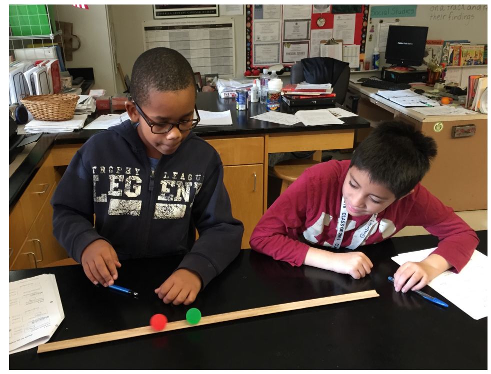
Motion Energy – Investigation 2

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

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Materials and Preparation

For the class:

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

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)

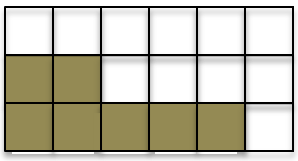
For each student:

- Motion Energy Student Notebook

Materials for each pair of students

Preparations:

- Set up and level the track on a table where students 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. The link to the video is on the *Focus on Energy* web site, under Curriculum Units -> Motion Energy -> Resource Quick Links.
- Read What’s Important about the Energy Tracking Lens?

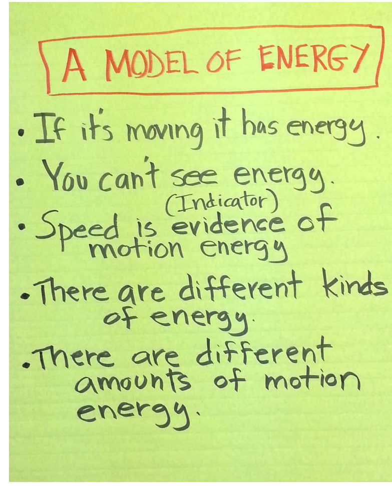
1. Introduction

All Class – 5 Mins

Start with a brief review of the Model of Energy that students developed during the previous class.

Explain the word **collision**: when objects crash into one another one we call it a "collision," or we say that they collide.

Explain that in this class students will observe and think about collisions and the idea that one ball can give energy to another ball as they collide. They will also think about how energy flows from one object to another; where the energy comes from and where it goes.



2. Collisions

Pairs/All Class – 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?

Roll Ball #1 toward Ball #2 at a moderate speed. After the collision, Ball #2 should be moving more quickly than Ball #1.

Did Ball #1 give energy to Ball #2? Explain why you think it did or did not.

Note: Ball #2 started with no motion energy (it was not moving) but after Ball#1 hit it, Ball #2 moved so it did have motion energy, and Ball #1 lost some motion energy (It slowed down). So, Ball #1 gave some of its motion energy to Ball #2.

How could I give Ball #2 even more energy?
➔Roll Ball #1 even faster.

Repeat the collision.

Scaffold students' ability to describe the collision in terms of motion energy. Reinforce the idea that changes in speed are what tell you about changes in motion energy.

> *Thinking 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 students return to their desks to work in pairs.

Give each pair of students:

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

Remind students 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, have students switch roles.

> *Remember, 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, which 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

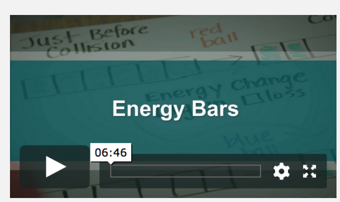
Share the following points:

- When scientists want to share their ideas with others, one thing they do is make drawings that show their ideas. Another term for these drawings is "representations".

- The cards you have been using, with the balls and *speed lines* for no motion, slow motion, and fast motion, are representations. They represent the speed at which the ball traveled.

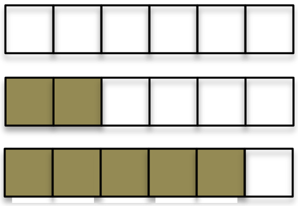
- Today students will learn about a representation for energy, not speed.

Watch a teacher introduce energy bars.



Energy Bars video available in Resource Quick Links on the Focus on Energy website

Refer to the large drawing of 3 energy bars on the white board or large piece of paper that you prepared ahead of time.



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

Use a ball to demonstrate the three options and ask students to say which energy bars to use (A, B, or C).

> *We are going to investigate energy changes that happen during a collision and you'll need to make lots of representations very quickly.*
> *• You can use speed lines to represent the motion of the balls.*
> *• You can use energy bars to represent the motion energy of the balls.*

3. Collisions Investigation

All class – 15 mins.

Students have watched several collisions by now.

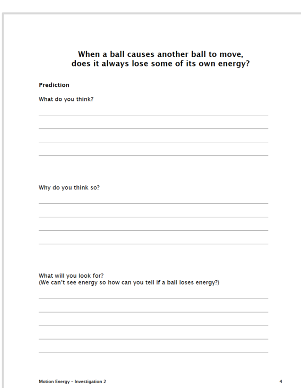
Introduce the investigation question:

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

The way to answer this question is to collect some data (this is what students are about to do). You will use the balls to cause several collisions, and each time students will watch carefully and record in their Student Notebooks how much energy the balls have, before and after the collision. They will then fill in Energy Bars to represent the amounts of energy.

Predict

First, ask students to turn to page 4 in their science notebooks and take 2-3 minutes to write their predictions and explain their reasoning.



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?)

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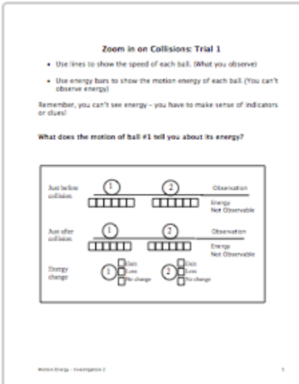
Notebook Page 4: *When a ball causes another ball to move, does it always lose some of its own energy?*

Collect data

Have students bring their notebooks and pencils with them as they gather around the demonstration track. Ask students to turn to page 5 in their notebooks called *Zoom In on Collisions: Trial 1*.



Notebook Page 5, *Zoom in on Collisions: Trial 1*

Do Trial #1 and practice using "speed lines" and energy bars.

Explain you are going to place Ball #2 on the track so it isn't moving and roll Ball #1 towards it but grab it shortly before the balls collide.

Ask students to use *speed lines* (similar to what was used on the cards) to describe the **motion** of both balls before the collision (point students to the "Just before collision" section at the top of the box on page 5.
*Now describe the **energy** of each ball –before the collision– by filling in the energy bars right underneath the images of the balls.*

Check that students understand the organization of the data sheet and how to use the speed lines and energy bars. When a ball is not moving, there are no speed lines and the energy bar should be empty. The energy bar for the moving ball should have 1-6 squares colored in depending on its speed.

Remind students of the distinction between the indicator (speed, which is visible) and motion energy (which is not visible).

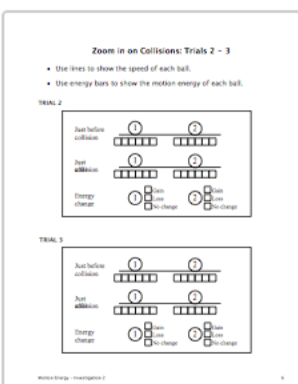
Now direct students to the "Just after collision" section in the middle of the box. Again, roll Ball #1 towards the stationary Ball #2, this time letting the balls collide. Have students complete both the observations and the energy bars.

Now have students describe the energy **change** for each ball – was there an energy gain, loss, or no change?

Repeat the investigation question

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

Explain they have just finished one trial. Do students agree that the first ball lost some of its motion energy after the collision? Is what they found always true, or might it ever be possible for the first ball to **not** slow down, **not** lose motion energy?



Complete Trials #2 and #3.
Tell the class you will now do two more trials. You will give them time after each trial to complete the speed lines (their observations) and the energy bars.

The main focus should be on Ball #1 immediately before and after the collision, since the investigation question is about Ball #1.

Notebook Page 6
Zoom in on Collisions: Trials 2 – 3

With everyone in the class watching closely, we'll try to find out if it is possible for Ball 1 to give some motion energy to Ball 2 AND to still keep the same amount of motion energy.
How would we know if Ball 1 keeps all of its motion energy?

➔ It would not slow down.


Can a ball cause another ball to move and NOT lose any energy?

What did you find out?

Does this make sense to you? Why or why not?

Think of an example from your everyday life where there's a loss of energy somewhere and a gain of energy somewhere else.
Describe your example.

After students have recorded the data for Trials #2 and #3, have them return to their desks and to use the evidence they have gathered from 3 trials to answer the questions on page 7 in the Student Notebook.

Notebook Page 7
When a ball causes another ball to move, does it always lose some of its own energy?

4. Make Meaning

All class – 15 mins

Have students bring their notebooks to the discussion circle so they can refer to their written responses and data.

The purpose of this discussion is to answer the investigation question.

> *Our investigation question today is:*
> **When a ball causes another ball to move, does it always lose some of its own energy?**
>
> *What did you predict?*
> Ask a few students to read their predictions from their notebooks. Be sure to give them time to explain the reasons behind their ideas.
>
> *What actually happened? What did you **see**? Refer to your notebooks.*
> ➔ Every time Ball #1 hit Ball #2, it looked like Ball #1 slowed down and Ball #2 changed from no motion to slow motion or fast motion.
>
> *Did anyone see something different?*

Consider the data from the whole class. It is unlikely that many students will have missed the reality that after a collision, the Ball #1 always slows down.

> *Now, what is the energy story? Today's question is actually about the energy, which we cannot see.*
> ➔ When Ball #1 hits Ball #2, Ball #2 gains energy. I know that because it speeded up – it went from having no motion to having motion. Ball #1 slowed down in every trial and that's evidence it lost some of its energy.

Be sure that all students agree that Ball #1 lost energy.

> *Does anyone have a different idea about the energy story?*
>
> *What do you think is the answer to our investigation question?*
>
> ➔ When a ball causes another ball to move, it always loses some of its own energy.
>
> *Let's think about energy gains and losses: when one ball gains motion energy, the other ball always loses motion energy. Gains and losses seem to go together. Let's keep thinking about this as we explore energy in other ways.*

Introduce the term *Transfer*

> *There is a word that is used to describe what happens when energy moves from one object to another. That word is **"transfer."***

Write the word **transfer** in a place where all can see it.

When one object collides with another, and gives some of its motion energy to the other object, we say that motion energy is transferred from one object to the other object.
Would someone describe the energy story of a collision between Ball #1 and Ball #2 using the word "transfer?"

➔ Before the collision, Ball #1 has a lot of motion energy, but when it hits Ball #2, some of its motion energy transfers to Ball #2.

Add to the model of energy

There were several new ideas about energy that the class discussed today. Let's look at our Model of Energy. What do you think we can add, based on our experience today?

Ask for volunteers to make suggestions as you add to the Model of Energy.

Listen for and highlight these key ideas.
- The term *transfer* describes what happens when energy moves from one object to another.
- Motion energy can be transferred between objects through collisions.
- In a collision, one ball gives (or transfers) some of its energy to another ball.
- One ball has to have energy to give or transfer energy to another ball.
- Energy Bars are a way to describe or represent how much energy an object has.
- Whenever there is a loss of energy somewhere, there's a gain in energy somewhere else (and vice versa).

If students do not mention one or two of these key ideas, you may call it to their attention. For example,

"I observed everyone using energy bars. What can we say about energy bars?"

Explain that the class will continue to investigate energy in systems with different components…not just balls and tracks… and that all of these ideas will continue to be important.

5. Quick Check

Individual – 10 mins.

> If you are unable to show the 10 second video and have students complete the Quick Check before the science class ends, find another time to implement it and to read student responses prior to starting the next Investigation, since the results can help shape how you proceed.

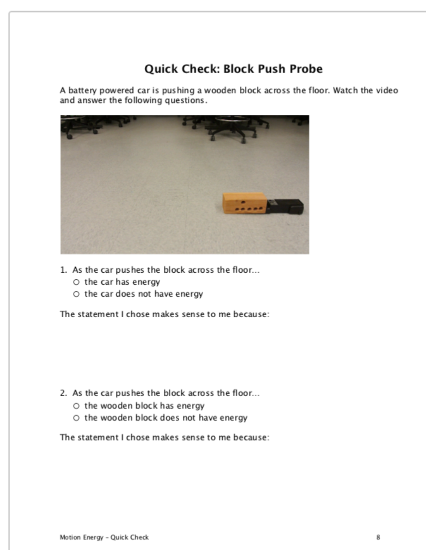
Block Push Probe

Show students the 10 second video *Quick Check: Block Push Probe* at least twice, and then ask them to turn to page 8 in their notebooks, read the *Block Push Probe* Scenario, and answer the questions.

This item will provide evidence of students' progress toward the learning goals for this investigation.

Students will need 5-10 minutes to complete the Quick Check. After you look at student results, plan time for students to discuss their responses.

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



Quick Check: Block Push Probe

A battery powered car is pushing a wooden block across the floor. 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:

Motion Energy – Quick Check 8

Notebook Page 8
Quick Check: Block Push Probe