MAINE MUSEUM OF INNOVATION LEARNING + LABOR

# Energy Innovation Kit

Teacher's Guide:
Lesson 1

Made possible in part by:

Margaret E. Burnham Charitable Trust

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## Introduction

Maine MILL's Innovation Kit program provides lessons and materials to schools throughout Maine designed to inspire them with stories, experiences, and paths for the future. The Energy Innovation Kit focuses on energy innovation, renewables, and solar energy. Students learn about the history of how power was generated in Maine's mills and factories, and how new forms of energy are captured and deployed. They explore electricity, make circuits, and build solar cars. They learn about jobs in the field, including electrician, solar installer, and electrical engineer, and hear from people in these jobs today. Our Energy Information Kit offers teachers 2 weeks (6-8 class periods) of lessons and activities and all the necessary materials to successfully complete each. Each lesson and activity is linked to Maine State Learning Standards and Next Gen Science Standards, where applicable, to help teachers achieve their curricular goals for the year.

## How to Use the Energy Innovation Kit Teacher's Guide

The lessons and activities in this kit are designed for students in upper elementary through middle school. Each lesson contains learning objectives, complete instructions for the lesson from set up to closing, assessment tools, and standards. Teacher's have the flexibility to deliver the lessons in sequential order, scaffolding students' knowledge, or they may select individual lessons based on students' past knowledge, experience or ability level. Where appropriate cross-curricular activities, alternate ideas for assessment and lesson alternatives are noted. Materials provided in the kit are only for the lessons provided in this teacher's manual and not for alternate suggested lessons.

## Care of the materials in the Energy Innovation Kit

Enough materials have been provided in this kit for 75 students (3 classes of 25 students each). Many activities require students to work in pairs or small groups. All materials in the Energy Innovation Kit are contained in sturdy plastic boxes. Handle the trunk the materials are delivered in with care, it will be heavy. It is recommended that teacher's store materials in a room that can be secured. Each box is labeled with the activity the material is for and a checklist for teachers to use when returning materials to the box. Please note any materials that may have been damaged on the checklist sheet.

## Note about Consumable Materials

Lesson 3 contains a selection of consumable materials for students to use in the construction of their model water wheels. Please return any unused materials with the kits to reduce the amount of waste.

# Energy Transformation Station Activity

## Innovation Kit Lesson 1

**Time:** 1 50-60 min. class period plus pre-reading and homework.

**Learning Objectives:**

- Students will be able to explain basic definitions of forms of energy - kinetic, potential, electrical, radiant, thermal, motion, sound, chemical, elastic, nuclear, gravitational.
- Students will be able to explain how energy changes from one form to another.
- Students will be able to identify evidence of the different forms of energy.
- Students will have a detailed understanding of GPE and KE.
- Students will be able to identify points when energy is stored or transferred.

**Materials Needed**

- Hair Dryer
- Colliding Spheres (Newton's Cradle)
- Tuning Fork and large erasers
- Rubber bands
- Pinwheels
- Marbles
- Ruler
- Timer
- "Understanding Energy " information sheet
- "Energy Transformation Station" lab sheets

**Pre-reading**

If students have not had any background lessons on forms of energy, or some years have passed, it is recommended that students read the "Understanding Energy" information sheet prior to the start of this lesson. This sheet can either be done together in class as a guided class read or as homework the night before. This sheet should be kept in their science notebook or folder so students can refer to it throughout the following station activity.

**Set Up**

1. Set up materials above in stations around the room. There should be enough stations for only 1 group of 2-3 students to work at a time. **You may choose to use all or some of these stations depending on the amount of students and the time you have for the class period.**
2. Have enough copies of the "Energy Transformation Station" and "Understanding Energy" sheets for each student.

As students enter the room set the mood with music. Before the bell rings/class period begins, play a song that mentions energy or electricity. There are lots of options out there but here are a few suggestions: High Voltage -AC/DC, I've Got the Power - Snap, Electric Avenue - Eddy Grant, Make a Circuit With Me - The Polecats, Electric Boogy (Electric Slide) - Marcia Griffths, Electric Youth - Debbie Gibson.

**Introduction**

1. Create a class mind map - Write "Energy" on the board. Ask the class "When you think of energy, what do you think of?" Write answers on the board. If pre-reading "Understanding Energy" was assigned this can be a quick informal survey for understanding or if not, a check for prior knowledge.
2. Watch Energy Defined Video from PBS Learning Media. Following the video ask the students to define energy using their own words and what it means to convert one form of energy to another.
3. Hand out copies of "Understanding Energy" sheets to each student if it was not assigned as a pre-reading activity. Review together and explain that students will need this information in order to complete the activity. Sheets should be kept in their science notebook or folder for future reference.

**Instruction, Teacher Modeling, Guided Practice**

1. Hand out copies of "Energy Transformation Station" lab sheets. If students have a science lab notebook these pages can be added to the notebook or they can be distributed as a separate packet.
2. Review the sheets together as a class. Explain how each station has an object to test and students have 5 minutes at each station. Establish expectations for each lab activity and behavior.
3. Divide students into groups of 2-3. You may choose to assign groups or allow students to choose their own.

**Independent Work Time**

1. Assign each group a station to start at and set a timer for 5 minutes.
2. Allow students 5 minutes to explore each item and to complete the Energy Transformation Station lab sheet for that station.
3. Rotate students to the next station after 5 minutes.

**Closing, Review and Assessment/Homework**

1. Stop students working 5 min before the end of class to clean up all materials and hand in worksheets. Incomplete sheets can be sent home as homework to return the next class period.
2. Have students return to the mind map the board. Ask students what would they add to the map based on their lab experience now? Can they identify any patterns?
3. Collect all lab sheets when completed and review for understanding.

**Standards**

*Maine Learning Results*

4-PS3-4 Apply scientific ideas to design, test and refine a device that converts energy from one form to another.

*Next Gen Science Standards*

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (Grade 4)

# Understanding Energy

Scientists define energy as the ability to do work. Energy makes things change. It can make an elevator go up and down, keep the lights on in our homes, keep our cars moving down the road, cook our food or keep it cold in the refrigerator. Energy makes our bodies grow and allows our mind to think. There are many different forms of energy but they can be divided into two categories, potential and kinetic energy.

## Kinetic Energy

Kinetic energy is motion; it is the motion of waves, electrons, atoms, molecules, substances, and objects.

| | |
|---|---|
| **Electrical Energy** | Electrical energy is the movement of electrons. Everything is made of tiny particles called atoms. Atoms are made of even smaller particles called electrons, protons, and neutrons. Applying a force can make some of the electrons move. Electrons moving through a wire are called electricity. Lightening is another example of electrical energy. |
| **Radiant Energy** | Radiant energy is electromagnetic energy that travels in waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Solar energy is an example of radiant energy. |
| **Thermal (Heat) Energy** | Thermal energy, or heat, is the internal energy in substances; it is the vibration and movement of the atoms and molecules within a substance. The more thermal energy in a substance, the faster the atoms and molecules vibrate and move. Geothermal energy is an example of thermal energy. |
| **Motion (Mechanical) Energy** | Motion energy is the movement of objects and substances from one place to another. Objects and substances move when an unbalanced force is applied according to Newton's Laws of Motion. Wind is an example of motion energy. |
| **Sound Energy** | Sound energy is the movement of energy through substances in horizontal waves. Sound is produced when a force causes an object or substance to vibrate; the energy is transferred through the substance in a wave. |

# Potential Energy

Potential energy is stored energy and the energy of position, or gravitational potential energy. There are several forms of potential energy.

| | |
|---|---|
| **Chemical Energy** | Chemical energy is energy stored in the bonds of atoms and molecules. It is the energy that holds these particles together. Biomass, petroleum, natural gas, propane, and the foods we eat are examples of stored chemical energy. Batteries also work by storing chemical energy. |
| **Elastic Energy** | Elastic energy is energy stored in objects by the application of a force. Compressed springs and stretched rubber bands are examples of elastic energy. |
| **Nuclear Energy** | Nuclear energy is energy stored in the nucleus of an atom; it is the energy that holds the nucleus together. The energy can be released when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called fission. The sun combines the nuclei of hydrogen atoms in a process called fusion. |
| **Gravitational Energy** | Gravitational potential energy is the energy of position or place. A rock resting at the top of a hill contains gravitational potential energy because of its position. Hydropower, such as water in a reservoir behind a dam, is an example of gravitational potential energy. |

## The first law of thermodynamics states that energy can neither be created nor destroyed, only altered in form.

What does that mean? We can not create energy from nothing but we can transform, or convert, one form of energy into another.

Name:_____

# Energy Transformation Station - Hair dryer

**Step # 1 - Plug in the hair dyer and turn it on.**

1. What type of energy is coming from the outlet in the wall to the hair dryer?

_____

2. What type of energy comes out of the hair dryer?

_____

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
| --- | --- |
| | |

Name another object that transforms energy in a similar way to the hair dryer. Explain how they are alike.

_____

_____

**Step #2 - Turn off and unplug the hair dryer. Wait until you are instructed to move to the next station.**

Name:_____

# Energy Transformation Station - Tuning Fork

**Step #1 - <u>CAREFULLY</u> pick up a tuning fork and eraser. The tuning fork is fragile and can break, so please treat with care.**

**Step #2 - Place the eraser so that it lies flat on the table. Holding the end of the tuning fork in your hand and <u>GENTLY</u> tap the fork on the eraser.**

**Step #3 - Hold the tuning fork up to your ear.**

What form of energy is coming from the tuning fork? _____

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
| --- | --- |
| | |

What did you hear, see and feel after you tapped the tuning fork? Record your observations in at least 3 sentences.

_____

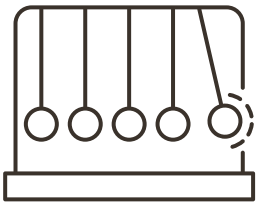
_____

_____

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Name:_____

# Energy Transformation Station - Colliding Spheres



**Step #1 - The Colliding Spheres, also called a Newton's Cradle, is fragile so please treat it with care. <u>CAREFULLY</u> lift one of the spheres on the end slightly higher than the others.**

What form of energy is this? _____

**Step #2 - Let the sphere go.**

Describe what happened. What form of energy is this?

_____

_____

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
| --- | --- |
| | |

**Step #3 - Try lifting 2 spheres and let them go. Now try 3 spheres. What happens each time?**

_____

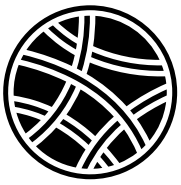
_____

_____

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Name:_____

# Energy Transformation Station - Rubber Bands



**Step #1 - Each person should take a rubber band.**

**Step #2 - Stretch the rubber band between your fingers.**

What form of energy is this?_____

**Step #3 - Aim for the floor and release the rubber band. Be careful not to hit anyone.**

What form did the energy take when you released the rubber band?

_____

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
| --- | --- |
| | |

**Step #3 - Think of another example of energy transforming in the same way as the rubber bands. Describe below.**

_____

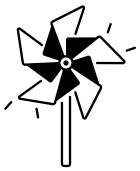
_____

_____

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Name:_____

# Energy Transformation Station - Pinwheel



**Step #1 - Each person should take a pinwheel.**

**Step #2 - Blow on the pinwheel so it spins.**

What form of energy is this?_____

What form did the energy take when the pinwheel started to spin?_____

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
| --- | --- |
| | |

**Step #3 - How does changing how hard you blow effect the rate that the pinwheel spins? Try turning the pinwheel in different directions. How does that effect the spin when you blow? Describe below.**

_____

_____

_____

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Name:_____

# Energy Transformation Station - Marbles

**Step #1 - Take the ruler and place one end on a book and the other end on the table so that it forms an incline.**

**Step #2 - Hold one marble at the top of the ruler on the book.**

What form of energy is this?_____

**Step #3 - Let go of the marble and allow it to roll to the bottom of the ruler to the table. Make sure to catch it before it rolls off the table!**

What form of energy is this? _____

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
| --- | --- |
| | |

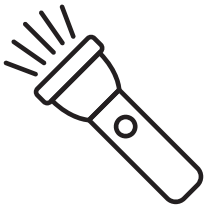
**Step #3 - Try stacking another book on top of the first so that your ramp is steeper. How does this change how fast the marble rolls? Describe below.**

_____

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Name:_____

# Energy Transformation Station - Flashlight



**Step #1 - Take the batteries and insert them into the flashlight. Make sure the batteries are lined up in the correct direction.**

What type of potential energy is in the battery? _____

**Step #2 - Turn on the flashlight. Troubleshooting: If the flashlight will not turn on trying changing the battery positions.**

What form of energy is needed to turn on the flashlight? _____

What form of energy does the flashlight produce? _____

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy in Battery | Energy in the Flashlight | Energy Coming from the Flashlight |
|---|---|---|
| | | |

**Step #3 - Many devises we use everyday require a battery to operate wirelessly. List as many things as you can that you use in a day that require a battery to operate.**

_____

_____

**Step #4 - Remove the batteries from the flashlight and clean up materials. Wait until you are instructed to move to the next station.**

Answer Key

# Energy Transformation Station - Hair dryer

**Step # 1 - Plug in the hair dyer and turn it on.**

1. What type of energy is coming from the outlet in the wall to the hair dryer?

Electric Energy

2. What type of energy comes out of the hair dryer?

Thermal and/or sound energy

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
|---|---|
| Electric | Thermal<br>Sound |

Name another object that transforms energy in a similar way to the hair dryer. Explain how they are alike.

There are a number of devises that covert electrical to thermal energy- oven, stove, curling iron/straightner, etc.

**Step #2 - Turn off and unplug the hair dryer. Wait until you are instructed to move to the next station.**

Name:_____

# Energy Transformation Station - Tuning Fork

**Step #1 - CAREFULLY pick up the tuning fork and eraser. The tuning fork is fragile and can break, so please treat with care.**

**Step #2 - Place the eraser so that it lies flat on the table. Holding the end of the tuning fork in your hand GENTLY tap the fork on the eraser.**

**Step #3 - Hold the tuning fork up to your ear.**

What form of energy is coming from the tuning fork? Sound Energy

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
|---|---|
| Mechanical | Sound |

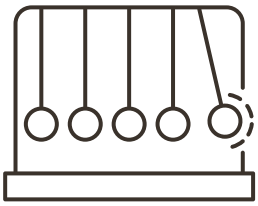
**What did you hear, see and feel after you tapped the tuning fork? Record your observations in at least 3 sentences.**

Answers will vary but expect observations of the sound the fork makes and the vibration they feel in their hands.

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Answer Key

# Energy Transformation Station - Colliding Spheres



**Step #1 - The Colliding Spheres, also called a Newton's Cradle, is fragile so please treat it with care. CAREFULLY lift one of the spheres on the end and lift is slightly higher than the others.**

What form of energy is this? Potential

**Step #2 - Let the sphere go.**

**Describe what happened. What form of energy is this?**

When the sphere falls and collides with the next one it causes the sphere on the opposite side to move. This is motion or mechanical energy.

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
| --- | --- |
| Potential | Motion<br>(Mechanical)<br>Sound |

**Step #3 - Try lifting 2 spheres and let them go. Now try 3 spheres. What happens each time?**

If 2 spheres are lifted, the opposite 2 will move. Students should note changes in speed, height of the moving spheres and differences in the sounds they make.

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Answer Key

# Energy Transformation Station - Rubber Bands

**Step #1 - Each person should take a rubber band.**

**Step #2 - Stretch the rubber band between your fingers.**

What form of energy is this? Potential

**Step #3 - Aim for the floor and release the rubber band. <u>Be careful not to hit anyone.</u>**

What form did the energy take when you released the rubber band?
Mechanical or Kinetic

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

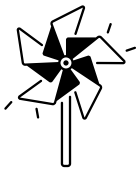
| Energy Before | Energy After |
| --- | --- |
| Potential | Mechanical<br>Kinetic |

**Step #3 - Think of another example of energy transforming in the same way as the rubber bands. Describe below.**
Answers will vary but could include springs, hair ties, etc.

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Answer Key

# Energy Transformation Station - Pinwheel



**Step #1 - Each person should take a pinwheel.**

**Step #2 - Blow on the pinwheel so it spins.**

What form of energy is this? Mechanical

What form did the energy take when the pinwheel started to spin? Mechanical

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
| --- | --- |
| Mechanical | Mechanical |

**Step #3 - How does changing how hard you blow effect the rate that the pinwheel spins? Try turning the pinwheel in different directions. How does that effect the spin when you blow. Describe below.**

Answers will vary but should include observations of the harder you blow the faster the wheel turns and changing the angle can make the wheel pin faster or slower.

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Answer Key

# Energy Transformation Station - Marbles

**Step #1 - Take the ruler and place one end on a book and the other end on the table so that it forms an incline.**

**Step #2 - Hold one marble at the top of the ruler on the book.**

What form of energy is this? Potential gravitational energy

**Step #3 - Let go of the marble and allow it to roll to the bottom of the ruler to the table. Make sure to catch it before it rolls off the table!**

What form of energy is this? Mechanical

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy Before | Energy After |
|---|---|
| Gravitational | Mechanical |

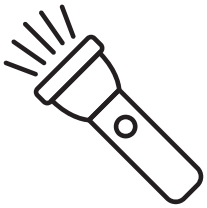
**Step #3 - Try stacking another book on top of the first so that your ramp is steeper. How does this change how fast the marble rolls? Describe below.**

The steeper the incline the faster the marble rolls.

**Step #4 - Clean up your materials. Wait until you are instructed to move to the next station.**

Name:_____

# Energy Transformation Station - Flashlight



**Step #1 - Take the batteries and insert them into the flashlight. Make sure the batteries are lined up in the correct direction.**

What type of potential energy is in the battery? Chemical

**Step #2 - Turn on the flashlight. Troubleshooting: If the flashlight will not turn on trying changing the battery positions.**

What form of energy is needed to turn on the flashlight? Electrical

What form of energy does the flashlight produce? Radiant

**Complete the table below. You may use text and/or a small drawing to illustrate your answer.**

| Energy in Battery | Energy in the Flashlight | Energy Coming from the Flashlight |
|---|---|---|
| Chemical | Electrical | Radiant |

**Step #3 - Many devises we use everyday require a battery to operate wirelessly. List as many things as you can that you use in a day that require a battery to operate.**

_____

_____

**Step #4 - Remove the batteries from the flashlight and clean up materials. Wait until you are instructed to move to the next station.**