Energy Part 2: Kinds of Energy

Last week we began thinking about **energy**. Although it's a word that has many everyday meanings, we examined the scientific definition:

> **Energy**: The ability to do work.

We further defined **work**:

> **Work** is done on an object when:
>
> - a force is applied on an object, *and*
> - the object moves in the direction of that force, *and*
> - the force and motion occur simultaneously
>
> If you applied the force and the object moved as you applied it then **you have done work on the object**.

Together, these definitions are a possible source of confusion. Does **energy** exist only when work is *actually* being done? Or does **energy** exist because, within a system, work can *possibly* be done? The answer to both questions is yes, because there are two kinds of **energy**: **kinetic** and **potential**.

Last week we asked you to begin thinking about these concepts:

What are some examples of potential energy? In other words, under what circumstances is the ability to work present, but no work is being done?

We'll begin our discussion with **kinetic energy**, then follow up with **potential energy**.

Kinetic energy

> **Kinetic energy** is the energy possessed by objects and substances in motion.

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- For example, a stone flying through the air has **kinetic energy**. As the stone moves through the air, it pushes against air molecules and moves them along in front of it. When the stone hits a window, it exerts a force on the window. If the push is great enough, pieces of glass are pushed forward in the direction of the force exerted by the stone. [This the principle use by CSI investigators to decide if a window was broken from the outside or the inside.] The *moving* rock has **kinetic energy.**

- Flowing water has **kinetic energy**; it does **work**. It pushes sand and stones it comes in contact with, displacing them downstream. Flowing water pushing on a water wheel turns the wheel, which then turns the grindstone. *Moving* water does **work**. It has **kinetic energy**.

Potential energy

If an object or substance has **potential energy,** it has the capability to do work. No **work** is being done at the moment, but the instance the force is put into action, **work** is done.

Some examples:

- A rock poised on the edge of a cliff has **potential energy**. While it is motionless, it is not doing **work**. However, once it begins to fall, it begins to do **work**, pushing air molecules, trees and smaller stones.

- The water stored in a dam has **potential energy**. While it is motionless, it is not doing work. However, should the dam break, the moving water pushes everything in its path forward. It does **work** on the objects in its path.

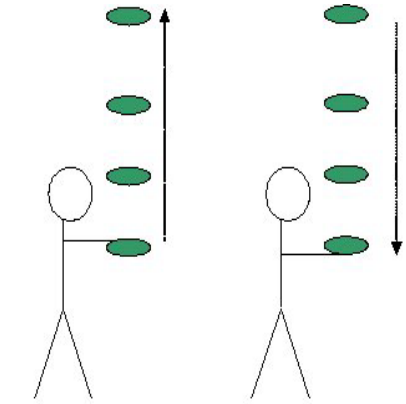

figure 1 figure 2

In the examples above, the rock, an object, and the water, a substance, have **potential energy,** which is released when they move from a higher position on the Earth's surface to a lower one. Specifically, the rock on the cliff and the water in the dam have **gravitational potential energy**. The higher a motionless object or substance is above the Earth's surface, the greater the pull between the Earth and the object or substance; therefore, the greater the **gravitational potential energy.**

Energy in a system

A child throwing a ball into the air (figure 1) and catching it (figure 2) is a system in which we can trace the relationships between **kinetic** and **gravitational potential energy**. Let's start the story at the point where the child is holding the ball in her hand.

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THE BALL'S MOTION

1. First, the ball is at rest in the child's hand.
2. Then it moves upward, slowing down until it reaches the highest point in its path.
3. For an instant, at the highest point, the ball is at rest.
4. Then it begins falling downward.
5. It falls faster and faster until the child catches it.

THE BALL'S ENERGY

1. Before the child throws the ball upward, it has some **gravitational potential energy** with respect to the ground.
2. After the ball leaves the child's hand, it has **kinetic energy**. It is pushing on and moving air molecules.
3. As the ball moves upward, its **kinetic energy** is decreasing (it is moving slower), BUT its **gravitational potential energy** is increasing. (Its distance from the Earth's surface is increasing.)
4. At the ball's highest point, all its **kinetic energy** has been converted to **gravitational potential energy**.
5. As the ball falls, its **kinetic energy** is increasing, *and* its **gravitational potential energy** is decreasing.
6. When the ball hits the child's hand, it pushes the child's hand downward, and heats the child's hand.
7. If the child catches the ball and holds it above the ground, the ball still has some **gravitational potential energy**.

The story of the energy the system containing a child and ball is far from complete. We will try to complete the story next time. Meanwhile, think about the gaps in the story. A question to ponder:

Ultimately, where did the ball's **kinetic energy** come from?

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What do the New York State standards say?

In the Elementary and Intermediate Core Curricula, Standard 4, The Physical Setting, Key Idea 4 states:

- *Energy exists in many forms, and when these forms change energy is conserved.*

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