubes to tell the energy story of the paint paddle and pompom.
    - You will have 10 minutes to figure out how to use cubes to explain how energy transfers and transforms in this system.
    - Prepare to share your whiteboard story to see if we can come to a consensus energy story.

After 10 minutes, model a make meaning discussion where a few groups share their whiteboards, and see if the group can agree on an explanation and what questions they are left with.

Make the point that while one groups is sharing, the rest of the group has responsibilities:

- How is their cube story the same or different from your group's?
- Do I agree or disagree with this energy story? Is there a question I'd like to ask?
- How many of the energy tracking lens questions did the presentation answer?

As the discussion wraps up, ask the group:

What did you like about energy cubes as a tool to represent energy flow in a scenario?

Did you run into any problems using the cubes?

What does each cube represent? (a unit of energy and the sticker tells the form in which energy appears)

What do the cubes do for you that Energy Bars do not?

What can we add to our Model of Energy?

Point out that there's no need to share every whiteboard when the "energy stories" are quite similar. Keep an eye out for variations during small group work and pick one or two to share. Ask the observers for any variations and to show these using the white board and cubes already on display.

Revisit the Model of Energy: what can we add or revise in our Model of Energy?

Note: You may want to address the practice of **modeling** at this point.

Here's what one workshop leader said:

Of the science practices described in the Framework and NGSS, perhaps the most challenging is Practice 3: Developing and Using Models. In Focus on Energy, this is the most important practice that students engage in from the very first day. Why? Because energy is abstract it requires a model. At the same time, energy is an ideal topic for students to immerse themselves in the modeling practice.

We are not talking about physical models or replicas but conceptual models. A conceptual model is an entity that lives in our heads. We need to represent this in some way.

The entity has rules it obeys – we are developing a model of energy and making a list of rules we think the entity, energy, obeys.

We have conventions for how we represent energy and the rules.If we take the energy cube representation for example, you might ask What does a whiteboard cube story show? What doesn't it show?

MOTION ENERGY INVESTIGATION 4: WHATS THE ENERGY STORY OF THE PROPELLER?

A. WHERE WE'VE COME FROM AND WHERE WE'RE GOING

In previous investigations we asked a set of questions that is now quite familiar that help us tell the energy story of a particular system: What did we observe? what forms of energy are present? Where does the energy come from and where does the energy go? What's the evidence? How can energy bars or energy cubes help communicate the story of something that can't be seen?

Whether it's colliding balls or flying pompoms, we keep asking the same set of questions we call **The Energy Tracking Lens**.

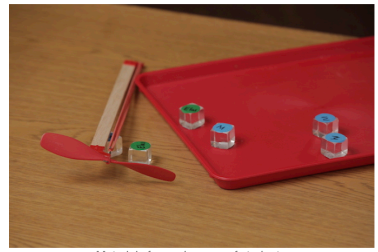
In Motion 4, students consolidate their learning about the Energy Tracking Lens, the use of energy bars and energy cubes to represent the flow of energy in a new scenario that involves both motion and elastic energy.

LEARNING TARGETS INTRODUCED IN MOTION 4

- 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 us reason about energy flow and transformation in a scenario.

PREPARATION AND MATERIALS

- 1 propeller tube set-up (see Teacher Guide)
- watch Motion 4, “Setting up and Using Equipment Video’
- **For each group of 2**: 1 propeller-elastic band system
- **For each group of 4**: Whiteboard. Marker, eraser, set of 6 energy cubes, M (motion) Elas (elastic) stickers
- **For the class:** a whiteboard, marker, eraser and set of 6 demo cubes
- Prepare to show the Unit Wrap Up video, Giant Paint Paddle (normal speed and slow motion) found in Resource Quick Links.


Materials for each group of students

B. ACTIVITY: WHAT’S THE ENERGY STORY OF THE PROPELLER?

INTRODUCE THE LAST ACTIVITY:

Finally, we are going to consolidate our learning from the last 4 investigations as we answer the question: What’s the energy story of the propeller?

Follow instructions in the TG for using the propeller in a tube to introduce this lesson. Emphasize the idea that when there’s evidence that there’s a gain of energy in a form you recognize (motion), you must ask the question Where did the energy come from and what form might it be?

Note: What’s in the tube? Typically, students may suggest a battery or a rubber band.

Show the Setting up and using equipment video – explain there’s one for every investigation and these will be important when they do the Thermal and Electrical units.

Hand out propellers and ask participants to explore and complete Student NB page 12. The notebook writing scaffolds using energy cubes to interpret this scenario.

In groups of 4, using whiteboards, ask the groups to use energy cubes or energy bars to tell the energy story of the rubber band powered propeller.

As you move from group to group, model questions teacher might ask their students as they work.

- How did you decide where to put the cubes before you released the propeller?
- What form of energy was present in the elastic band while it was unwinding? What’s the evidence?
- What made you decide that the propeller had elastic energy (it didn’t – but some students may think it does because after it stops moving, it is in the same position it was in prior to unwinding, confusing its position with the property of elastic objects). The propeller was not deformed, rather it changed position.)

Time permitting, gather in a circle to share whiteboards

Add to or revise the Model of Energy.

C. ADMINISTER THE UNIT WRAP UP PROBE

Show the Giant Paint Paddle video and ask participants to record responses on the final NB pages.

Point out the Interpretation Guide and where to find it. (Resource Quick Links)

Discuss Formative assessments embedded in the curriculum. Read Formative Assessment found on the homepage, curriculum (top nav bar) -> before you start.

Offer a few tips:

- Make sure all students know what they are being asked: read questions aloud, move about so that if students appear confused you can get them on track. Provide supports as needed, e.g., word wall.
- Use this as a learning opportunity by discussing responses to the prompts as a class.
- If a few students appear confused, find time to work with them individually, however, more general confusion will call for revisiting key activities and ideas.

D. WHAT'S NEXT?

After they complete the Motion Unit, students will be armed with a framework for thinking about energy, the Energy Tracking Lens, the need to develop and use a model of energy, and some representational tools to use for reasoning and communicating ideas about energy flow.

Thus prepared, they will extend their learning to new forms of energy (thermal and electrical) in more complex scenarios.

THERMAL AND ELECTRICAL ENERGY UNITS AND CURRICULUM WRAP UP

A. WHERE WE'VE COME FROM AND WHERE WE'RE GOING

At the end of the Motion Unit, your students will

- have been introduced all the key energy ideas that are targets of the *Focus on Energy* curricula;
- learned how to develop a class Model of Energy, revise it add to it, and use it;
- know how to represent energy transfers and transformations using energy bars and energy cubes;
- be able to use the Energy Tracking Lens to tell the energy story of a scenario or phenomenon.
- be asking "where did the energy go" when the ball came to a stop, the paint paddle stopped moving, the rubber band and red propeller were motionless. Part of the answer to these questions will be addressed in the Thermal Energy unit.

That's a lot in just 5 lessons!

B. WHAT'S NEXT

Students get to put their learning to work in thermal and electrical energy contexts.

- It's likely they are already asking where the energy goes when the ball stops rolling, the pompom lands, or the propeller stops spinning.
- Thermal energy plays an important role in everyday life. For example, in many if not most motion phenomena, some motion energy is lost in the form of thermal energy (think about the wheels of moving vehicles.) Most students can accurately predict what will happen to the temperature of a cold can of soda left on the kitchen table overnight.
- Or electrical energy which plays an important role in everyday life and solar energy that is part of important conversations about renewable or non-renewable energy sources.

Have samples of materials on hand that are used in the investigations that make up these two units so you can give participants a quick trip through the key activities:

<u>Thermal</u>: Pop the stopper introduction to a new form of energy (thermal)

- Rock in cup of hot water (what happens to the thermal energy as the warmed rock cools spontaneously on the table? Where did the energy go? The room air doesn't seem warmer.)
- Heat transfer in a closed insulated box (mini-room) – this stimulates a discussion of dissipation and the idea of changes that are too small to sense or measure with our instruments.

<u>Electrical</u>: A hand cranked generator transforms motion energy to a new form, electrical energy, which can be transformed to motion or thermal energy or can be stored in a capacitor.

- Hand cranked generator used to spin propeller, storing electrical energy in a capacitor,
- Solar panel used to spin propeller or store energy in a capacitor introduces light/solar energy which can be transformed for use or stored and is renewable.

Down the road, students will be able to add to and apply their Model of Energy, the Energy Tracking Lens, and representations to reason about energy on an even larger scale, for example, Earth's energy balance.

C. CURRICULUM WRAP UP

You find a description of this activity using the Curriculum tab at the top of the home page and selecting Curriculum Wrap Up from the dropmenu.

The units wind up with a return to the anchor phenomenon, the video montage. Students watch the montage once again. They select one of the vignettes or video clips and, in pairs, "tell the energy story." They share their stories and reflect on ways their knowledge and skills have increased since they first viewed the vignettes.

AT THE END OF THIS WORKSHOP WHERE WILL YOU BE?

You will have

1. Experienced all key activities in the Motion Unit (see above)

2. Be familiar with the architecture of a FoE lesson, learning goals, step-by-step instructions for facilitating activities

3. Be knowledgeable about where to find resources, such as:

Setting Up and Using Equipment videos
Assessments, Quick Checks and Wrap up Probes
Reminders about how to introduce cubes or the benefits of small group discussions

WHAT'S NEXT FOR YOU?

- You get to teach the unit, buoyed by a detailed teacher guide, set up videos and support from *Focus on Energy* colleagues. Teaching the unit will probably the greatest professional learning opportunity of all!

- Some groups will have 2 follow up PLCs, one focused on thermal energy and the other on electrical. The PLC will include:
    - Report from the classroom (how did the motion unit go?)
    - Preparing to teach the next unit (get out a set of materials and try them together)
    - Looking at student work (what are students' ideas about energy?)

WRAP UP THE WORKSHOP BY RETURNING TO SPARKLZ

RETURN TO SPARKLZ

Ask participants to work in table groups.

Hand out a Sparklz toy, a whiteboard and markers to each group and ask them to "tell the energy story of Sparklz."

Facilitate a wrap-up discussion:

What's different about the energy story you wrote before the workshop and the one your group has just written as we wrap up?

Before they experience *Focus on Energy* activities, when asked to "tell the energy story of Sparklz," participants typically describe a mechanism (the key turns, the coil, that connects to the gears, that … etc.). They do not mention forms of energy or transfers or transformations. They may draw components of the toy.

After they experience the units, they may refer to forms (the coil has elastic energy, the key, wheels, scraper, gears have motion energy). They may use cube diagrams or energy bar representations and may describe transfers or transformations. (motion energy is transferred from the hand to the key to the coil where it is transformed to elastic energy and then back to motion energy, etc.

RECAP GOALS

Do participants think they are

- familiar with a framework and language for reasoning about the flow of energy in everyday phenomena?
- fluent navigating the *Focus on Energy* curriculum website and resources for teachers?
- Knowledgeable with a coherent set of classroom activities designed for learning about Energy forms, transfer, transformation, and tools for reasoning and communicating ideas about energy flow including:
    - the Energy Tracking Lens
    - representations: Energy bars, cubes, sketches, flow diagrams,
    - developing and using a Model of Energy;
- ready to teach the *Focus on Energy* curriculum units in your classrooms?

APPENDICES

LINKS TO STANDARDS

Link to NGSS: https://www.nextgenscience.org/topic-arrangement/4energy

Practices

All practices, except Using Mathematical and Computational thinking, are embedded in these investigations. Three are emphasized:

- Developing and Using Models
- Constructing Explanations
- Engaging in Argument from Evidence

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- The faster a given object is moving, the more energy it possesses. (4-PS3-1)
- Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2), (4-PS3-3)

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. In such collisions some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2), 4-PS3-3
- Light also transfers energy from place to place. (4-PS3-2
- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may havew been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4)

Crosscutting Concept

Energy and Matter

- Energy can be transferred in various ways between objects. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4)

Building Toward Common Core Standard(s)

ELA standards:

CCSS.ELA-LITERACY.SL.2.1

●-Participate in collaborative conversations with diverse partners

about topics and texts with peers and adults in small and larger groups.

CCSS.ELA-LITERACY.W.2.7

●- Participate in shared research and writing projects (e.g., read a

number of books on a single topic to produce a report; record science observations).

CCSS.ELA-LITERACY.W.2.8

●- Recall information from experiences or gather information from

provided sources to answer a question.

8 PRACTICES OF SCIENCE FROM THE FRAMEWORK FOR K-12 SCIENCE EDUCATION

The K-12 Practices are derived from those that scientists and engineers actually engage in as part of their work. The authors of the *Framework for K-12 Science Education* consider the eight practices listed below to be essential elements of science and engineering learning for all students. These practices are not taught independent of content nor separate from one another. Rather, students use the practices to answer investigation questions, learn key ideas about the nature of energy, and hone their skills "telling the energy story."

As they engage in *Focus on Energy* activities, students will use all of these practices, however, the emphasis in this curriculum is on three of them, indicated by an asterisk (*).

1. Asking questions (for science) and defining problems (for engineering)
2. *Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. *Constructing explanations (for science) and designing solutions (for engineering)
7. *Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

SAMPLE LETTER TO PARTICIPANTS

January 2, 2019

Dear Fourth Grade teachers,

We look forward to the *Focus on Energy* workshop on January 8. The workshop is an introduction to *Focus on Energy*, a science curriculum unit that actively engages fourth graders in firsthand investigations of energy as it flows through collisions, launching pompoms into the air, and spinning propellers. When the workshop ends, you'll have probed key energy concepts, experienced the same activities as students only from an adult learner perspective, and become fluent users of tools such as "energy bars" and "energy cubes." You'll adeptly navigate the *Focus on Energy* website and, we hope you'll be eager and ready to get started in your classrooms.

Prior to the workshop, we hope you'll take time for a bit of preparation.

1. Find the Focus on Energy website - URL: https://focusonenergy.terc.edu.
2. On the homepage of the website, find (and watch) "Introduction to the Focus on Energy Project," a 2:47 minute video.
3. From the homepage, click the About tab -> Papers and Presentations -> "Looking Through the Energy Lens" and read this short article from *Science and Children*.

The workshop will be held in Conference Room 2 at the Central Office Building from 8:30 a.m. to 3:00 p.m. We will break at mid-day for lunch but please note that lunch will not be provided. **Please bring your laptop for our work.**

We'll see you on January 8. Happy new year!

Science Coordinator and Workshop Leader

Focus on Energy Workshop Goals

By the end of the workshop, participants will:

- be familiar with a framework and language for reasoning about the flow of energy in everyday phenomena;

- become fluent navigating the *Focus on Energy* curriculum website and resources for teachers;

- experience a coherent set of classroom activities designed for learning about Energy forms, transfer, transformation, and tools for reasoning and communicating ideas about energy flow including:
    - the Energy Tracking Lens
    - representations: Energy bars, cubes, sketches, flow diagrams,
    - developing and using a Model of Energy;

- be ready to teach the *Focus on Energy* curriculum units in your classrooms.