Reframing Energy Learning in Elementary School

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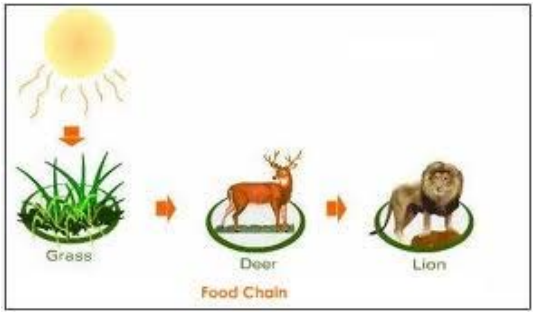
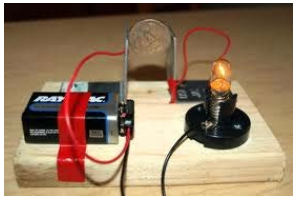
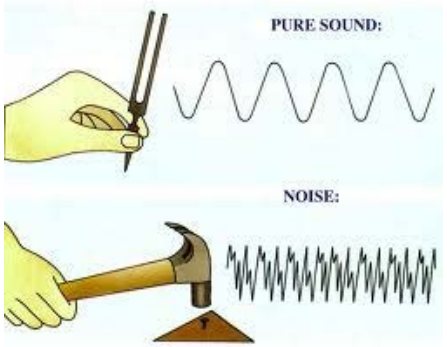
TERC, Cambridge MA

MSELA, November 2016

Energy in elementary school: What is the challenge?



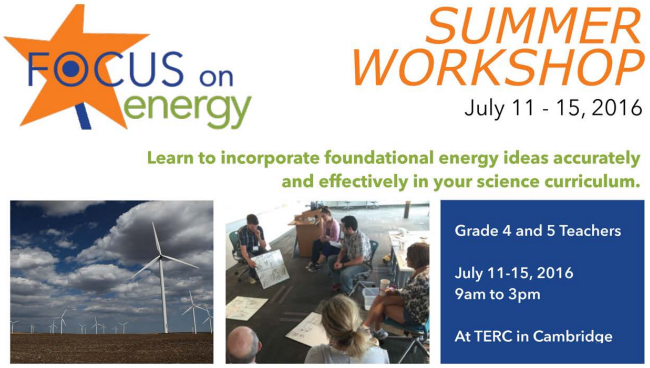




Preparing Elementary Teachers to Meet the New Standards

Classroom Activities

Web-based Resources



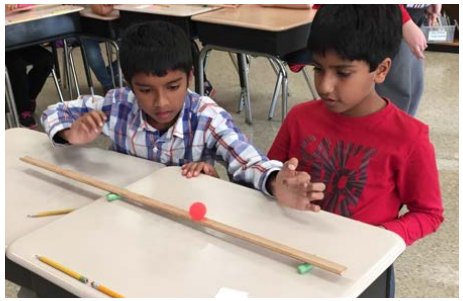
Teacher Workshop

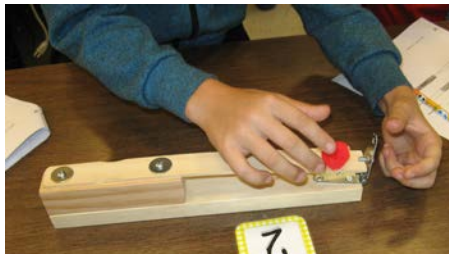
A system of resources and support for teaching and learning about energy in elementary school.

A 4-year NSF DRK-12 development project

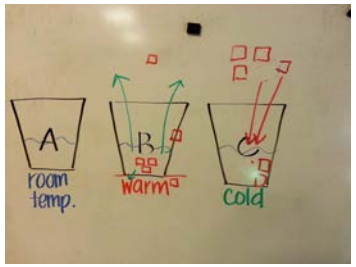
Classroom Activities

Motion and Elastic

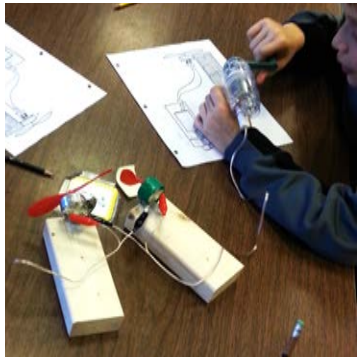


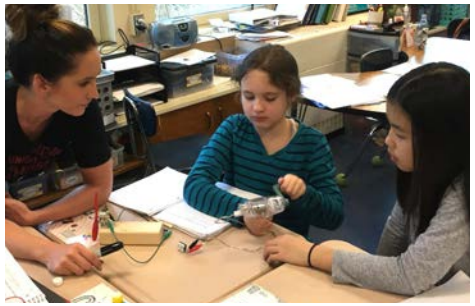


Thermal



Electrical





FOCUS on energy

SUMMER WORKSHOP

July 11 - 15, 2016

Learn to incorporate foundational energy ideas accurately and effectively in your science curriculum.

Grade 4 and 5 Teachers

July 11-15, 2016
9am to 3pm

At TERC in Cambridge

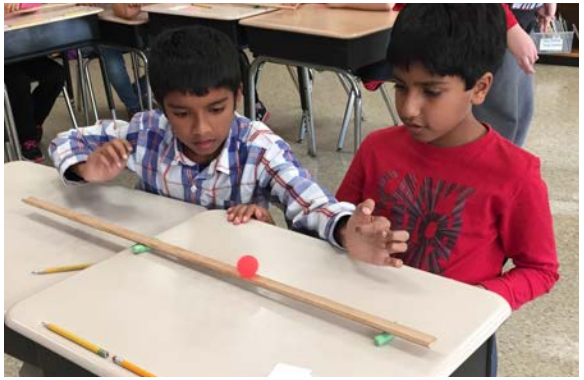
3 Strands:

- Learning about Energy
- Listening to Children's Ideas
- Planning to integrate energy into your curriculum

TERC

Web Based Resources

Classroom activities reflect the vision of the Massachusetts standards



- Lessons focus on core energy ideas
- Students learn core ideas through through science practices
- Lessons are carefully sequenced

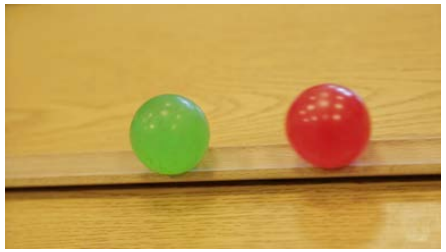
In each investigation, students

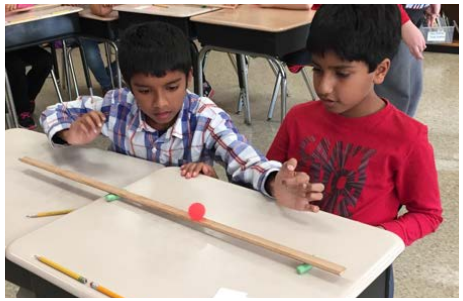
- Ask a question
- Explore and collect data
- Make meaning

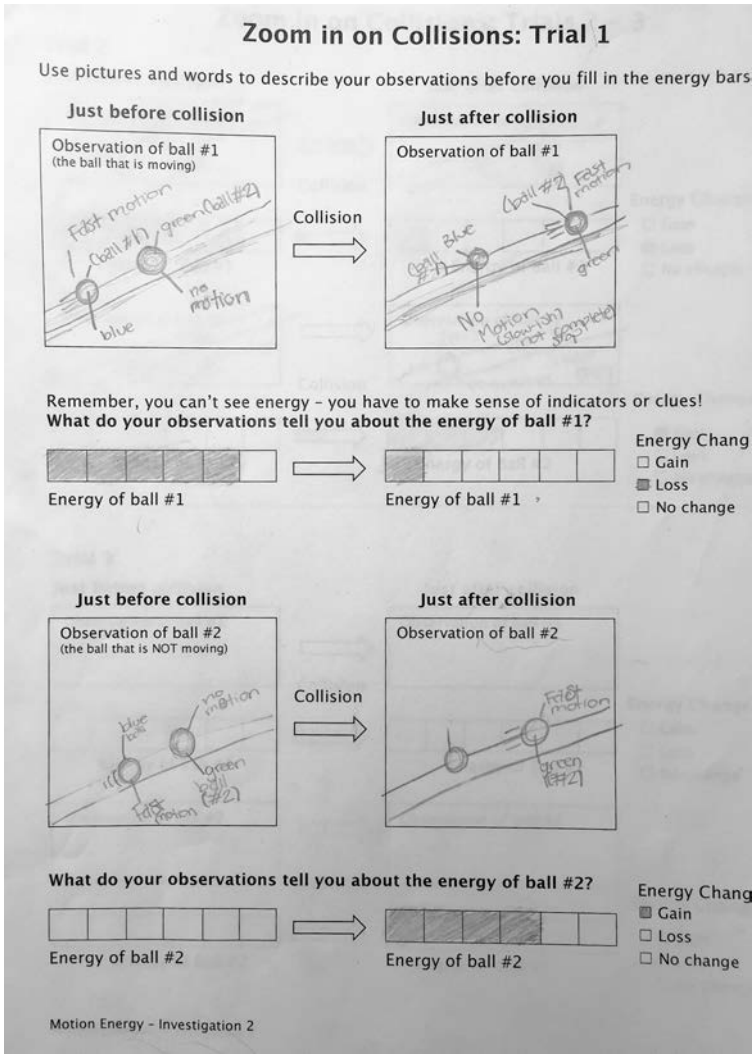
Learning about motion energy

Collisions:

Can a ball cause another ball to move AND not lose any of its own energy?







Zoom in on Collisions: Trial 1

Use pictures and words to describe your observations before you fill in the energy bars

Just before collision

Observation of ball #1
(the ball that is moving)

Collision

Just after collision

Observation of ball #1

Remember, you can't see energy – you have to make sense of indicators or clues!
What do your observations tell you about the energy of ball #1?

Energy of ball #1

Energy of ball #1

Energy Chang
☐ Gain
■ Loss
☐ No change

Just before collision

Observation of ball #2
(the ball that is NOT moving)

Collision

Just after collision

Observation of ball #2

What do your observations tell you about the energy of ball #2?

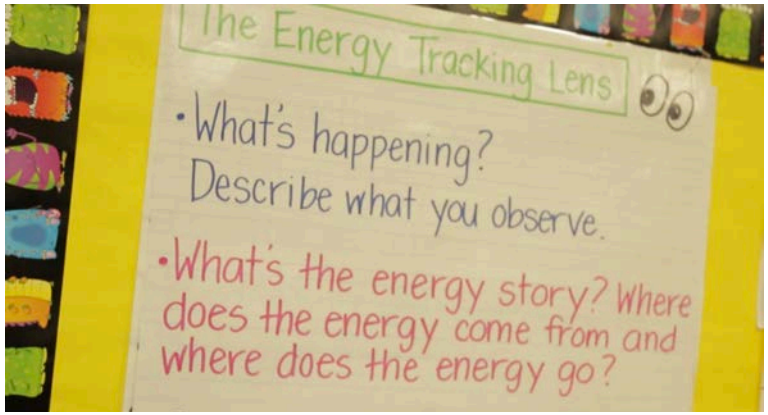
Energy of ball #2

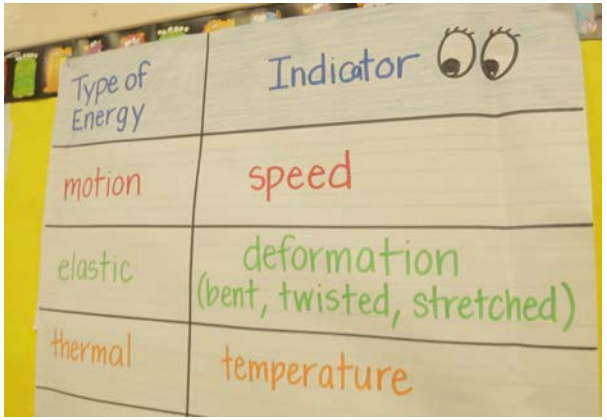
Energy of ball #2

Energy Chang
■ Gain
☐ Loss
☐ No change

Motion Energy – Investigation 2

Building a Framework for Looking at Phenomena in Terms of Energy





Part 1. Describe what you observe.

Part 2. Tell the energy story.

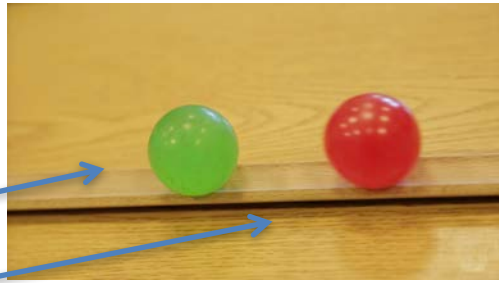
What are the system components?

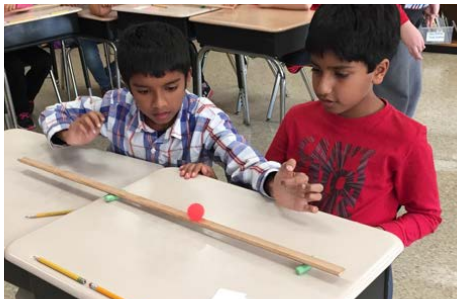
Form (s) of energy?

Energy gain?

Energy loss?

-- If the green ball's energy increased, **Where did the energy come from?**





Adding to the framework: adding another form of energy and energy transformation

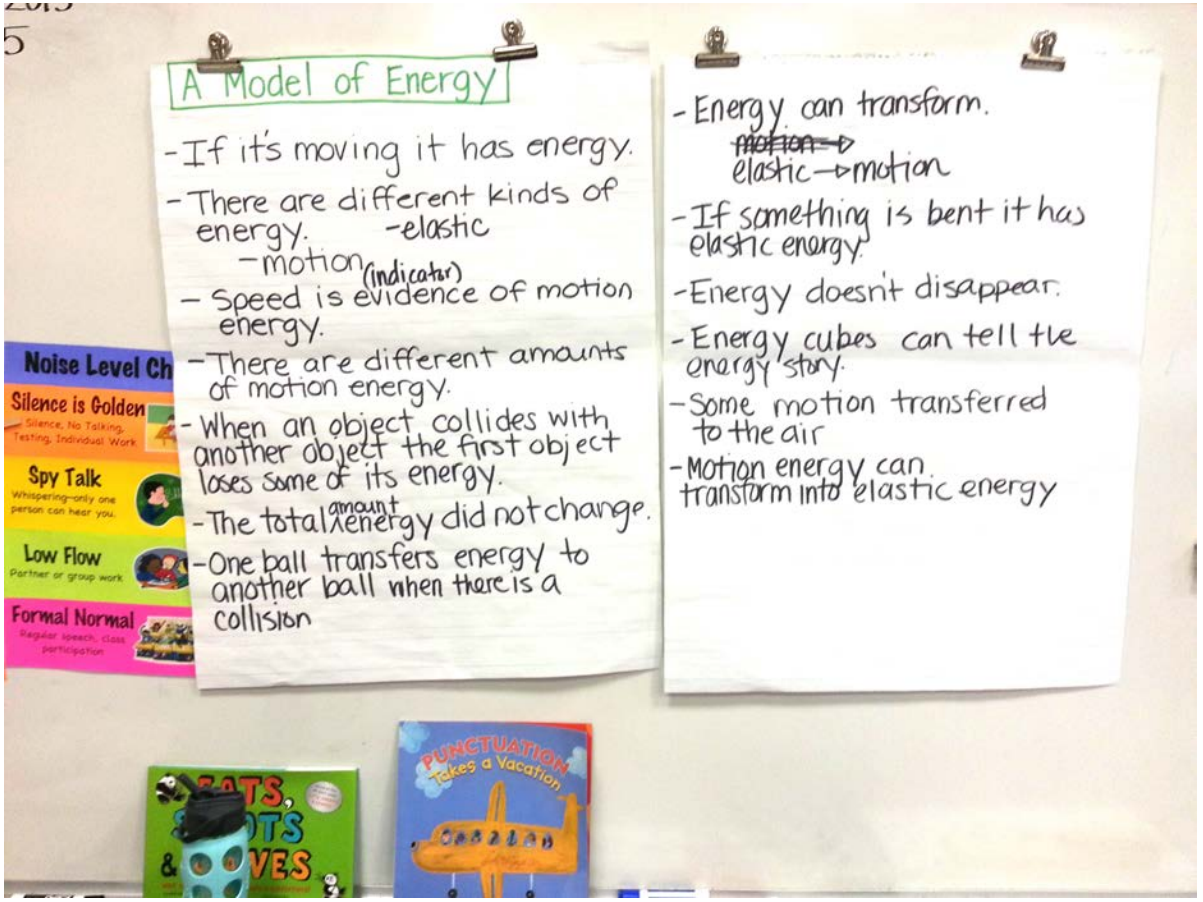
Part 1. Describe changes you observe.

Part 2. Tell the energy story.

- Components of the system?
- Form(s) of energy?
- Energy gain?
- Energy loss?
- Energy transfer?
- Energy transformation?
- Where does the energy come from?
- Where does the energy go?

If the pompom gained energy, what lost energy?

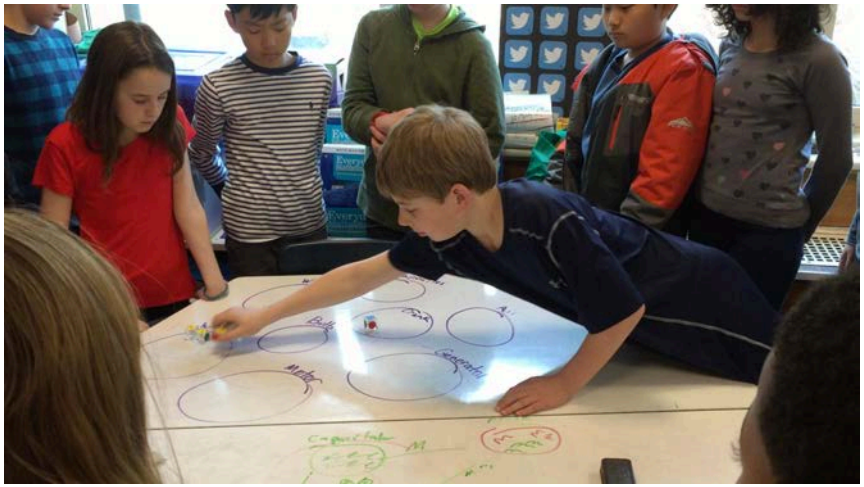
Generating and using a conceptual model of energy

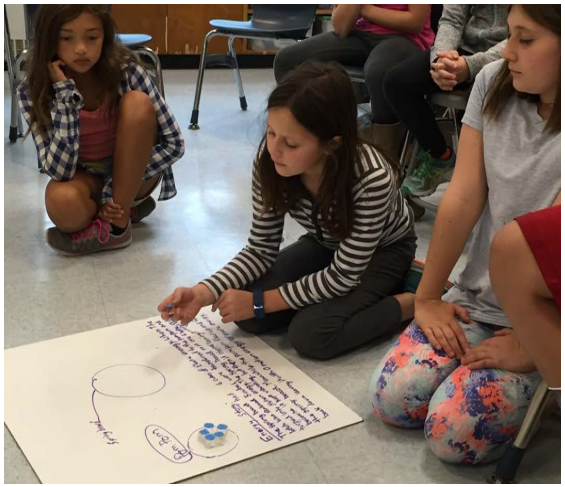


Representing Energy Flow

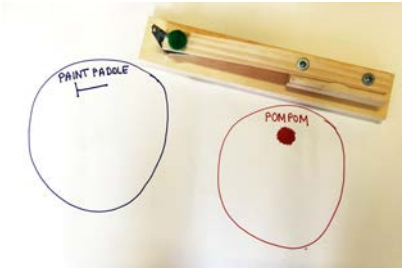
Energy is abstract!!!

Students use representations to communicate and reason about energy flow.





Energy Cube Rules



Each cube is a unit of energy.

Regions on a paper represent objects involved in the scenario.

Each cube indicates its form of energy with a symbol (such as "M" for motion energy) on the side facing up.

To represent energy transformation, cubes flip so that a different symbol (such as "Elas" for elastic energy) faces up .

The number of cubes showing a particular symbol on the upward side corresponds to the quantity of a particular form.

The number of cubes in a region corresponds to the quantity of energy in an object.

To show energy transfer, cubes move from one region to another.

Energy Cube Representation

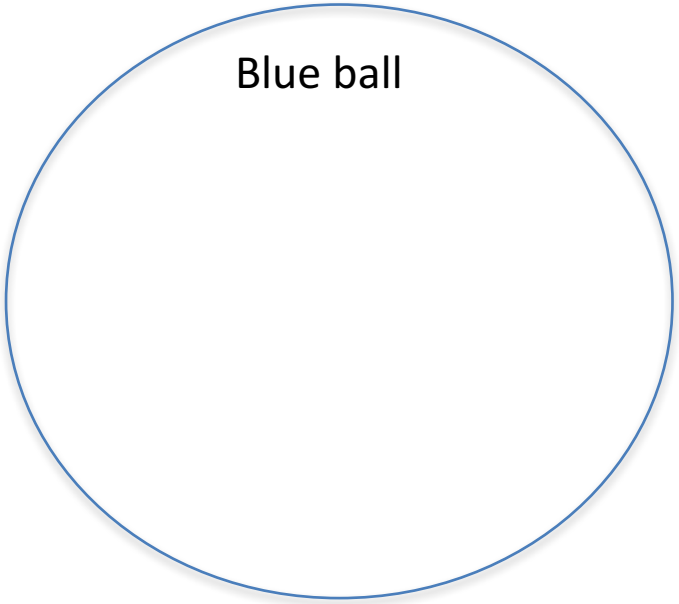
Slide the cubes to represent energy changes during the collision.

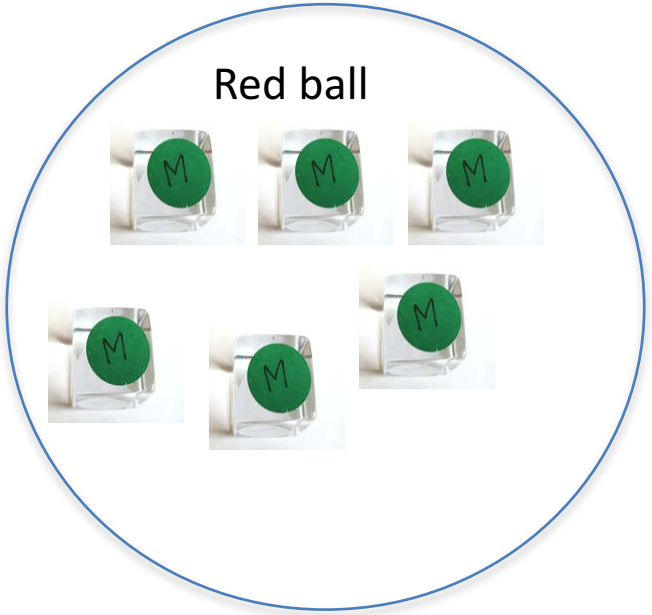
Blue ball

Red ball

Energy Cube Representation

Red ball moving along the track
Blue ball stationary

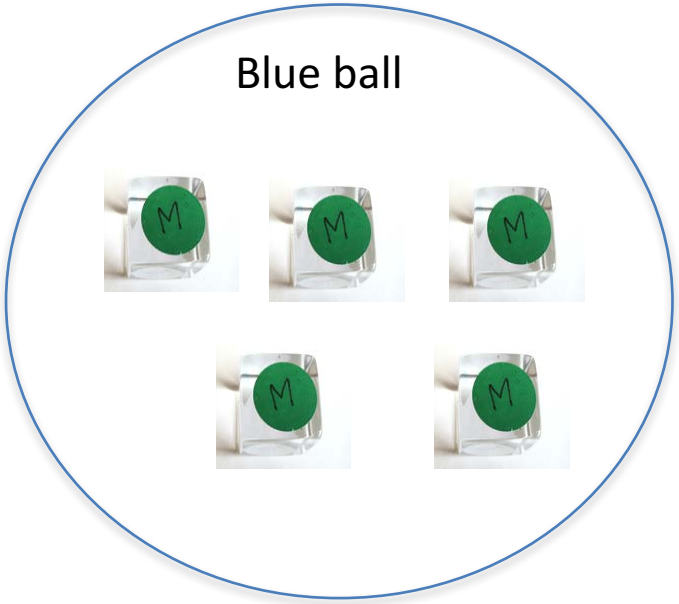




Energy Cube Representation

Slide the cubes to represent energy changes during the collision.

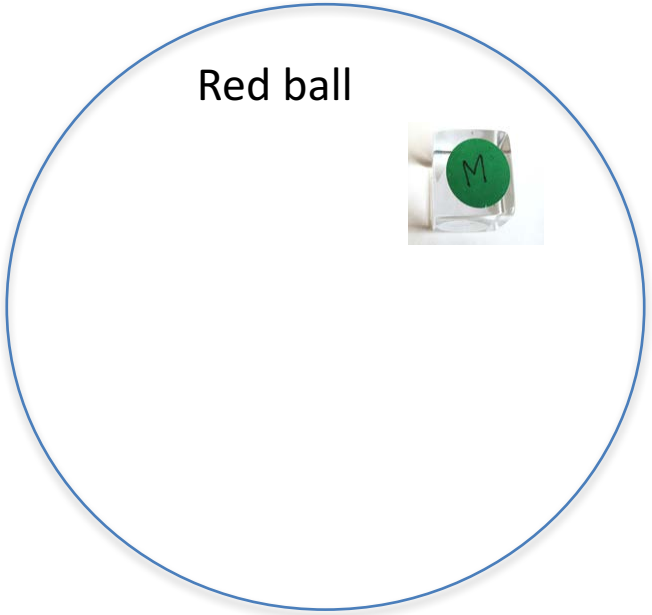
Blue ball



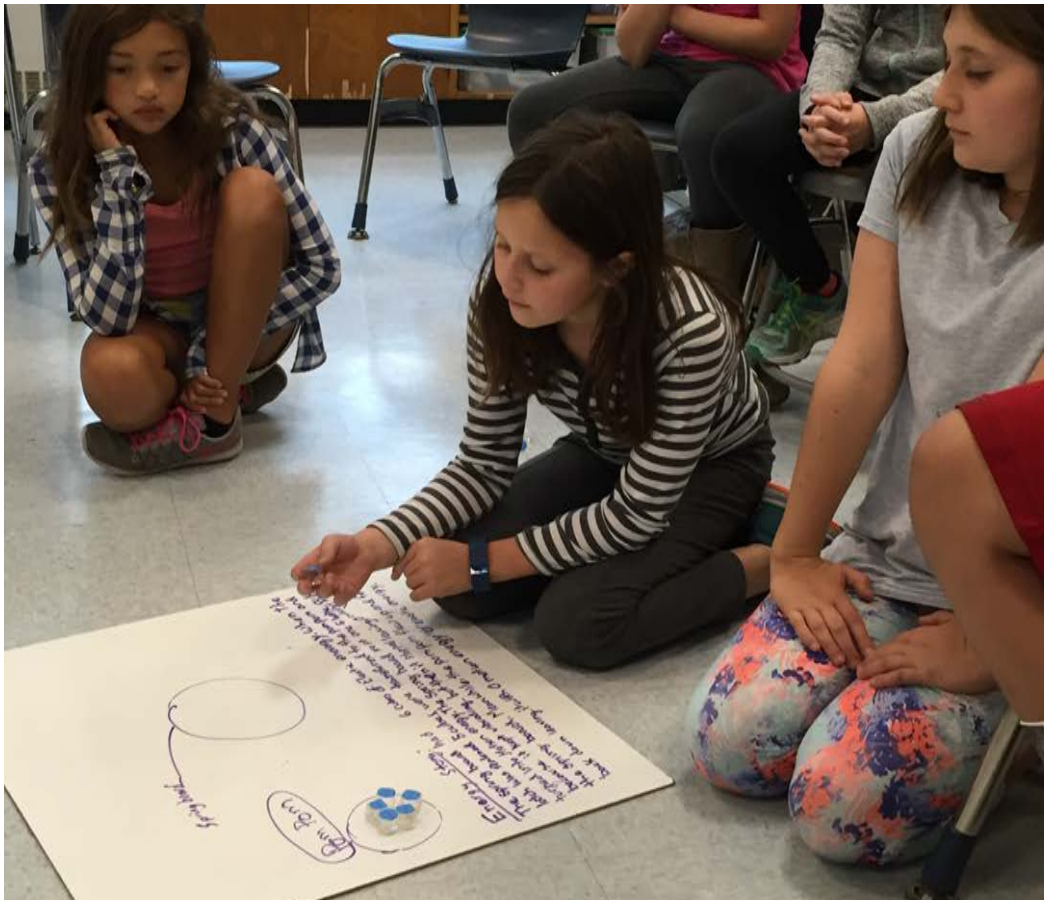
Blue ball moving fast

Red ball moving slowly

Red ball



What's the Energy Story of the Paint Paddle and the Pompom?



The propeller and elastic band

- ❑ 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?

Use energy cubes and
Energy Tracking Lens questions.

Paint Paddle

Pompom

The paint paddle and pompom

- ❑ System Components?
- ❑ Form(s) of energy?
- ❑ Energy gains and losses?
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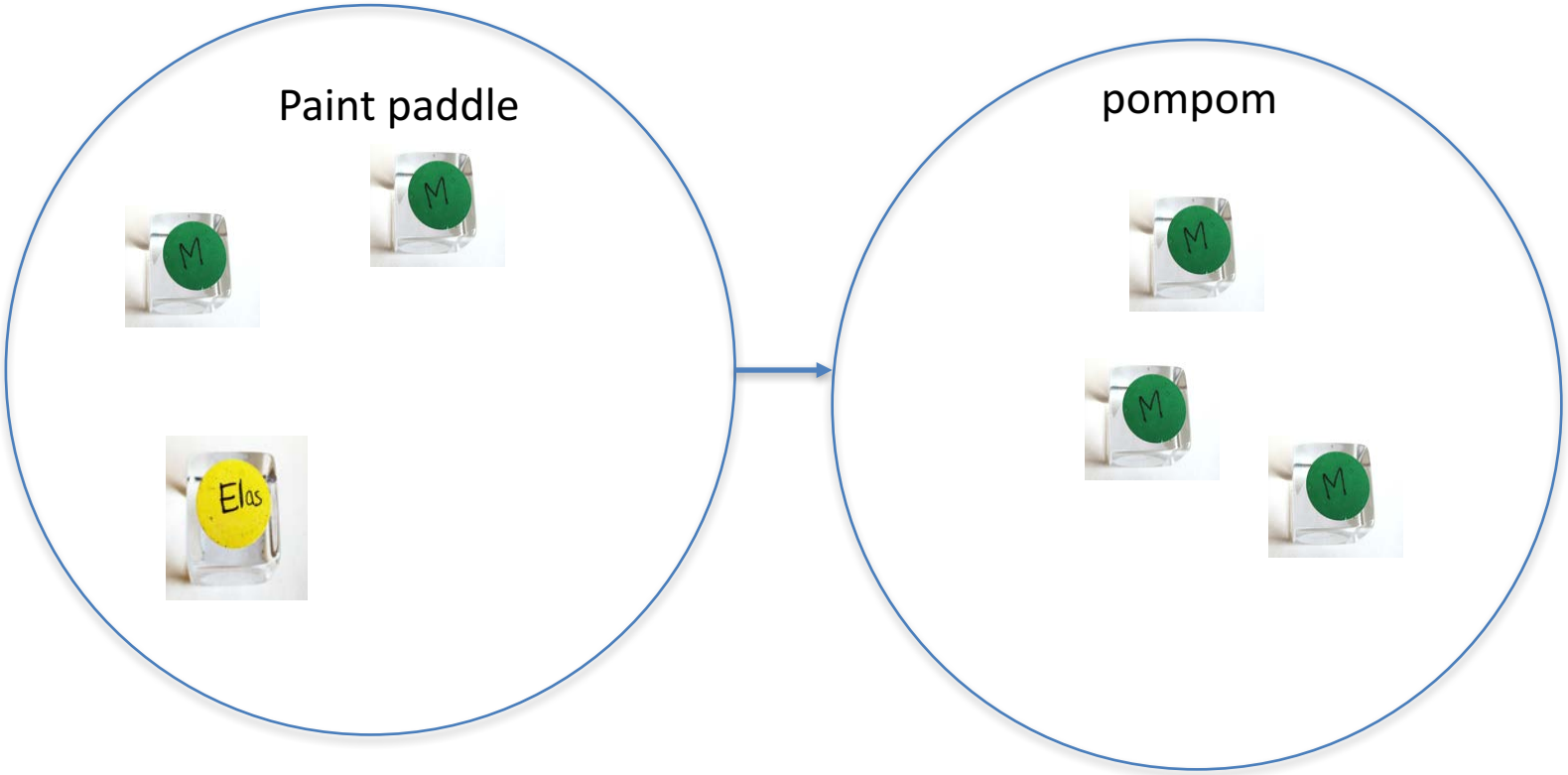

The paint paddle and pompom

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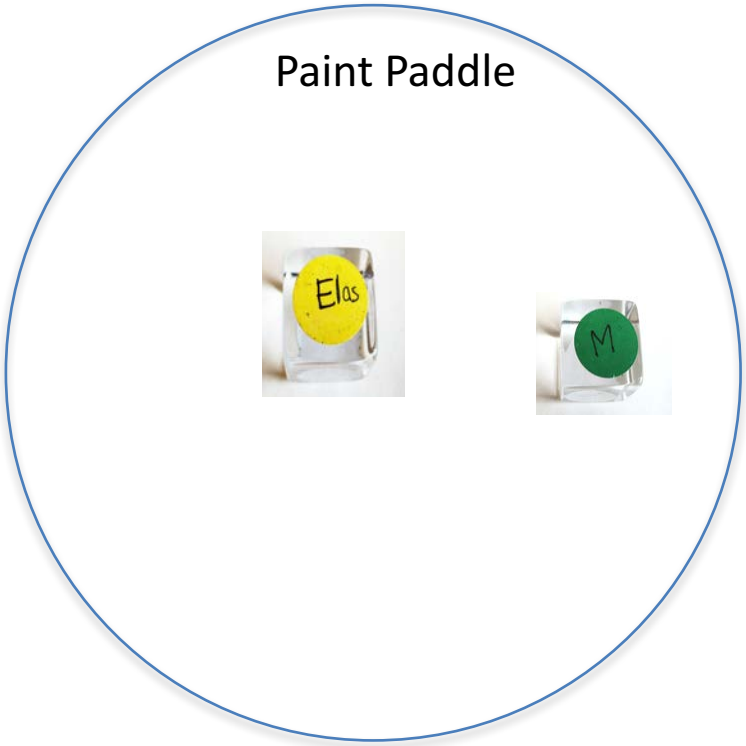
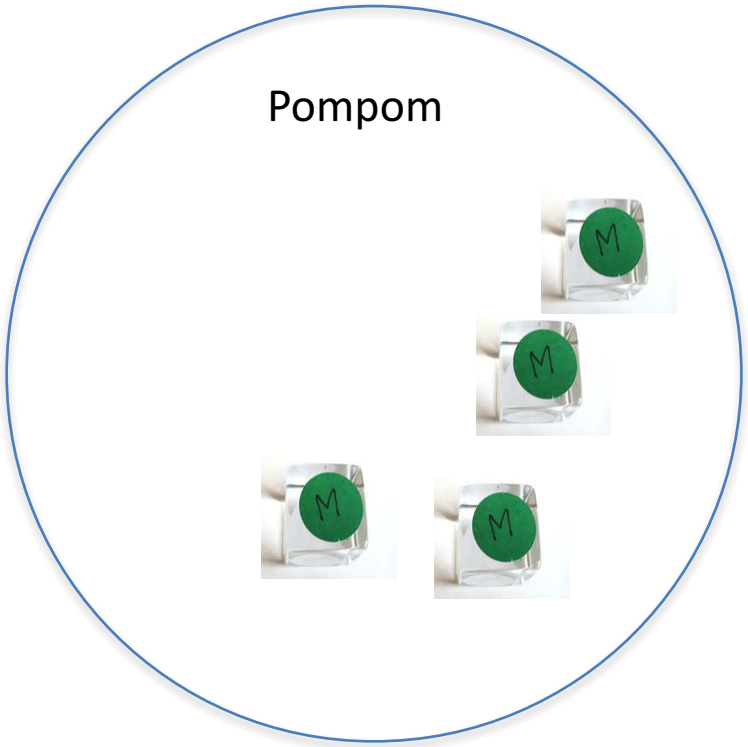




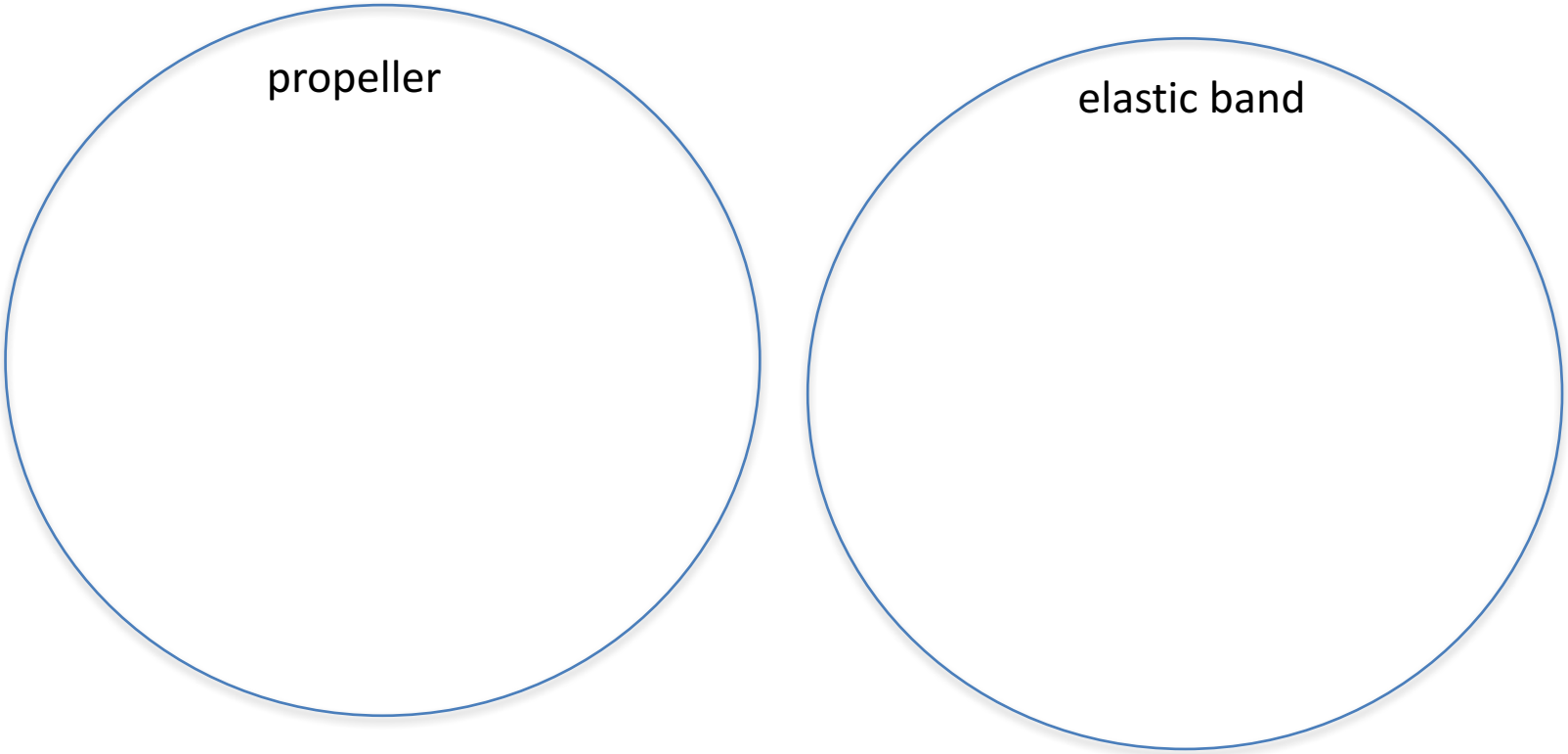
The propeller and elastic band

- Turn the propeller 10-20 times and hold.
- Release the propeller.
- Observe changes in the propeller and the rubber band.
- Use energy cubes to describe the energy flow.

The propeller and elastic band

- ❑ 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?

Use energy cubes and
Energy Tracking Lens questions.



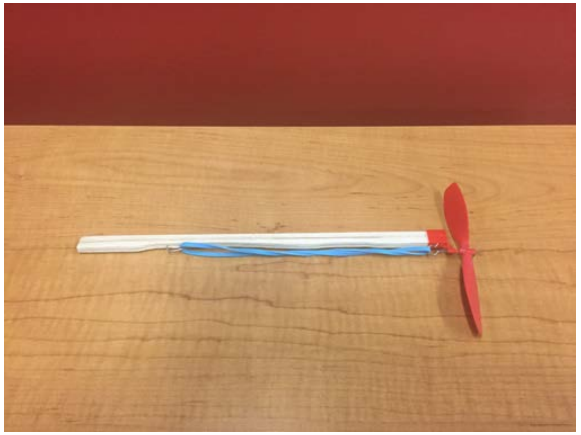
Looking Through The Energy Tracking Lens

What is the Evidence?

Part 1. What do you observe?

Part 2. Tell the energy story

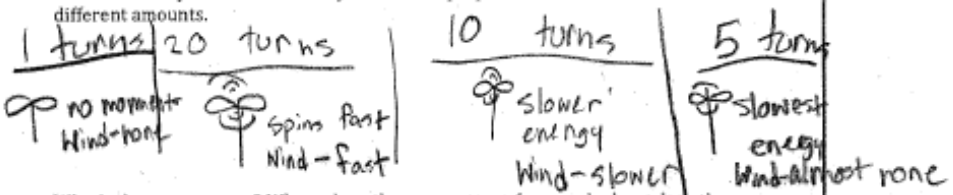
- What are the system components?
- What form(s) of energy?
- Increase in motion energy?
- Decrease in elastic energy?
- Transformation from elastic to motion energy?
- Where does the energy come from and where does the energy go?



The Energy Tracking Lens

- What's happening?

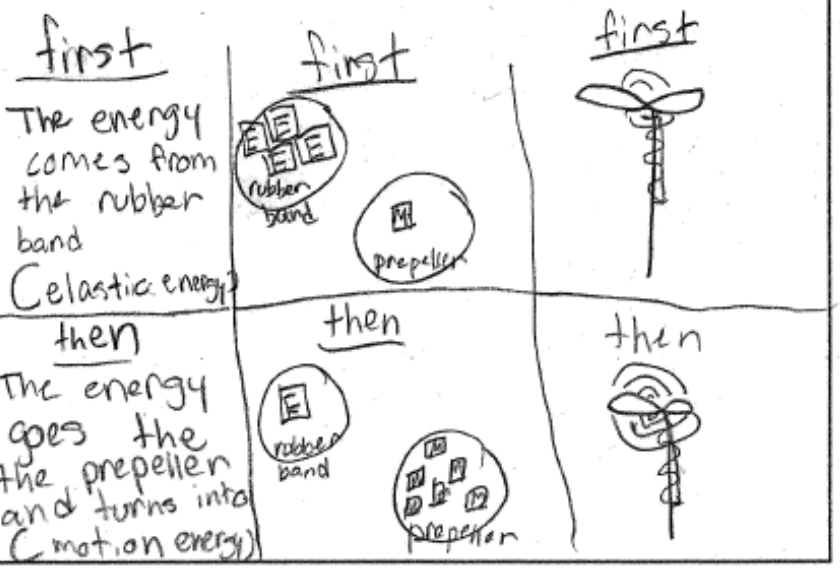
  Describe what you observe when you turn the propeller or twist the elastic band different amounts.

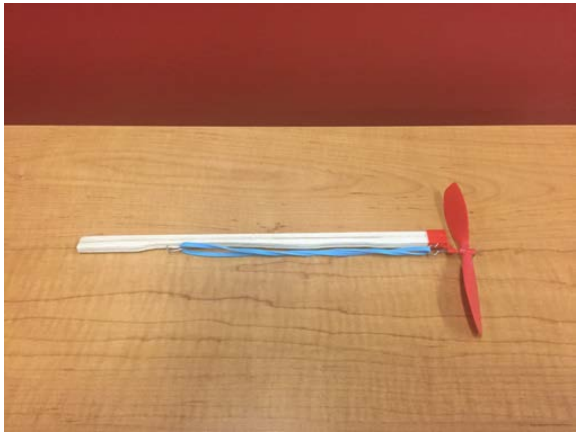


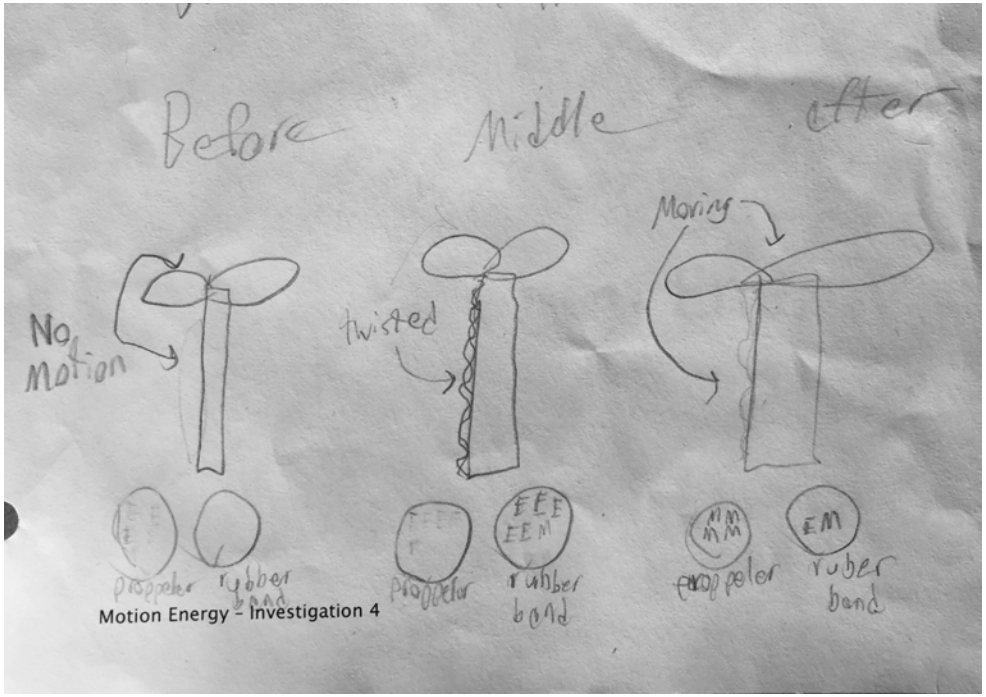
- What's the energy story? Where does the energy come from and where does the energy go?

  Track the energy flow. You can use drawings, words, labels, and arrows. Show:

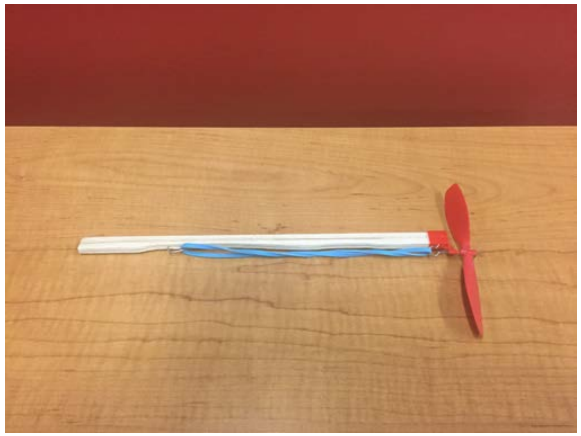
  - ☑ Components of the system
  - ☑ Forms(s) of energy
  - ☑ Energy transfers and transformations
  - ☑ Energy gains and losses

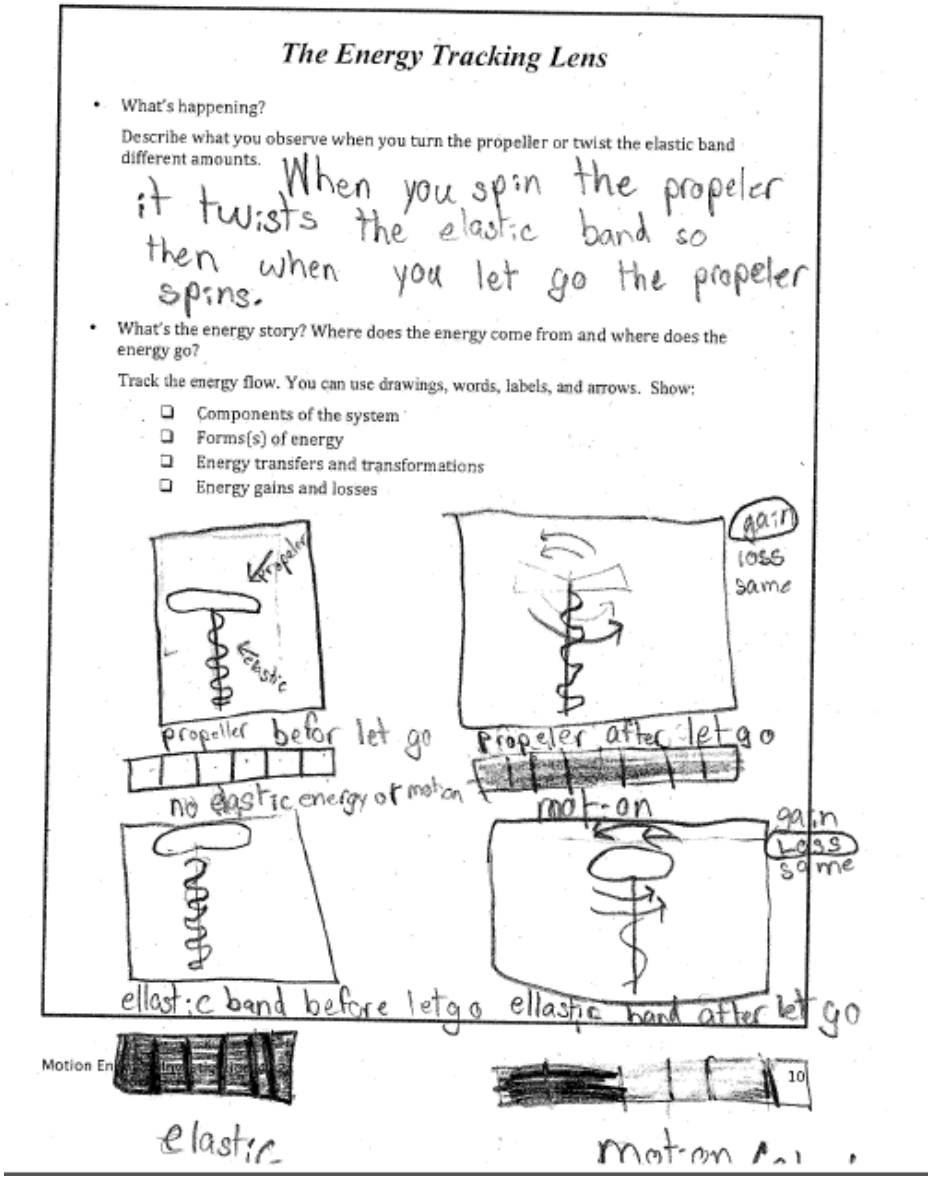





Before
Middle
After
No motion
twisted
Moving
propeler
rubber band
propeler
rubber band
propeler
rubber band

Representing forms and flow of energy





The Energy Tracking Lens

- What's happening?

  Describe what you observe when you turn the propeller or twist the elastic band different amounts.

  When you spin the propeler it twists the elastic band so then when you let go the propeler spins.

- What's the energy story? Where does the energy come from and where does the energy go?

  Track the energy flow. You can use drawings, words, labels, and arrows. Show:

  - ❑ Components of the system
  - ❑ Forms(s) of energy
  - ❑ Energy transfers and transformations
  - ❑ Energy gains and losses

Classroom Activities

‘This was just so well thought out and pieced together carefully. And it builds up so nicely the ideas on top of each other and the investigations are so engaging and the students really get into them. But they’re not so complex that you can’t set them up in a prep period.”

Teacher Workshop

"Got me excited to teach the unit and I feel equipped to facilitate the lessons in the classroom. It was a phenomenal learning experience on a topic that I was unfamiliar /nervous to teach. THANK YOU!"

Teacher Workshop

- "I felt challenged and taken seriously as an adult learner and respected as a professional. I've added to, clarified and honed my own understanding and am ready to use my stronger skills and these excellent materials to help students use the Energy Tracking Lens!"

Pilot Study

- 9 Teachers
- Summer Workshop: July 11-17, 2017
- Teach Focus on Energy 2017-2018

  Contact: Sara_Lacy@TERC.edu

  Sally_Crissman@TERC.edu

Curriculum

- Available to everyone September, 2018
- Focusonenergy.TERC.edu