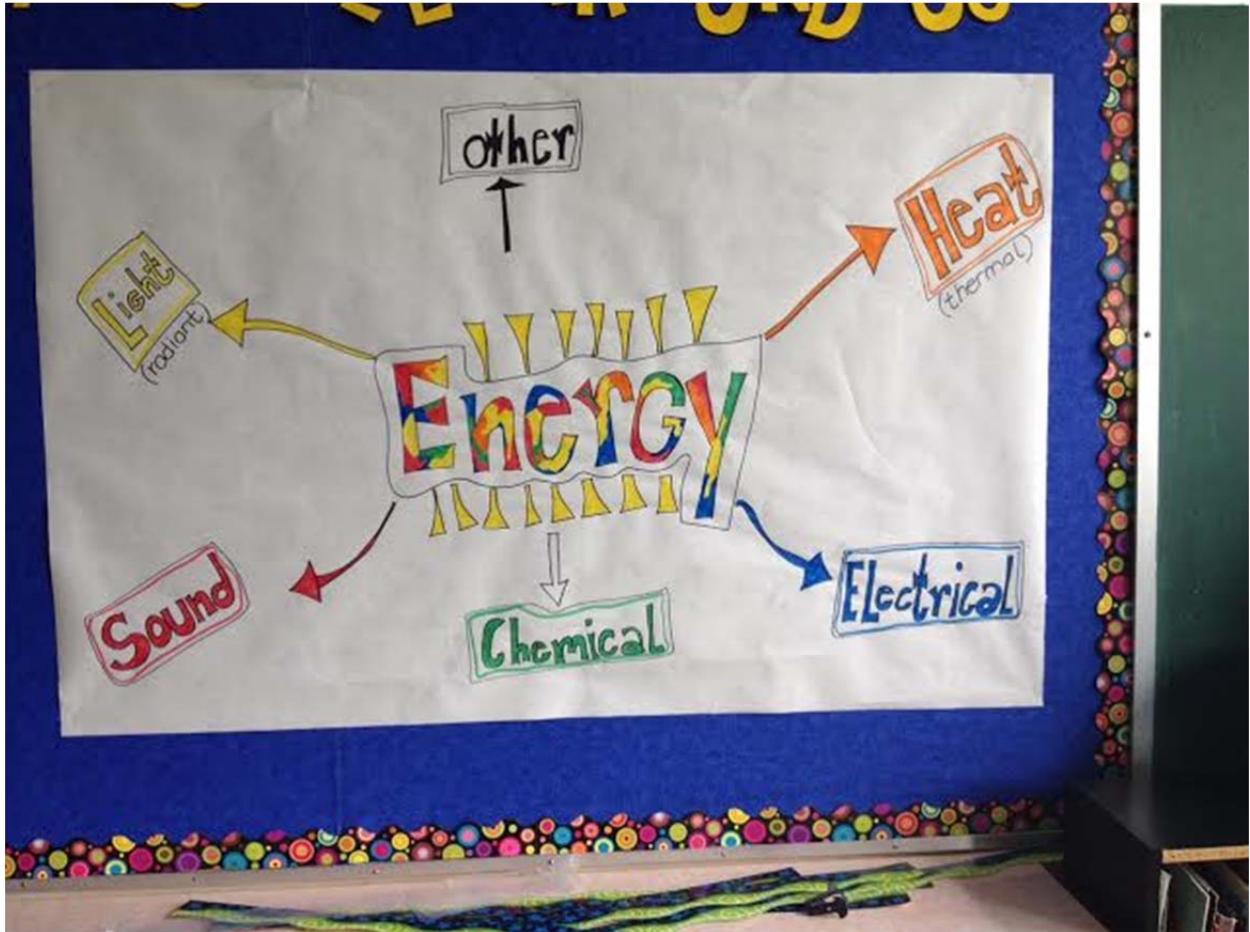


Appendix A—Lesson 1: Picture of Energy Concept Map



## Appendix A— Lesson 4b: Archimedes Story of the Death Ray

### Science of Destruction: Archimedes' War Machines

Archimedes was born in 287 B.C. in the city-state of Syracuse, then a part of [ancient Greece](#), in what is modern-day [Sicily](#). Aside from his travels to [Egypt](#) for his formal education (read more about that in "[Did the ancient Greeks get their ideas from the Africans?](#)"), Archimedes spent his life in Syracuse. When the Roman army set sail to lay siege on his home in the year 214, Archimedes turned his attention from calculations to finding new and inventive ideas for dealing death to [Roman](#) legions.

One of Archimedes' more famous quotes is, "Give me a lever long enough and a place to stand and I will move the world" [source: [Stanford](#)]. Archimedes used his knowledge of physics to fend off Roman ships approaching the fortified walls of Syracuse. One of the war machines Archimedes created was a giant iron claw, operated by virtually the entire [population](#) of Syracuse from inside the city's walls. Outside, the claw was capable of picking up entire Roman ships and plunging them into the sea. Archimedes used [catapults](#) and heavy timbers to hurl objects at the ships in the distance [source: [Archimedes Palimpsest](#)].

These war machines were complex, but perhaps the most effective (and coolest sounding) of Archimedes' instruments of destruction was the **death ray**. The name evokes thoughts of some huge, clumsy [steampunk](#) contraption pushed to the edge of the Syracusan walls. One can imagine the Roman soldiers' terror-widened eyes as the death ray came into view and made an increasingly high-pitched hum as it powered up before suddenly unleashing a deadly laser upon the ships, reducing them to [atoms](#) in one massive burst.

This wasn't the case. Instead, the death ray was actually a series of mirrors that reflected concentrated [sunlight](#) onto Roman ships. The ships were moored within bow and arrow range (in ancient Greece, anywhere from 200 to 1,000 feet (about 60.96 to 304.8 meters). According to legend, the Roman ships were burned by the collective, condensed sunlight shone from these mirrors [source: [McLeod](#)]. Ship after ship in the Roman fleet caught fire and sank in the [Mediterranean](#), casualties of the death ray.

The historian [Galen](#) was the first to describe the death ray in his account of the sack of Syracuse, written more than 350 years after the siege ended. Although other historians recorded the siege in earlier writings, none mentioned the death ray. Because of these earlier omissions of the death ray, the contraption is often viewed as pure myth, fantasy, or exaggeration. Over the years, numerous attempts have been made to prove or disprove whether Archimedes' death ray could've worked—but these experiments have yielded mixed results. At least two of them proved the death ray was possible. Keep reading to find out about those.

<http://history.howstuffworks.com/historical-figures/archimedes-death-ray1.htm>

## Appendix A—Lesson 5: Comparison Paragraphs for Analysis of Data

### Compare and Contrast

The \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ are similar because they all \_\_\_\_\_. In addition, they \_\_\_\_\_.

---

---

They are different because the \_\_\_\_\_, but the \_\_\_\_\_ . In addition, the \_\_\_\_\_ . However, the \_\_\_\_\_, whereas \_\_\_\_\_ . Therefore, \_\_\_\_\_ .

Remember to ask yourself: Will it be clear to the reader what I mean when I write the pronouns, “they” and “it”?

Instructions:

After filling in data on the “Does Location Matter?” sheet, lead a discussion on how each location’s characteristics are similar and how they are different. Fill in Comparison Chart throughout the discussion. Then show students how the details fit into the paragraph analysis frame.

Presenting this paragraph frame to students helps reluctant writers and ELL students understand what is expected and gets them started with their thinking. With students who need modifications, I have them compare only two locations. The rest of the class compares three locations. For more information on

Compare and Contrast Charts or paragraphs, go to: *Writing In Science* by Betsy Rupp Fulwiler:

<https://www.heinemann.com/shared/onlineresources/E01070/chapter2.pdf>

Compare and Contrast

The \_\_\_\_\_ and the \_\_\_\_\_ are similar because they both \_\_\_\_\_.  
In addition, they <sup>both</sup> \_\_\_\_\_.  
..... Add more as needed

The \_\_\_\_\_ and the \_\_\_\_\_ are different because the \_\_\_\_\_, but the \_\_\_\_\_. Also, the \_\_\_\_\_, whereas \_\_\_\_\_.  
..... Add more as needed

Remember to ask yourself, Will it be clear to another scientist what I mean when I use pronouns such as they and it? If not how can I edit to make it clearer?

**Appendix A— Lesson 7: Solar Oven Picture**



## Appendix B—All Lessons: Kid-Friendly Glossary

### Lesson 1: Establishing Context

**Energy:** The power or ability to make things happen. Energy makes things happen. It makes change possible.

**Heat energy:** Energy that comes from the temperature of matter. The hotter the substance, the more its molecules vibrate, and therefore the higher its thermal energy.

**Light energy:** Energy of *electromagnetic waves*. It is a form of energy that can travel through space. For example, via radiation we receive the heat from the sun, which is located very far from the earth.

**Solar energy:** The radiant energy of the sun, which can be converted into other forms of energy, such as heat or electricity.

**Solar:** Coming from the sun or related to the sun.

### Lesson 2: What Is Heat and How Do We Measure It?

**Celsius:** A temperature scale (**Celsius scale**) in which 0° represents the ice point and 100° the steam point. *Symbol:* C.

**Fahrenheit:** A temperature scale (**Fahrenheit scale**) in which 32° represents the ice point and 212° the steam point. *Symbol:* F.

**Friction:** A force that holds back the movement of a sliding object.

**Heat:** Added or external energy that causes a rise in temperature, expansion, evaporation, or other physical change.

**Temperature:** The temperature of an object has to do with how hot or cold it is, measured in degrees Celsius (°C). Temperature can also be measured in a Fahrenheit scale.

**Thermometer:** A tool to measure temperature.

### Lesson 3: How Does Color Affect Temperature?

**Absorb:** To take in without echo or reflection; soak in.

**Control:** What stays the same in a science investigation.

**Hypothesis:** An educated guess; what you think will happen using your science background information or experiences.

**Variable:** What you changed in a science investigation; what you are testing.

**Conclusion:** A final decision or judgment; an opinion or decision that is formed after a period of thought or research.

## Lesson 4a: How Do You Effectively Use a Protractor to Measure an Angle?

**Angle:** Union of two different rays sharing a common vertex.

**Acute angle:** Angle with a measure of less than 90 degrees.

**Obtuse angle:** Angle with a measure greater than 90 degrees, but less than 180 degrees.

**Perpendicular:** Two lines are perpendicular if they intersect, and any of the angles formed between the lines is a  $90^\circ$  angle.

**Protractor:** Instrument used in measuring or sketching angles.

**Vertex:** A point, often used to refer to the point where two lines meet, such as in an angle or the corner of a triangle.

**Straight angle:** Angle that measures 180 degrees.

## Lesson 4b: How Does the Angle of the Sun Affect Temperature?

**Reflection:** When a light ray hits an object and bounces off, it is called reflection.

**Refraction:** When light moves from one substance to another it changes speed and direction. That change in direction is called refraction.

## Lesson 5: Does Location Matter?

**Comparison:** The act of looking at things to see how they are similar or different.

**Similar:** Almost the same as someone or something else.

**Difference:** The quality that makes one person or thing unlike another.

**Analysis:** A careful study of something to learn about its parts, what they do, and how they are related to each other.

## Lesson 6: What Is the Most Effective Way to Prevent an Ice Cube from Melting?

**Insulator:** A material that allows little or no heat, electricity, or sound to go into or out of something.

## Lesson 7: Putting It All Together

**Criteria:** A standard on which a judgment or decision may be based.

**Constraint:** Something that limits or restricts someone or something.

## Appendix B—Lesson 1: Energy Transfer Exit Ticket



### Energy Transfer: Lesson 1 Exit Ticket

What is energy?

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What is light/radiant energy?

---

---

What is heat/thermal energy?

---

---

## Appendix B— Lesson 3: How Does Color Affect Temperature?

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

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



How does color affect temperature?

Hypothesis: When I \_\_\_\_\_

\_\_\_\_\_ then \_\_\_\_\_

\_\_\_\_\_.

Beginning temperature: \_\_\_\_\_

Temperature at 30 minutes: \_\_\_\_\_

Temperature at 60 minutes: \_\_\_\_\_

Conclusion: I observed \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_.

Therefore, I think \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_.

## Appendix B— Lesson 4b: Student Handout

### Lesson 4b: Does the angle of the sun affect temperature?

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



Time	Angle Degree	Temperature	Observations

Conclusion:

My data shows: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

I know: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## Appendix B— Lesson 5: Comparison Chart



### Does Location Matter?

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

Same or Similar

--

Different


## Appendix B— Lesson 5: Does Location Matter?



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

Hypothesis:

I think \_\_\_\_\_

\_\_\_\_\_

because \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_.

Data table:

Location	Temperature	Description

## Appendix B—Lesson 6: Keeping it Cool



Name:

Hypothesis:

Draw a picture of how you packed your ice. Label the materials used.

Data Table:

Time/Amount	Time/Amount	Time/Amount	Time/Amount

Conclusion:

## **Appendix B—Lesson 7: Solar Oven Engineering Design Work Sample**

Names of team members:

Problem to be addressed:

Criteria:

Constraints:

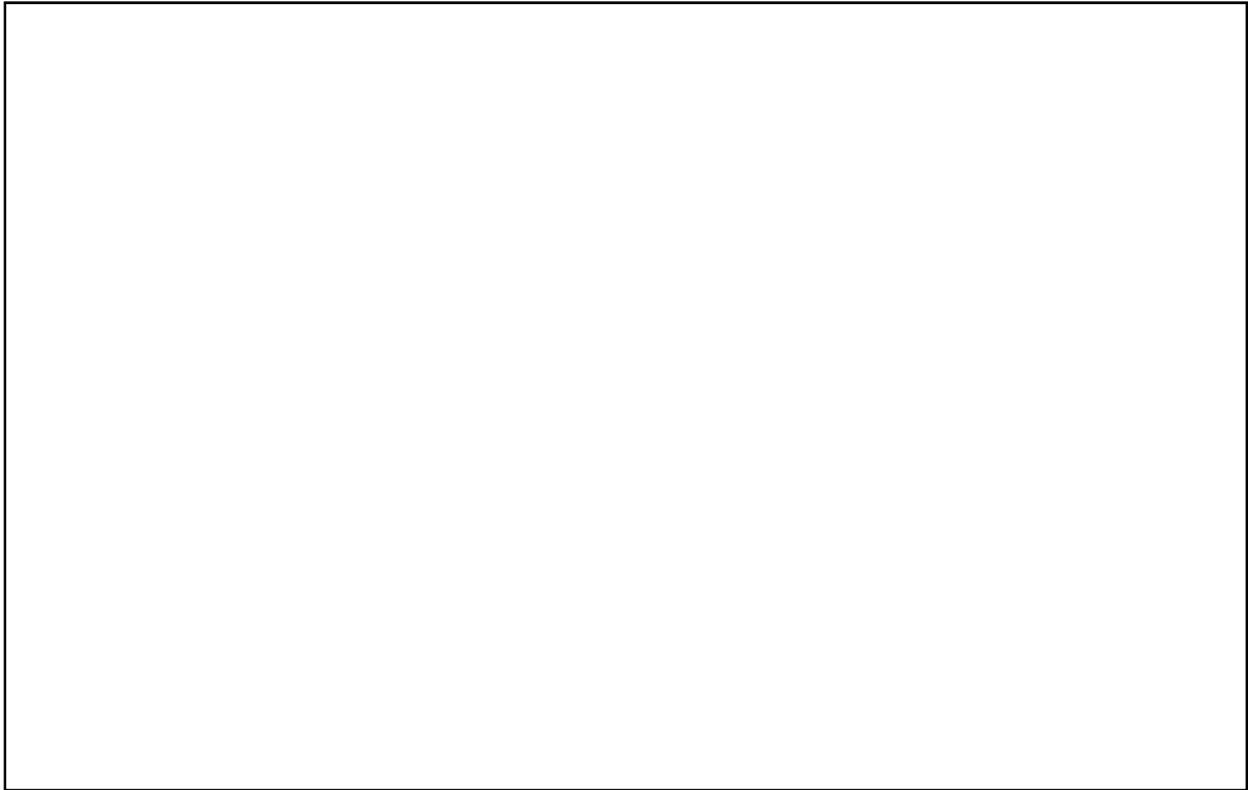
Prior science knowledge and experiences:

## First Design Plan

Make a line drawing of your design plan. Label the different parts and tell why they are there.  
What are their purposes?

Evaluate:

Team Design: Make a line drawing of your team design plan. Label the different parts and tell why they are there. What are their purposes?



Evaluate: What compromises did you make? Why will this design work more effectively than your design?

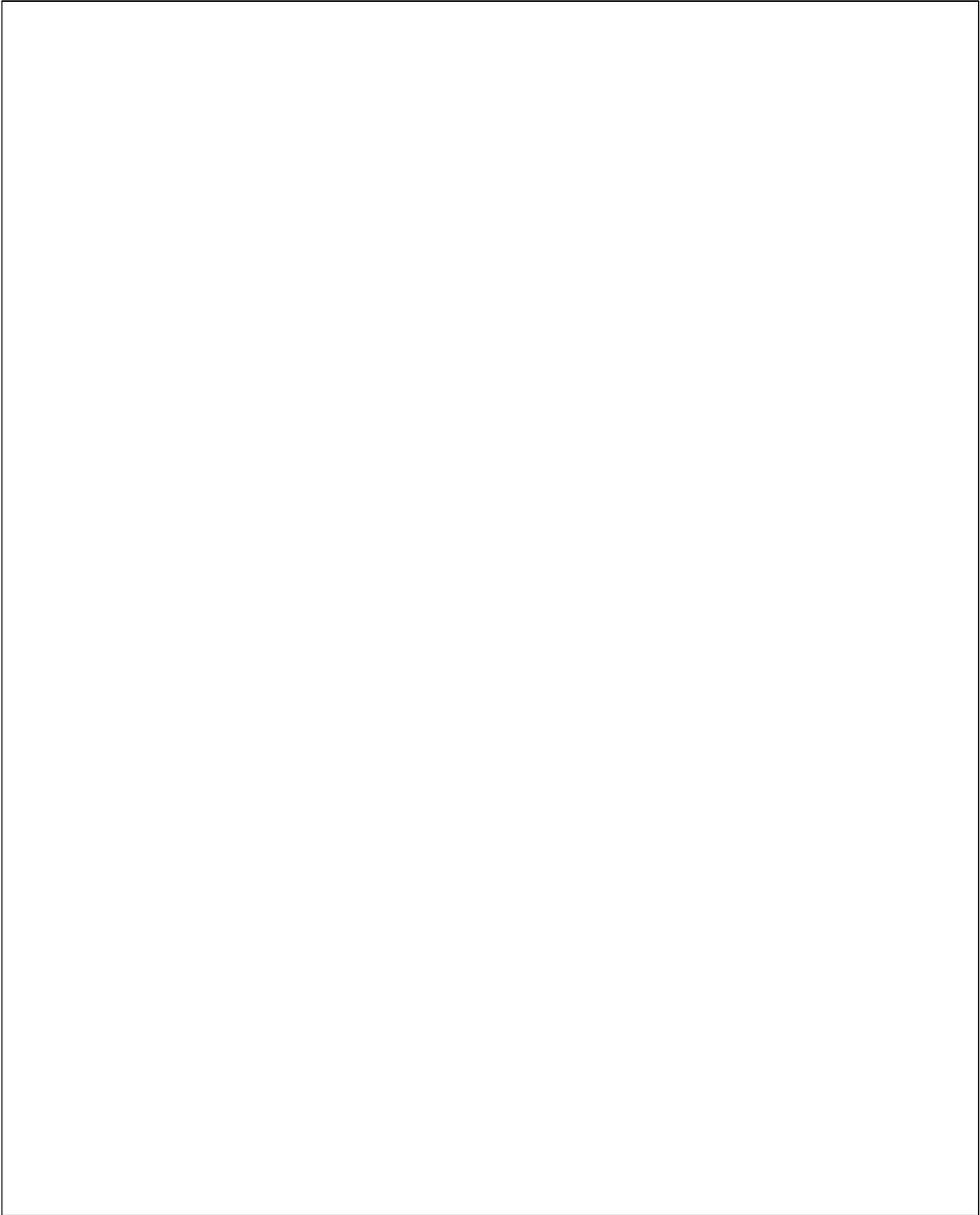
### Testing Solutions and Collecting Data

- o Build a prototype of your design.
- o Write observations about the result of your first design and tell of modifications needed. Identify unexpected outcomes.
- o When modifications have been made, write observations and tell of further modifications.

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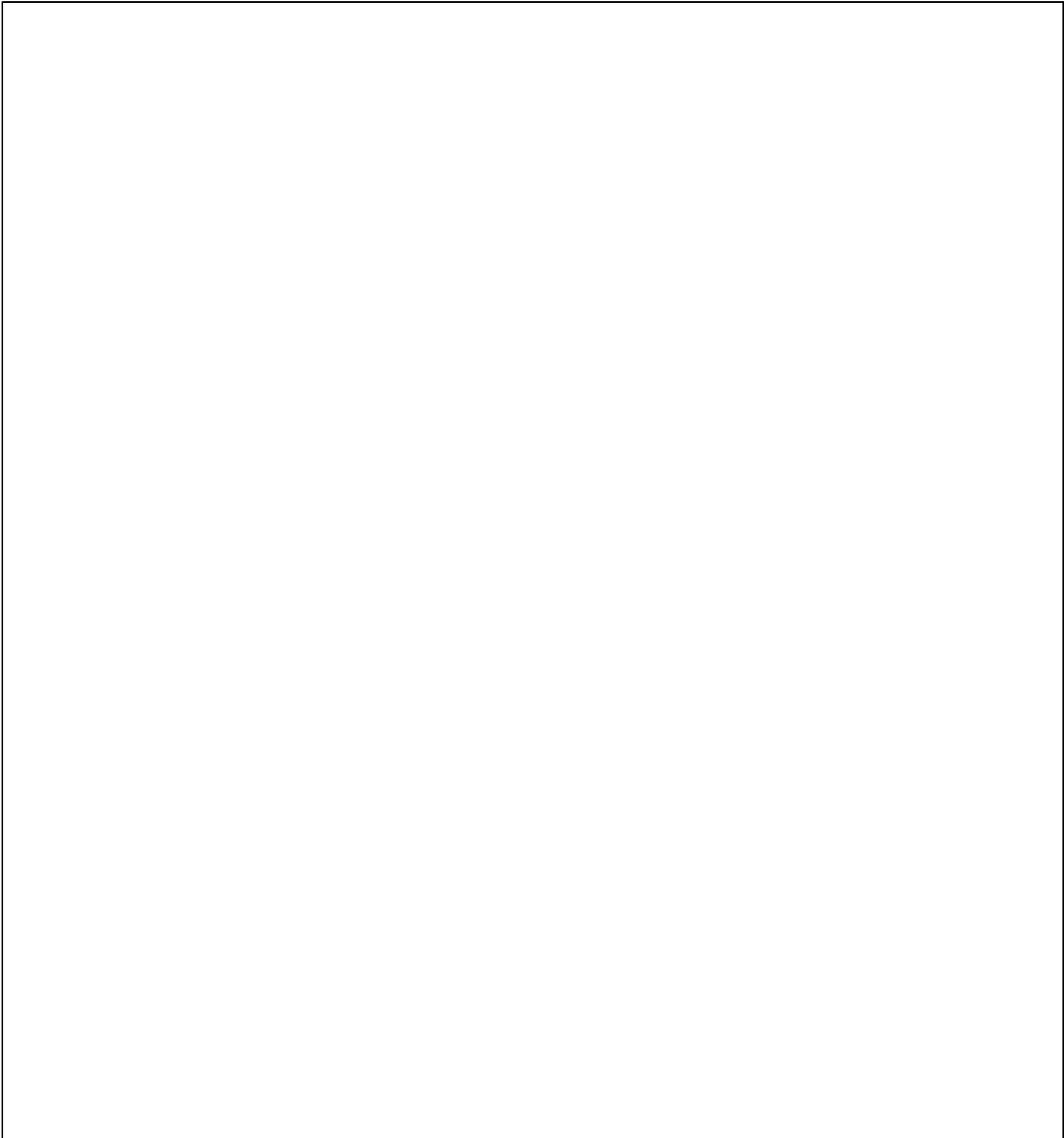
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Final Design



## Analyzing and Interpreting Results

- o Summarize your results, including attention to whether or not criteria and constraints were met.
- o Evaluate the tested solution in terms of design and performance.
- o Did you make any trade-offs? What were they and why did you make the decision?
- o Identify and explain possible design improvements.

A large, empty rectangular box with a thin black border, occupying the lower two-thirds of the page. It is intended for the student to write their analysis and interpretation of results based on the prompts listed above.

## Appendix C—Lesson 1: *What is Energy* Article

### What is energy?

Look around you. Is anything moving?

Can you hear, see or feel anything? Sure... this is because something is making something happen, and most probably, there is some power at work. This power or ability to make things happen is what we can call energy. It makes things happen. It makes change possible.

Look at the sketch below to see an example of things working, moving, or happening... with energy.



Energy move cars along the roads and make aeroplanes fly. It plays our music on the radio, heats our rooms and lights our homes. Energy is needed for our bodies, together with plants to grow and move about.

**Scientists define ENERGY as the ability to do work.  
Energy can be neither created nor destroyed.**

### KINDS OF ENERGY

With the above explanation in mind, let us learn more.

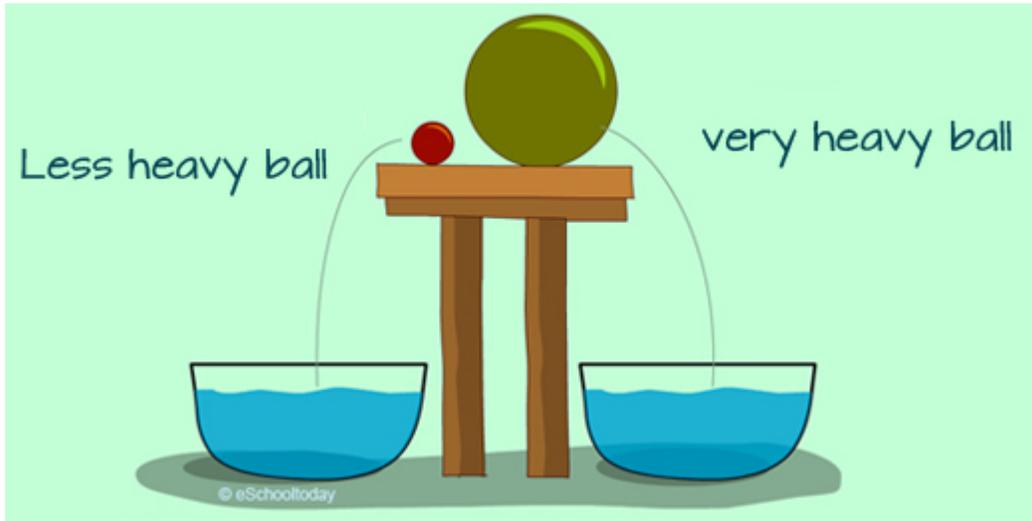
Energy can be (is) stored or transferred from place to place, or object to object in different ways. There are various kinds of energy.

Let's start by looking at **kinetic energy**.

### Kinetic Energy

All moving things have kinetic energy. It is energy possessed by an object due to its motion or movement. These include very large things, like planets, and very small ones, like atoms. The heavier a thing is, and the faster it moves, the more kinetic energy it has.

Now let's see this illustration below.  
There is a small and large ball resting on a table.



Let us say both balls will fall into the bucket of water.  
What is going to happen?



You will notice that the smaller ball makes a little splash as it falls into the bucket. The heavier ball makes a very big splash. Why?

**Note the following:**

1. Both balls had potential energy as they rested on the table.
2. By resting up on a high table, they also had gravitational energy.
3. By moving and falling off the table (movement), potential and gravitational energy changed to **Kinetic Energy**. Can you guess which of the balls had more kinetic energy? *(The big and heavier ball)*

Let's see another classic example.

If you are in a hot room and you turn on the fan, what do you begin to feel? Air (wind). The speedy movement of the fan's blades has kinetic energy, which is then transferred into air (wind) that you now feel.

Other examples of Kinetic Energy include a moving car, moving wheel, and a moving arrow.

## Mechanical Energy

Mechanical energy is often confused with **Kinetic** and **Potential Energy**. We will try to make it very easy to understand and know the difference. Before that we need to understand the word '**Work**'.

'**Work**' is done when a force acts on an object to cause it to move, change shape, displace, or do something physical. For, example, if I push a door open for my pet dog to walk in, work is done on the door (by causing it to open). But what kind of force caused the door to open? Here is where **Mechanical Energy** comes in.

**Mechanical energy** is the sum of kinetic and potential energy in an object that is used to do work. In other words, it is energy in an object due to its motion or position, or both. In the 'open door' example above, I possess potential chemical energy (energy stored in me), and by lifting my hands to push the door, my action also had kinetic energy (energy in the motion of my hands). By pushing the door, my potential and kinetic energy was transferred into mechanical energy, which caused work to be done (door opened). Here, the door gained mechanical energy, which caused the door to be displaced temporarily. Note that for work to be done, an object has to supply a **force** for another object to be **displaced**.

Here is another example of a boy with an iron hammer and nail. In the illustration below...



(1) The iron hammer on its own, has no kinetic energy, but it has some potential energy (because of its weight).

(2) To drive a nail into the piece of wood (which is work), he has to lift the iron hammer up, (this increases its potential energy because of its high position).

(3) And force it to move at great speed downwards (now has kinetic energy) to hit the nail.

The sum of the potential and kinetic energy that the hammer acquired to drive in the nail is called the Mechanical energy, which resulted in the work done.

## Sound energy

Sound is the movement of energy through substances in longitudinal (compression/rarefaction) waves.

Sound is produced when a force causes an object or substance to vibrate — the energy is transferred through the substance in a wave. Typically, the energy in sound is far less than other forms of energy.

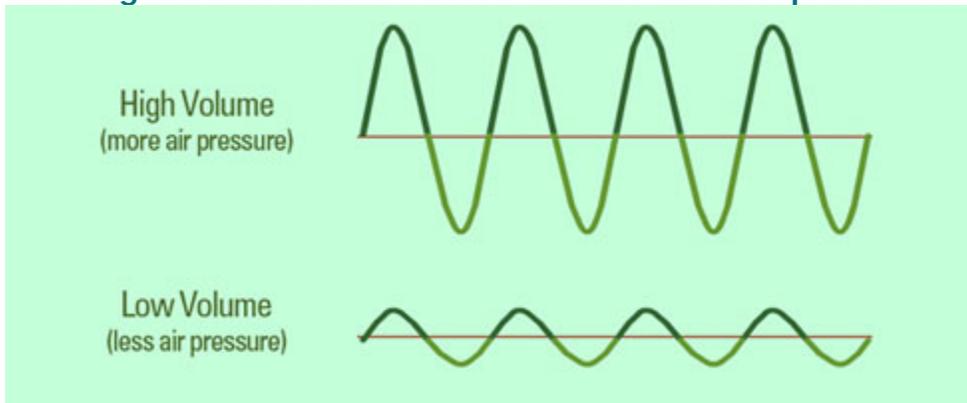
Let's see this illustration.



A vibrating drum in a disco transfers energy to the room as sound. Kinetic energy from the moving air molecules transfers the sound energy to the dancers eardrums. Notice that Kinetic (movement) energy in the sticks are being transferred into sound energy.

Sound vibrations create sound waves which move through mediums such as air and water before reaching our ears.

**The diagram below shows how a sound wave is represented:**



Sound energy is usually measured by its pressure and intensity, in special units called *pascals and decibels*. Sometimes, loud noise can cause pain to people. This is called the **threshold of pain**. This threshold is different from person to person. For example, teens can handle a lot higher sound pressure than elderly people, or people who work in factories tend to have a higher threshold pressure, because they get used to loud noise in the factories.

## Heat (Thermal energy)

Matter is made up of particles or molecules. These molecules move (or vibrate) constantly. A rise in the temperature of matter makes the particles vibrate faster. Thermal energy is what we call energy that comes from the temperature of matter. The hotter the substance, the more its molecules vibrate, and therefore the higher its thermal energy.

For example, a cup of hot tea has thermal energy in the form of kinetic energy from its vibrating particles. When you pour some milk into your hot tea, some of this energy is transferred from the hot tea to the particles in the cold milk. What happens next? The cup of tea is cooler because it lost thermal energy to the milk. The amount of thermal energy in an object is measured in *Joules (J)*

We cannot discuss thermal energy without touching on *Temperature*. Heat and Temperature are not the same thing.

### Temperature

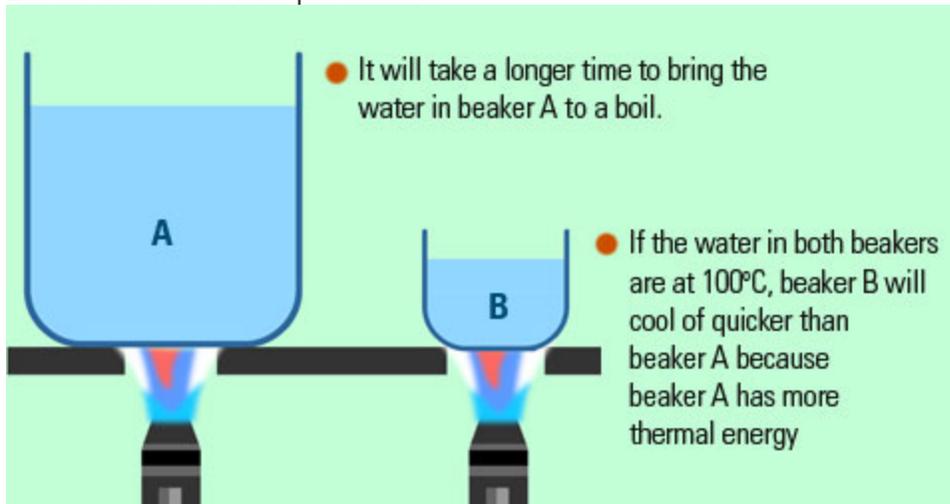
The temperature of an object is to do with how hot or cold it is, measured in degrees Celsius ( $^{\circ}\text{C}$ ). Temperature can also be measured in a Fahrenheit scale, named after the German physicist called Daniel Gabriel Fahrenheit (1686 – 1736). It is denoted by the symbol 'F'. In Fahrenheit scale, water freezes at  $32^{\circ}\text{F}$ , and boils at  $212^{\circ}\text{F}$ . In Celsius scale, water freezes at  $0^{\circ}\text{C}$  and boil at  $100^{\circ}\text{C}$ .

A *thermometer* is the instrument used to measure the temperature of an object.

Let's look at this example to see how *thermal energy* and *temperature* are related:

● A swimming pool at  $40^{\circ}\text{C}$  is at a lower *temperature* than a cup of tea at  $90^{\circ}\text{C}$ . However, the swimming pool contains a lot more water. Therefore the pool has more thermal energy than the cup of tea even though the tea is hotter than the water in the pool.

Let us see this example below:



If we want to boil the water in these two beakers, we must increase their temperatures to 100°C. You will notice that will take longer to boil the water in the large beaker than the water in the small beaker. This is because the large beaker contains more water and needs more heat energy to reach 100°C.

## Conduction, Convection and Radiation.

Heat can be transferred from particle to particle or object to object in three different ways. These are **Conduction, Convection and Radiation**. Click on the buttons above to learn more.

### Chemical energy

**Chemical Energy is energy stored in the bonds of chemical compounds (atoms and molecules). It is released in a chemical reaction, often producing heat as a by product (exothermic reaction).** Batteries, biomass, petroleum, natural gas, and coal are examples of stored chemical energy. Usually, once chemical energy is released from a substance, that substance is transformed into an entirely new substance.

For example, when an explosive goes off, chemical energy stored in it is transferred to the surroundings as thermal energy, sound energy and kinetic energy.

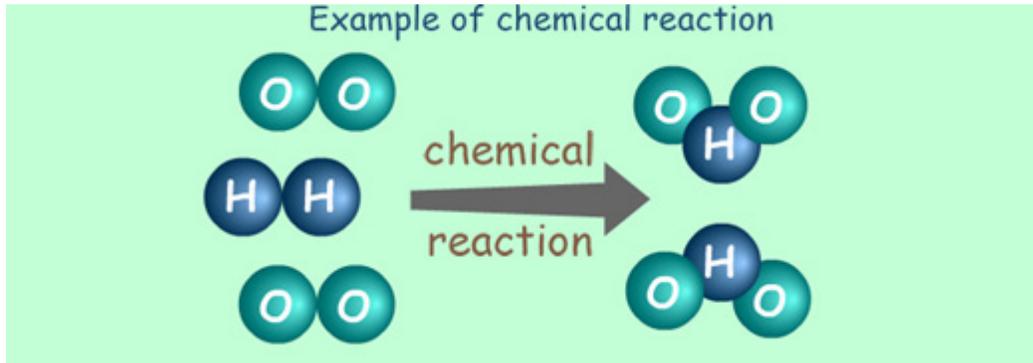


Let's see one good example in the fire-place illustration.

The dry wood is a store of chemical energy. As it burns in the fireplace, chemical energy is released and converted to thermal energy (heat) and light

energy. Notice that the wood now turns into ashes (a new substance)

Food is also a good example of stored chemical energy. This energy is released during digestion. Molecules in our food are broken down into smaller pieces. As the bonds between these atoms loosen or break, a chemical reaction will occur, and new compounds are created. When the bonds break or loosen, oxidation occurs almost instantly.



*In the example above, notice that new compounds are formed from the breakdown of other molecules or atoms. Chemical reaction causes that.*

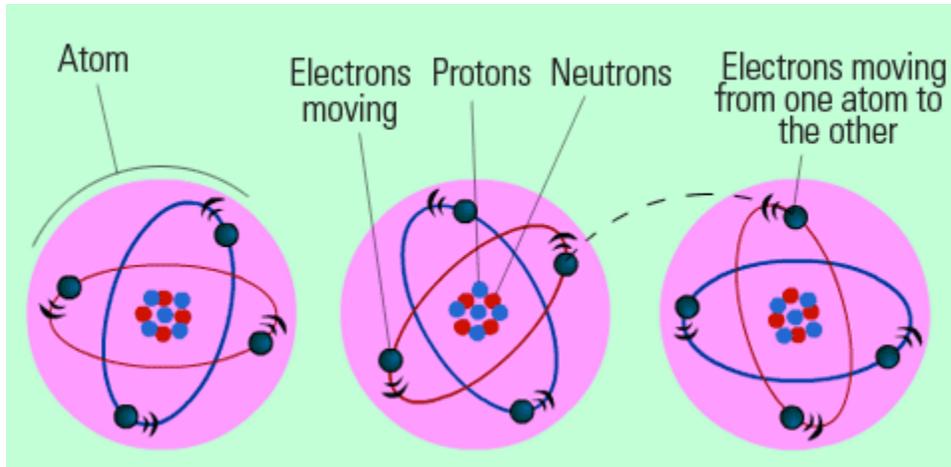
A chemical reaction is involved in this breakdown. The energy produced keeps us warm, maintain and repair bodies, and makes us able to move about. Different foods store different amounts of energy.

Energy in food is measured in kilocalories (or Calories). Can you think of some very good examples of chemical energy?

## Electrical energy

Matter is made up of atoms. In these atoms, there are some even small stuff called **electrons** that are constantly moving. The movement of these electrons depend on how much energy is has. This means every object has **potential energy**, even though some have more than others.

Humans can force these moving electrons along a path from one place to the other. There are special mediums (materials), called conductors, that carry this energy. Some materials *cannot* carry energy in this form, and they are called insulators. We generate **electrical energy** when we succeed in causing the electrons to move from one atom to the other, with the use of magnetic forces.



Once we harness electrical energy, it can be used for work or stored.

### ***How does an electric current work?***

A battery transfers stored chemical energy as charged particles called electrons, typically moving through a wire. For example, electrical energy is transferred to the surroundings by the lamp as light energy and thermal (heat) energy.

Lightning is one good example of electrical energy in nature, so powerful that it is not confined to a wire. Thunderclouds build up large amounts of electrical energy. This is called static electricity. They are released during lightning when the clouds strike against each other.

## **Gravitational Energy, Potential Energy**

It is important to know the difference between **potential energy** and **gravitational energy**.

Every object may have Potential energy but Gravitational energy is only stored in the height of the object. Any time that a heavy object is kept high up, a force or power is likely to be holding it up there. This is the reason why it stays up and does not fall. It is important to note that the heavier the object, the more its potential energy.

Let's see the diagram below:

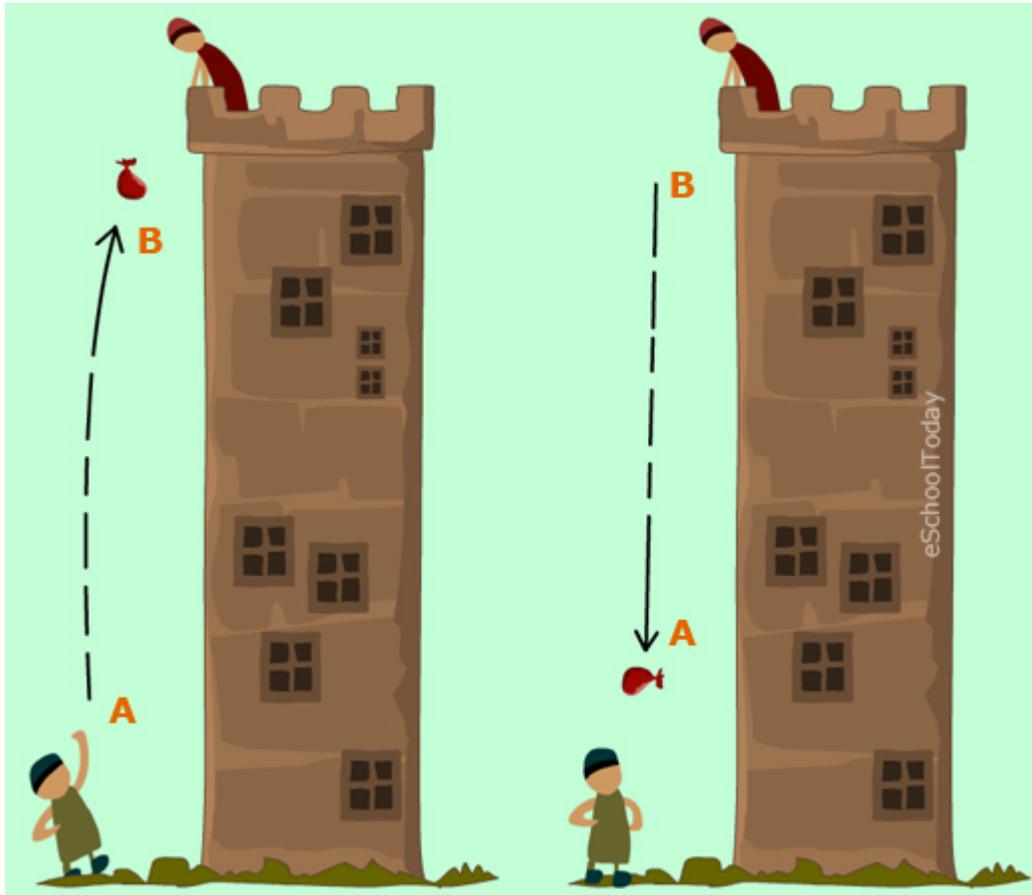
Consider Mr Green throwing a bag of gold coins to Mr Red, who is up a tower. As Mr Green throws the bag from A to B, potential energy is transferred from Mr Green into the bag, which now has kinetic energy.

As the bag moves upwards, kinetic energy decreases, and gravitational energy increases. At the highest point (B) Kinetic energy is zero, and Gravitational potential energy is highest.

As the bag did not get to Mr Red, it starts falling from point B downwards due to gravity. It starts falling slowly (kinetic energy is low) and then speeds up downwards.

At point A, bag is at full speed and kinetic energy is highest, while gravitational energy is nearly lost.

When the bag of gold coins hits the ground, kinetic energy is converted into heat and sound by the impact.



It is worth noting that the higher the gravitational energy of an object moving downwards, the lower the kinetic energy, and the lower the kinetic energy of an object moving upwards, the higher its gravitational energy.

## Radiant Energy

**Radiant energy** is energy of *electromagnetic waves*. It is a form of energy that can travel through space. For example, we receive the heat from the sun, which is located very far from the earth via radiation. The sun's heat is not transmitted through any solid medium, but through a vacuum. This is possible by electromagnetic waves.

Before we go any further, let us understand what **electromagnetic waves** are.

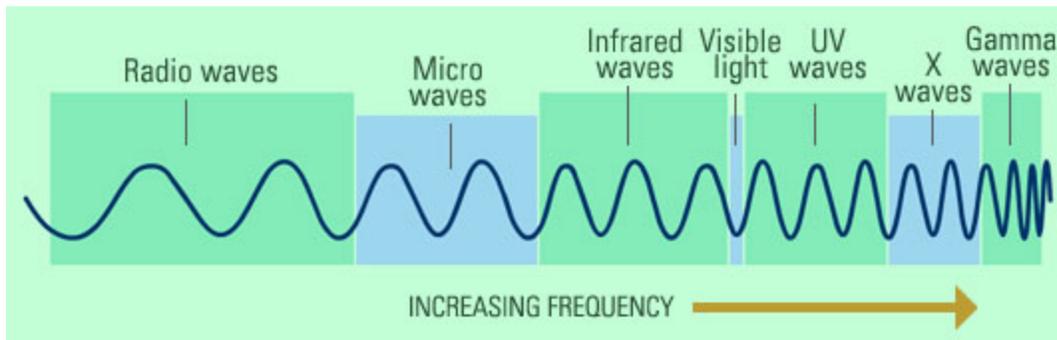
Each time static energy from electric and magnetic force come together, they induce an electric field around them.

An example of **electric static force** is the shock you get when you hold a metal door knob.

An example of a **magnetic force** is the pull that attracts metals to the magnet. Now, the electrical field induced causes waves, called electromagnetic waves, and they can travel through vacuum (air), particles or solids. These waves resemble the ripple (mechanical) waves you see when you drop a rock into a swimming pool, but with electromagnetic waves, you do not see them, but you often can see the effect of it.

The energy in the electromagnetic waves is what we call **radiant energy**.

There are different kinds of electromagnetic waves and all of them have different **wavelengths**, properties, **frequencies** and power, and all interact with matter differently. The entire wave system from the lowest frequency to the highest frequency is known as the **electromagnetic spectrum**. The shorter the wavelength, the higher its frequency and vice versa. White light for example, is a form of radiant energy, and its frequency forms a tiny bit of the entire electromagnetic spectrum.



*In the illustration above, you will see the different radiant energy levels represented by their wavelengths.*

When radiant energy comes into contact with matter, it changes the properties of that matter. For example, when micro-waves (which forms part of the entire spectrum) are set off in a microwave oven, the water molecules in the food are charged and caused to vibrate billions of times per second, generating heat, that causes the food to cook. The microwave oven works with the concept of radiant energy (electromagnetic waves).

[www.eschooltoday.com/energy/kinds-of-energy/all-about-energy.html](http://www.eschooltoday.com/energy/kinds-of-energy/all-about-energy.html)

What is Energy?

## Energy Basics

### Energy is the ability to do work

Energy comes in different forms:

- Heat (thermal)
- Light (radiant)
- Motion (kinetic)
- Electrical
- Chemical
- Nuclear energy
- Gravitational

People use energy for everything from making a jump shot to sending astronauts into space.

There are two types of energy:

- Stored (potential) energy
- Working (kinetic) energy

For example, the food a person eats contains chemical energy, and a person's body stores this energy until they use it during work or play.

### Energy sources can be categorized as renewable or nonrenewable

When people use electricity in their homes, the electrical power was probably generated by burning coal, by a nuclear reaction, or by a hydroelectric plant on a river, to name just a few sources. Therefore, coal, nuclear, and hydro are called energy sources. When people fill up a gas tank, the source might be petroleum refined from crude oil or ethanol made by growing and processing corn.

Energy sources are divided into two groups:

- Renewable (an energy source that can be easily replenished)
- Nonrenewable (an energy source that cannot be easily recreated)

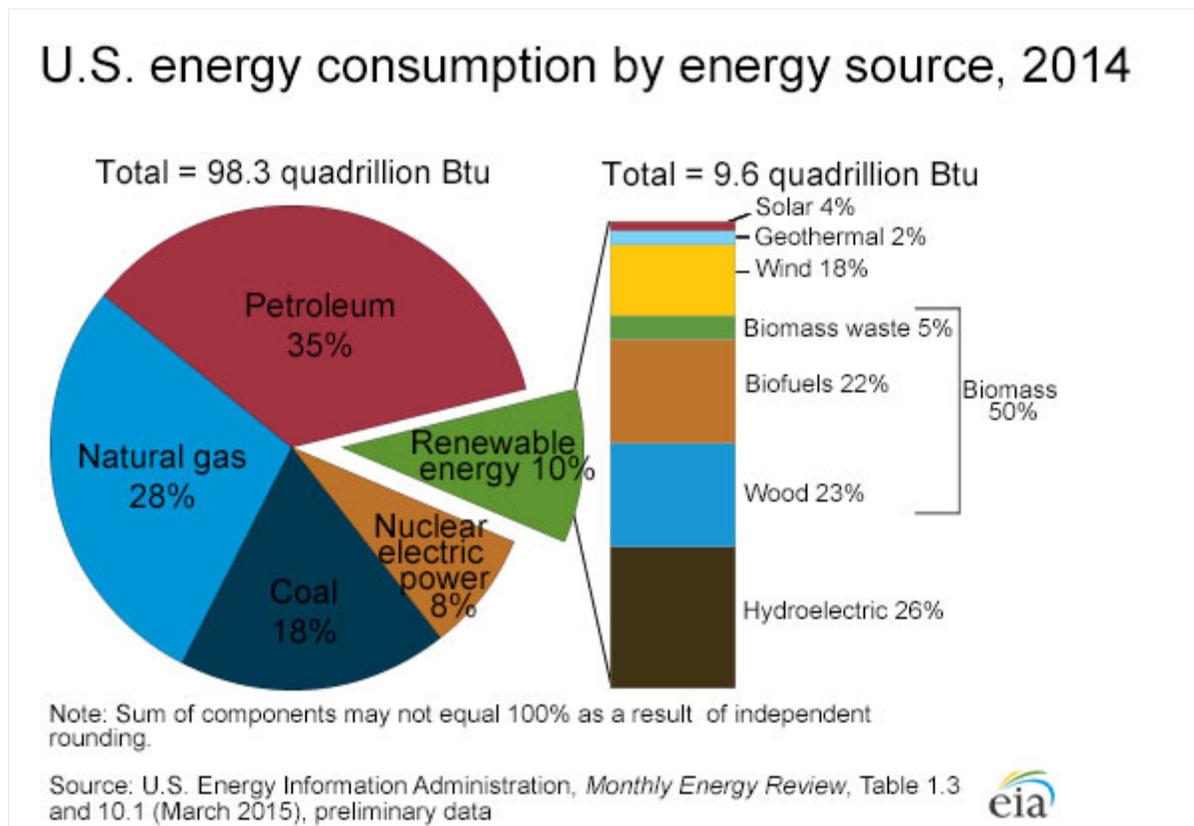
Renewable and nonrenewable energy sources can be used to produce secondary energy sources like electricity.

### Renewable energy

There are five main renewable energy sources:

- Solar energy from the sun, which can be turned into electricity and heat
- Wind energy

- Geothermal energy from heat inside the earth
- Biomass from plants, which includes firewood from trees, ethanol from corn, and biodiesel from vegetable oil
- Hydropower from hydroelectric turbines



## Nonrenewable energy

People get most of their energy from nonrenewable energy sources, which include fossil fuels (oil, natural gas, and coal). These energy sources are called fossil fuels because they were formed over millions of years by the action of heat from the earth's core and pressure from rock and soil on the remains (or fossils) of dead plants and creatures like microscopic diatoms. Another nonrenewable energy source is uranium, whose atoms can be split (through a process called nuclear fission) to create heat and eventually electricity.

People use renewable and nonrenewable energy sources to generate the electricity needed for homes, businesses, schools, and factories. Electricity powers computers, lights, refrigerators, washing machines, and heating and cooling systems.

Most of the gasoline used in cars and motorcycles, and the diesel fuel used in trucks, tractors, and buses are both made from crude oil and other hydrocarbon liquids that are nonrenewable

resources. Natural gas, used to heat homes, dry clothes, and cook food, is also a nonrenewable resource.

The chart shows what energy sources the United States used in 2014. Nonrenewable energy sources accounted for 90% of all energy used in the nation. Biomass, which includes wood, biofuels, and biomass waste, is the largest renewable energy source accounting for about half of all renewable energy and 5% of total energy consumption.

## Forms of Energy

*Energy forms are either **potential** or **kinetic**. **Potential** energy comes in forms that are stored including — chemical, gravitational, mechanical, and nuclear. **Kinetic** energy forms are doing work — like electrical, heat, light, motion, and sound.*

## Forms of Energy Basics

What is energy?

Energy makes change possible. Energy moves cars along the road and boats through the water.

Energy bakes a cake in the oven, keeps ice frozen in the freezer, and lights homes.

Scientists define energy as the ability to do work. Modern civilization is possible because people have learned how to change energy from one form to another and then use it to do work.

Forms of energy

There are many forms of energy, but they can all be put into two categories:

- Potential energy
- Kinetic energy

### Potential energy

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

**Chemical energy** is energy stored in the bonds of atoms and molecules. Batteries, biomass, petroleum, natural gas, and coal are examples of stored chemical energy. Chemical energy is converted to thermal energy when people burn wood in a fireplace or burn gasoline in a car's engine.

**Mechanical energy** is energy stored in objects by tension. Compressed springs and stretched rubber bands are examples of stored mechanical energy.

**Nuclear energy** is energy stored in the nucleus of an atom—the energy that holds the nucleus together. Large amounts of energy can be released when the nuclei are combined or split apart.

**Gravitational energy** is energy stored in an object's height. The higher and heavier the object, the more gravitational energy is stored. When a person rides a bicycle down a steep hill and picks up speed, the gravitational energy is being converted to motion energy. Hydropower is another example of gravitational energy, where gravity forces water down through a hydroelectric turbine to produce electricity.

### **Kinetic energy**

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

**Radiant energy** is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Light is one type of radiant energy. Sunshine is radiant energy, which provides the fuel and warmth that make life on earth possible.

**Thermal energy**, or heat, is the vibration and movement of the atoms and molecules within substances. As an object is heated up, its atoms and molecules move and collide faster. Geothermal energy is the thermal energy in the earth.

**Motion energy** is energy stored in the movement of objects. The faster they move, the more energy is stored. It takes energy to get an object moving, and energy is released when an object slows down. Wind is an example of motion energy. A dramatic example of motion is a car crash, when the car comes to a total stop and releases all its motion energy at once in an uncontrolled instant.

**Sound** is the movement of energy through substances in longitudinal (compression/rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate. The energy is transferred through the substance in a wave. Typically, the energy in sound is smaller than other forms of energy.

**Electrical energy** is delivered by tiny charged particles called electrons, typically moving through a wire. Lightning is an example of electrical energy in nature.

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