**Energy**

## Grade: 4 Unit Plan

Big Ideas:

Energy can be transformed (ie. What is energy input and and energy output? What is energy conservation? What is the relationship between energy input, output, and conservation?)

Content:

Energy

* has various forms (energy can be described in these ways: the energy of motion (kinetic), light, sound, thermal, elastic, nuclear, chemical, magnetic, gravitational, and electrical.)
* Is conserved (the law of conservation of energy – energy cannot be created or destroyed but can be changed.)

Devices that transform energy

* Devices that transform energy change input energy into a different output energy (e.g. glow stick (chemical to light), wind-up toy (elastic to mechanical), flashlight (electrical to light.)

Curricular Competencies:

* Questioning and predicting
* Planning and conducting
* Processing and analyzing data and information
* Evaluating
* Applying and innovating
* Communicating

# Sequence of Lessons:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Lesson** | **Outcomes or Expectations** | **Assessment or Evaluation** | **What will the teacher do?** | **What will the students do?** |
| 1. What is Energy? | Students will learn what energy isStudents will perform an experiment, and record their findings | Participation in class discussionExperiment recordings | Lead class discussionCoiling snake demoSupervise experiment | Participate in class discussionDo the “dispersal of food coloring through different temperatures of water” experiment |
| 2. Kinetic and Potential Energy | Students will learn the difference between Kinetic and Potential energy | Experiment recordingsTicket out the door: what is the difference between kinetic and potential energy? | Show the “snake in a can” demoSupervise the rubber band experiment | Do the rubber band experiment |
| 3. Newton’s Laws of Motion | Students will learn Newton’s first and third law of motion | Collisions graphic organizerCan students explain what’s happening with the energy transfer in their collisions? | Ball bouncing and billiard ball demoSupervise collision examples | Students will come up with their own examples of collisions from different materials provided. They will talk about the energy transfer in their collisions and fill out a graphic organizer |
| 4. Energy Types and Conversions | Students will learn the different types of energy, and what happens when energy changes | Energy conversion handout | Set up and supervise the different stations for students to go through | Do the activities at the different stationsFill out Energy Conversion handout |
| 5. Sources of Energy | Students will learn where energy comes from and have a review of the energy material we have covered so far | Jeopardy game | Solar Energy DemoOrganize the jeopardy game | Participate in the jeopardy game |
| 6. Tracing the Path of Energy | Students will follow the path of energy (from point of use, through all the steps until the energies point of origin)Cross-Curricular Possibility: Arts Education (have students create visual representation of the energy path)English Language Arts: Write about the different steps in the path that energy takes | Presentation of their research | Supervise students work Answer questions when needed | Research their energy, find out the different changes it goes through, and where it originates.Present material in an interesting way |

# Lesson #1 – What is Energy?

Brainstorm as a class “what is energy?”

**Coiling Snake Demo**: Hold the “snake” over a light bulb or a flame. Explanation: When the candle burns, two forms of energy are released, heat and light energy. The heat causes the air to rise up, which in turn makes the snake spin around. (The snake does not move up because the coiled shape of the snake allows the heat to rise through the middle and spin the snake.)

**Class discussion:** The energy we need comes from the food we eat. The energy required to turn the pedals of a bicycle comes from the person riding the bicycle. Cars and trucks get their energy from gasoline. Some homes are heated using oil or natural gas or firewood. When designing heating and cooling systems, engineers study thermal energy and how it creates air movement. They place heat vents and radiators low, near the floor because they know that hot air rises. As hot air rises it mixes with the existing room air, preventing "cold" spots and making the space more comfortable. The same is true for cool air vents that are placed high, near the ceiling. The cool air sinks, evenly mixing with the existing room air.

**Vocabulary:**

**Energy** – the ability to cause motion and change.Energy is massless, but exists in interactions between matter.

3 states of matter in relation to movement (speed) of molecules in each state: solid, liquid, and gas. Discuss heat as a form of energy.

Energy that allows objects to change or move is called **kinetic energy.** The faster an object changes or moves, the more energy the object possesses. Molecules move slowest in a solid and fastest in a gas because they have the least energy in a solid state and the most energy in a gaseous state. Increases in heat energy make ice melt into water, and water evaporate into vapor. Similarly, decreases in heat energy make water freeze into ice. Introduce students to the **Law of Conservation of Energy**: Energy can be transferred from one object to another, or transformed from one type to another, but energy can never be lost or created.

**Activity**: Students in groups will have 4 different temperatures of water, students will drop food coloring into each, recording the time it takes for the food coloring to fully disperse in the water. Have students graph their findings. To challenge them, have them predict how much time it takes for a temperature of water they did not test.

**Teacher Explanation:** Temperature is an average of the (kinetic) energy of the particles in a sample of matter. Thus, an increase in temperature describes an increase in the amount of heat energy in the water. As discussed in the focus activity, an increase in heat energy leads to an increase in the movement of molecules. Faster water molecules help disperse the food dye faster.

**Song** to show students “What is energy?”:<https://www.youtube.com/watch?v=o_5oYuDY2qM>

**Assessment**: Experiment recordings, participation in discussions.

# Lesson #2: Kinetic and Potential Energy

***Vocabulary:***

**Kinetic Energy** - energy that an object has because of its motion

**Potential Energy** - stored energy; energy that an object has because of its position

Kinetic energy is converted into potential energy. An object that has a higher relative position to the ground will have more potential energy, because it works against the force of gravity. Gravity is constantly at work. Think of the expression “What goes up must come down”. An object that is up in the air has potential energy due to its position. When it falls, it has kinetic energy.

 The “snake-in-a-can” joke is an example of Potential Energy (PE) and Kinetic Energy (KE). Show this as a demo to the class

**Rubber band experiment:** Investigate how the distance you stretch a rubber band at rest relates to the distance the rubber band travels after being released.

Bill Nye energy video:

<https://www.youtube.com/watch?v=haJWh9Pa-io>

The difference between kinetic and potential energy: <https://www.youtube.com/watch?v=vl4g7T5gw1M&feature=player_embedded>

# Lesson #3: Newton’s Laws of Motion

***Vocabulary:***

**Newton’s First Law of Motion** - An object that is moving will keep moving, and an object at rest will remain at rest, unless energy is used to change its motionDemonstrate this law with a ball. Talk about how inertia is involved in this law by using examples of trying to move stationary objects or stop moving objects. **Inertia** is an object's resistance to movement or to a change in motion. So this explains why if something is moving, it will tend to keep moving in the same direction and at the same speed and if something is still, it will tend to keep still, unless you forcibly change its motion. It would be hard to stop a speeding shopping cart or move a big refrigerator because of the object's inertia, it would take energy to overcome the inertia, which is why it feels strenuous to try to do so.

**Newton’s Third Law of Motion** - For every action there is an equal and opposite reaction.

Demonstrate this law by pushing against the side of a table. Discuss how neither you nor the table move. Point out how your hand becomes squished against the side of the table to prove that there is force being used. Ask students what would happen if you pushed harder than the table pushed back? What about the opposite scenario, where the table "pushes" back harder than you push it?

**Activity:**

Hold up a medium sized ball to show it to the class. Ask students to predict what will happen when the ball collides with the floor. Drop the ball, and then catch it after it has bounced back to roughly its starting height. Repeat, but now let it bounce a few times before you catch it. Ask students to explain what just happened using Newton’s laws. How does the first law apply to this situation? If energy must be used to change something’s movement, why does the ball not stay in the same place after you let go of it? What is the source of energy acting on the ball to move it downwards? How does the third law apply to this situation? Why didn’t the floor seem to move, if the ball hits it and it responds equally? What happens to the total energy in this collision?

**Teacher Explanation:** When the ball fell, it kept moving until it was stopped by the force of hitting the ground. The ball fell because gravity exerts a downward force on all objects. The force of gravity, however, does not give the ball enough energy to break through the floor, so the ball did not keep traveling downwards through the floor. Once it hits the floor it starts traveling upwards. This is because the action of the ball hitting the floor is matched with the equal and opposite reaction of the floor “hitting” the ball. The floor moves, but this change is so little compared to the size of the floor that we cannot see the change. The ball, which is much smaller, has a more visible movement. The energy of gravity acting on the ball is transferred to the floor. An equal amount of energy is transferred back into the ball, allowing it to bounce.

Place one billiard ball on a flat surface about 2 feet away from the second billiard ball. Explain to the students that you will be using one of the balls to hit the other one. Ask them to write a prediction in their science journals about what will happen after the collision. Using one of the billiard balls, hit the other. The first ball should stop after colliding with the second, and the second should continue moving at about the same speed as the initial speed of the first ball. Ask students to explain what just happened using Newton’s laws. How does the first law apply to this situation? How does the third law apply to this situation? What happens to the total energy in this collision?

**Teacher Explanation**: The ball that was moving kept moving until it hit the second ball, and the second ball was stationary until it was hit by the first ball. After the collision, the first ball stopped moving and remained stationary, and the second ball continued moving until it was stopped. When the first ball hit the second and caused it to start moving, the second ball also “hit” the first, causing it to stop moving. The energy of the first ball is entirely transferred to the second ball.

Split the students into groups of about 4. Each group will have the chance to come to the front of the classroom to demonstrate a collision, with help from the teacher. Show students a variety of balls of different sizes and masses, such as basketballs, golf balls, ping pong balls, fishing weights, tennis balls, etc. You should have multiples of some of these objects so that students can play around with different and/or similar masses. Have one student in the group pick two of the balls available. Have another student in the group decide whether those two balls will collide in a situation where one ball is initially travelling faster than the other, when they travel at the same speed, or when one ball is initially stationary. As a class, make predictions about what would happen when those two balls collide. Students should explain their reasoning using Newton’s first and third laws and also take into account the relative speeds and masses of the balls involved in the collision. The teacher will then ask the remaining two students in the group to demonstrate the collision. Remember to always keep the movement linear. If both balls are moving, they should be moving towards each other. Have each group come up and demonstrate a collision. Students should record observations in their lab notebooks about what actually happened in each collision, including a simple illustration of the paths of the balls. Students should also note the energy transfers that occur in each collision.

**Assessment:** Collisions Graphic Organizer

 Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Newton's Laws of Motion: Collisions**

**Newton’s First Law of Motion**: An object that is moving will keep moving, and an object at rest will remain at rest, unless energy is used to change its motion

**Newton’s Third Law of Motion**: For every action there is an equal and opposite reaction

**Inertia**: Resistance to change in motion

How would you explain Newton's Laws in your own words?

Where have you seen examples of these laws in your life?

**Demo 1: Ball bounce**

How does the first law apply to this collision?

How does the third law apply to this collision?

What happened to the total energy in this collision?

**Demo 2: Simple collisions**

How does the first law apply to this collision?

How does the third law apply to this collision?

What happened to the total energy in this collision?

# Lesson 4: Energy types and Conversions

***Vocabulary:***

**Sound Energy** - energy produced by vibrations and transferred through sound waves

**Radiant Energy** - energy produced by light

**Thermal Energy** - energy produced through the movement of particles and measured as heat

**Electrical Energy** - energy produced through the movement of electrically charged particles and transferred into motion, light, or heat

**Mechanical Energy (Motion)** - energy of motion that causes change

**Chemical Energy** - stored energy released by a chemical reaction, such as burning gas or coal

**Activity:** Stations will have different forms of energy:

Station 1 – wind up flashlights (mechanical to electrical)

Station 2 – music box (mechanical to sound)

Station 3 – sand jar (mechanical to thermal) (When we shake the container of sand, the grains of sand move against one another. This movement causes friction, which transforms the mechanical energy of the shaking into heat energy that raises the temperature of the sand. The container with less sand should heat up more because the sand inside is more free to move and collects more kinetic energy than the sand in the full container.)

Station 4 – Baking soda and vinegar balloons (chemical to mechanical)

**Closure:** Discuss the following scenario: A driver is leisurely driving on a mountain road, when all of a sudden a moose pops out of nowhere. The driver slams down on his breaks, and the car comes to a screeching stop right in front of the moose. Thankfully, neither driver nor moose is injured during this incident. However, the car was moving so fast that you could see sparks if you looked really closely and car’s tires left dark scorch marks on the road. Where did all the mechanical kinetic energy of the moving car go when the car stopped? Write what you think happens down for a “ticket out the door” activity. Try to use as much vocabulary as you can!

**Teacher** **Explanation**: The mechanical kinetic energy of the moving car converted into other forms of energy, including sound energy (the screeching tires), radiant energy (the sparks), thermal energy (which left the scorch marks), and mechanical energy (that moved in the opposite direction of the car to slow and eventually stop it).



**Energy Conversions Station Instructions**

**Station 1: Flashlight**

1. There is a hand cranked flashlight at this station. Turn the crank once and see what happens.
2. While one person is timing, another person should turn the crank exactly 1 cycle. Time the light to see how long it lasts. Record this information in your notebooks. What do you think would happen if you turned the crank more than 1 cycle?
3. Switch roles so that everyone gets to try different jobs. Now time and record how long the light from 2 crank cycles lasts. Try again, this time cranking the flashlight 3 full cycles. What is happening as you crank the flashlight more?

**Station 2: Instrument**

1. Have you ever seen inside a music box, or wondered how they work? There is a windup music box at this station. Try winding it up.
2. What happened when you wound up the music box? How did it work? Ask a teacher to see if your hypothesis was correct!
3. Think about the other musical instruments you know of. Can you explain how they work, using your hypothesis about how the music box works? Discuss with your group.

**Station 3: Sand Jar**

1. Notice that there are two bins with sand in them. Observe how these two bins are different.
2. Using the thermometers, measure and record the temperature of the sand in each bin. These are the **initialtemperatures** of the sand. Are they the same or different? After you finish measuring, take the thermometers out.
3. Put the lids on the bins and take turns shaking the bins. Pass both bins around to all your group members. Make sure you shake both bins for the same amount of time. Remember to keep your motions as similar as possible.
4. When you’re done shaking, take off the lids and measure the temperatures again. These are the **final temperatures** of the sand. Find the change in temperature of both bins of sand by subtracting the initial temperatures from the final temperatures.

**Station 4: Balloons**

1. There are two flasks at this station. If you have 3 people in your group, one person will measure out the baking soda for one balloon, the second person will measure out the baking soda for the second balloon, and the third person will measure out and pour the vinegar for both flasks. If you have 4 people in your group then the third person will only measure out and pour the vinegar for one flask, and the fourth person will measure out and pour the vinegar for the second flask.
2. Remember that the instruments you will be working with are **tools**, not toys, so be careful!
	1. **Balloon people**: If you are working balloons, you will be in charge of measuring out the correct amount of baking soda for each balloon. Then you will use the funnels to pour this baking soda into the balloon. After the vinegar has been poured into the flasks, you will put the balloon securely over the top of the flask. Each balloon gets its own flask. The “top” of the balloon, where the baking soda is, should hang down because it is heavy. Once you have made sure the balloon covers the entire top of the flask, lift this part of the balloon so that the baking soda falls down into the flask. One of the balloon people should measure out **½ teaspoon** of baking soda. The other should measure **1 ½ teaspoon** of baking soda. Make sure you know which amount you are measuring.
	2. **Vinegar people**: If you are working on vinegar, you will be in charge of measuring out the correct amount of vinegar for each flask. Use the graduated cylinders and pour up to the line on the cylinders that says “**100 mL**”. Then you will pour the vinegar into the flask.

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Energy Conversions Student Record Sheet**

Record your observations while working at the different stations. Continue to think about the following questions: Which types of energy did you observe? Was energy transferred from one place to another? From one type to another?

**Station 1: Flashlight**

1. What happens when you turn the crank?
2. What type of energy are you applying to the crank?
3. What type of energy does the flashlight produce?
4. What happened to the length of time that the light stayed on when you cranked the flashlight more? Why do you think this happened? Can you explain it in terms of the Law of Conservation of Energy?
5. What energy conversion did you observe in this experiment?

**Station 2: Instrument**

1. What type of energy are you applying to the music box?
2. What type of energy does the music box produce?
3. How does the music box work?
4. What energy conversion did you observe in this experiment?

**Station 3: Sand Jar**

1. How are the two bins of sand different?
2. What is the **initial temperature** of each bin?
3. What is the **final temperature** of each bin?
4. What is the change in temperature of each bin?

(change in temperature = final temperature - initial temperature)

1. Did the bins of sand have the same change in temperature? Why do you think this happened?
2. What energy conversion did you observe in this experiment?

**Station 4: Balloons**

1. What happened in this experiment?
2. Why do you think one balloon was bigger than the other?
3. What type of energy did mixing the baking soda and vinegar create?
4. What type of energy made the balloons expand?
5. What energy conversion did you observe in this experiment?

# Lesson 5– Sources of Energy: Energy Conversion in the Real World

***Vocabulary***:

**Renewable Resource** - a natural resource that can be used to produce energy, but does not get used up in the energy production process (example: wind)

**Nonrenewable Resource** - a limited natural resource that can be used to produce energy, but cannot be easily replaced or produced by humans (example: coal)

**Energy Cycle** - exchange, transfer, and storage of radiant energy from the sun

**Solar Energy Demo**: Two aluminum pans with equal amounts of water. Record the temperature in the pans, and then place one in a sunny area and one in a shaded area (if there’s no sun, you can use a lamp.) The sun produces solar energy, which comes in the form of light and heat. We observed this as we watched the sun warm up the water in the pan outside. Engineers use solar energy to design heating systems for buildings and water. They also harness solar energy with solar panels that convert the sun's energy into electricity.

**Energy Jeopardy Game**

# Lesson 6 – Tracing the Path of Energy

This project will be student directed, and students will choose the type of energy they want to investigate. They will follow its path at the point of use, back to its original source. Students can choose how to present their information, but it should consist of pictures of each step, as well as explanation.

An example of an energy path: