Bringing Science Alive: Forms of Energy

Packet #8G

1. Energy

Energy is the ability to cause motion or change. Everything around you has energy. For example, a rolling bowling ball has energy and can knock over bowling pins. A hot frying pan has energy and can change a raw egg into a cooked egg. Food, including your breakfast, has stored energy. When you digest food, the energy is released and your body uses this energy to do things like breathe and move around.

Energy is not made of matter, but all matter has energy. Energy is a concept that scientists use to construct explanations about motion and change. It can be used to predict how much change can occur in a particular system, given evidence such as measurements of the motion and positions of the system’s components. For example, scientists studying the phenomena shown in the photos may ask questions like why do healthy ecosystems have more prey than predators? How fast will the wind blow in a hurricane? How much electricity can solar panels produce? How bright will fireworks be?

Scientists track the energy in each part of the system, and use it to predict the motion and change that can occur in other parts of the system. For example, they could add up all the energy available from eating prey in an ecosystem, and use that to determine how many predators could survive using that amount of energy.

Scientists can use the concept of energy to explain complex interactions such as those that happen in ecosystems and hurricanes. But energy can also explain simpler events, such as the one shown in Figure 1. Look closely at the image of the hammer hitting a nail. What is happening? You might describe the scenario using forces. You exert a force on the hammer to make it move. Then, the hammer exerts a force on the nail to make it move. Finally, the nail
exerts a force on the wood to change its shape. However, you can also describe this scenario using
ergy. When you swing the hammer, your hand and the hammer have energy because they are
moving. When the hammer hits the nail, some of the energy is transferred to the nail, and the nail
moves down. As the nail moves, it transfers some energy to the wood as it pushes the wood out of
its way.

**Answer the following questions according to the reading:**

1. **What is energy?** Give an example of energy on a small scale, a medium scale, and a large
   scale. (Use real-world examples)

2. **Why do scientists track the energy in a system?**

3. **In the system of a hammer and nail, how would you use forces to describe the interaction of
   the objects? How would you use energy to describe the interaction of the objects?**

**2. The Two Forms of Energy**

A snowboarder stands at the top of a hill and looks down. She sees a second snowboarder gliding
on a flat area at the bottom of the hill. Which snowboarder has energy?

Both snowboarders have energy; they just have different forms of energy. Energy exists in two
forms. The form of energy stored in a system due to the positions of objects interacting at a distance
is potential energy. The second form of energy is kinetic energy, which is the energy an object
has due to its motion.

![Potential Energy](image)

**Potential Energy** Potential energy exists when objects within the system are
interacting in a force field. The positions of the objects determine how much
potential energy there is. For example, look at the snowboarder at the top of the hill in Figure 2A. She is located high in Earth’s
gravitational field. As a result of her position relative to Earth, there is potential energy. Now,
observe her when she is halfway down the hill. At this location, she is lower in Earth’s gravitational
field. As a result, there is less potential energy. As she descends the hill and approaches the bottom,
her potential energy decrease. How can you determine how much potential energy there is in a
given system? Recall how reference points determine the speed and direction in which an object is moving. Similarly, reference points determine how much potential energy there is. The position of the objects is relative to a reference point that is defined as having zero potential energy. Once the snowboarder reaches the bottom of the hill, she cannot move farther down. So, you might define the bottom of the hill as the point that has zero potential energy. But what if you designated the middle of the hill as the point with zero potential energy? Then, at the bottom of the hill, the snowboarder would have negative potential energy.

**Kinetic Energy** Of course, a snowboarder is not going to stay at the top of a hill. She will eventually go down the hill on her board, as seen in Figure 2B. When she moves, she has kinetic energy. All moving objects and particles have kinetic energy because they have the ability to move another object or particle and cause it to move or change. The snowboarder gliding along at the bottom of the hill also has kinetic energy because he is moving.

**Both Forms of Energy** A system may have only potential energy, only kinetic energy, or both. The system with the snowboarder standing still at the top of the hill has only potential energy. She is not moving, so she does not have kinetic energy. The system with the snowboarder gliding at the bottom of the hill has only kinetic energy because we defined the bottom of the hill as the reference point for the potential energy. A system with a snowboarder going down a hill has both potential energy and kinetic energy. The system has potential energy because the snowboarder is in Earth’s gravitational field and she is above the point in the system defined as having zero potential energy. The system also has kinetic energy because the snowboarder is moving.

### Check for Understanding:

A system with a snowboarder going down a hill has:

- A. Kinetic Energy
- B. Potential Energy
- C. Both
- D. Neither

### Answer the following question according to the reading

1. Energy exists in which two forms? What is the difference?
2. In your own words, explain a system in which objects have both potential energy and kinetic energy. (ex. Rollercoasters)

3. **Tracing Energy Transformation in a System**

Recall that a snowboarder experiences different amounts of potential energy and different amounts of kinetic energy at different points along the hill. As she travels down the hill, the amount of potential energy and kinetic energy she has changes. How can you track these energy changes?

Scientists use models to describe energy changes within a system to make predictions about how much energy an object has at a given time. A system is made of components, inputs, processes, and outputs. The components interact in processes that cause changes in the form of energy; inputs and outputs are energy that enter and leave the system.

What are the components of the system shown in Figure 3? The snowboarder has energy, so it is the component. To get to the top of the hill, the snowboarder rides a chairlift to the top of the hill. This input results in the system of the snowboarder and Earth having potential energy. The snowboarder starts going downhill, losing potential energy and gaining kinetic energy. This process converts the potential energy gained from the input into kinetic energy. As the snowboarder continues moving, she undergoes other processes that change the energy’s form. Kinetic energy is changed into potential energy at one moment as the snowboarder jumps up into the air. Then, the potential energy is converted to kinetic energy again as she descends and lands. As she slides to the bottom of the hill, the kinetic energy is used to overcome friction with the snow. This output results in energy leaving the components of the system—the snowboarder.
4. Conservation of Energy

Believe it or not, the total energy of all the rolling balls does not change. The break of a rack of pool balls demonstrates a scientific law about energy. The law of conservation of energy is a scientific law that states the total energy of an isolated system always remains the same. An isolated system is a system that does not have any energy inputs or outputs. This law means that energy cannot be created or destroyed. It does not mean that a given form of energy always remains the same. The energy of an object can be converted. The law also does not mean that a single object always has the same amount of energy. An object's energy can be transferred to another object in the isolated system when the two objects exert forces on each other. Energy can be lost in several ways. The sound made by the balls hitting each other is one way that energy is lost. Some of the kinetic energy is converted to the kinetic energy of vibrating air particles to create sound waves. As a result, the balls slow down. However, the most common process in losing energy is through friction. Friction happens when objects rub against each other, such as when pool balls roll on a pool table. The force of friction causes the molecules of the table to move faster. When the particles move faster, the temperature of the objects increases. Since the particles are moving faster, their kinetic energy has increased. How? Kinetic energy from the moving objects (such as the rolling pool balls) is transferred to the particles. Because kinetic energy is transferred away from the moving objects, the objects slow down.

Answer the following questions according to the reading:

1. What is the law of conservation?
   __________________________________________________________

2. How might a system seem to lose energy?
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