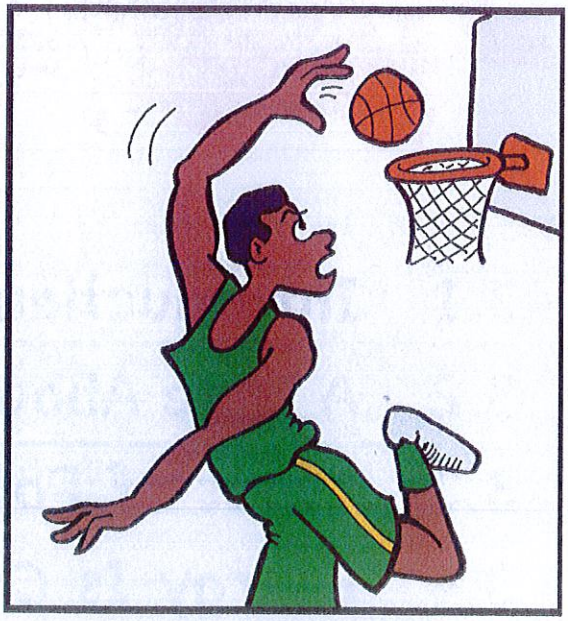
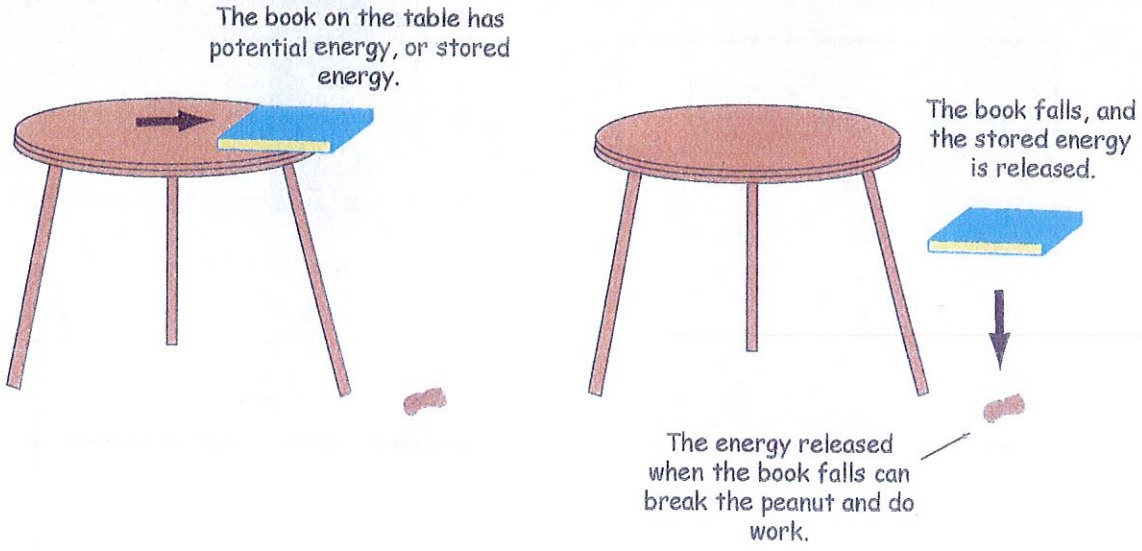
3.1 Potential Energy

What is potential energy (pə-ten'-shəl e'-nər-jē)? You've probably heard the word "potential" used before. For example you may have heard someone say, "He's got potential," or "The tropical storm has the potential to become a hurricane." In both of these statements, the word *potential* refers to something that has the capacity to happen or become. "He's got potential" simply means that he has the possibility of becoming something like a great basketball player or future leader, but he isn't one right now. The tropical storm may become a hurricane, but it isn't right now. It only has the *potential* to become one. Recall from Chapter 2 that energy is used to do work. Simply put, potential energy is energy that has the *potential to do work*.



Potential energy is a type of energy often called stored energy. An example of an object with potential energy is a book on a table. It may not seem like the book can do work, but because the book is not on the floor but is raised, it has the *potential* to fall off the table.



When the book falls off the table, it strikes the floor with a force. This force could be used to crack open a peanut, smash a marshmallow, or make a big noise. The book can use the potential energy to do work.

This type of potential energy is called gravitational (gra-və-tā-shə-nəl) potential energy because the force of gravity is required to bring the book from its elevated position (on the table) to its final position (on the floor). The amount of gravitational potential energy of an object equals the amount of work that was needed to lift the object in the first place.

The amount of gravitational potential energy can be calculated by multiplying the weight of the object by the height:

gravitational potential energy (GPE) = weight x height

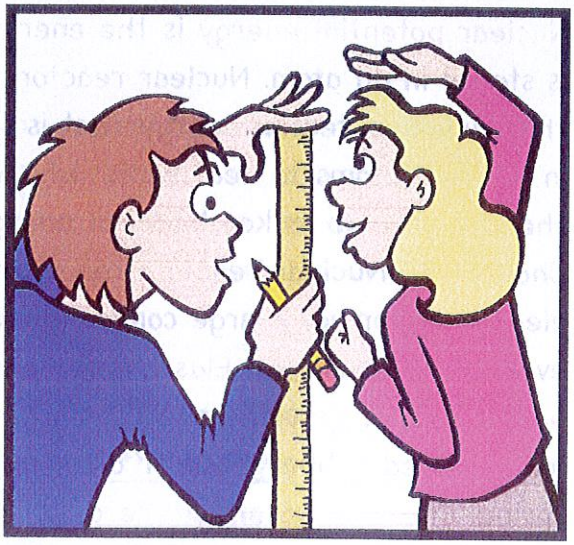
For example, if the book on the table is 1 meter (3.28 feet) above the floor and it weighs 1 kilogram (2.2 pounds), the gravitational potential energy (GPE) would be:

GPE = 1 meter x 1 kilogram (3.28 feet x 2.2 pounds)

or

GPE = 1 kilogram-meter (7.2 foot-pounds)

3.2 A Note About Units



What is a unit? In physics, a unit is simply the name given to a type of measurement. For example, when you measure your height, your mom might have you stand next to a wall and mark a place on the wall by the top of your head. Using a ruler, she can then measure how tall you are by putting one end of the ruler on the floor and the other end on the mark on the wall. Your height might be something like 1.25 meters (4 feet, 2 inches). "Meters" and "feet" and "inches" are called units.

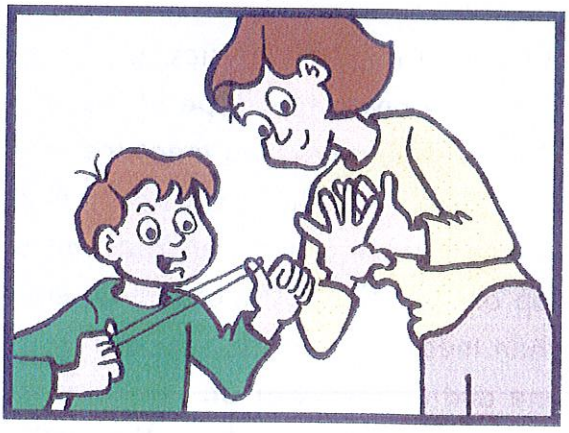
Meters, feet, and inches measure how long something is, but other units, like kilograms and pounds, may tell us how much something weighs or, like liters and gallons, how much liquid something can hold. Time also has units, like hours, minutes, or seconds. It tells us how long something takes to happen; for instance, how long it might take for an egg to reach the ground if it is dropped from a tall building.

In the United States, we often use what are called British units, like feet and inches. But most scientists use metric units. Metric units are usually easier to work with than British units because they can be evenly divided by 10. British units are usually converted to metric units when used in science. The table shows some units in both metric and British.

British		Metric	
1 inch	-	10 mm	1 cm
1 ft	12 inches	100 cm	1 m
1 mi	5280 ft	1000 m	1 km

3.3 Types of Potential Energy

There are actually several different types of potential energy. We already saw gravitational potential energy, which is energy associated with the position of an object. There are also nuclear (nü'-klē-ər) potential energy, elastic (i-las'-tik) or strain potential energy, chemical potential energy, and several others.



Nuclear potential energy is the energy that is stored in an atom. Nuclear reactors use the nuclear potential energy that is stored in uranium atoms to heat water which can then be used to make electrical energy. (See Chapter 5.) Nuclear reactors can provide electricity for very large communities and even whole countries! Elastic or strain potential energy is the energy stored in an extended rubber band or a compressed spring. Chemical potential energy is the energy that is stored in molecules, such as those found in batteries, fuels, or foods.

3.4 Energy Is Converted

What happens to the potential energy of the book, the battery, or the rubber band once the energy is released? Is it still potential energy? No. The potential energy of the book, the battery, and the rubber band have all been released and converted into another type of energy. It is important to know that:

Potential energy is useful (can do work) only when it has been converted into another form of energy.

Can you think of other uses for batteries? Tree decorations perhaps? Or maybe a nice hood ornament? Not really. In fact, batteries are useless unless they are actually used—for instance, to light a flashlight or power a CD player. When a battery is used to power a CD player or a flashlight, the *chemical potential energy* inside the battery is released by chemical reactions and converted to electrical energy. The electrical energy can then be converted into light energy in the flashlight or mechanical energy in the CD player.

3.5 Kinetic Energy

We saw in the last section that potential energy must be converted into another form of energy before it can do work. What kind of energy is it converted into? When the book was dropped from the table, the gravitational potential energy had to first be converted into kinetic (ki-ne'-tik) energy before it could do work on the peanut.

What is kinetic energy? The word kinetic comes from the Greek word *kinetikos*, which means "putting into motion," so kinetic energy is the *energy associated with things that are moving*. The potential energy of the book on the table is converted into kinetic energy when it falls—that is, while it is moving toward the floor. The

book has no kinetic energy as it sits on the table, only potential energy. When the book is moved from the table and begins to fall, the potential energy is converted into kinetic energy. The farther it falls, the more kinetic energy it gains and the more potential energy it loses.

By the time it hits the floor, all of the potential energy has been converted into kinetic energy. The total amount of energy has not changed—only the form of energy. Physicists say that the total energy is conserved. That is, all of the potential energy has been converted into another form of energy. Energy is never lost—only converted. We will learn more about the conservation of energy in Chapter 10.

How much kinetic energy does the book have? It depends. The kinetic energy of an object depends on two things—one is the mass of the object, and the other is the speed of the object. We will learn more about mass in Chapter 4. What we need to remember about kinetic energy is the following:

For a certain speed, the more mass an object has,
the more kinetic energy it has;
and
For a certain mass, the more speed an object has,
the more kinetic energy it has.

So, a heavy book will have more kinetic energy than a lighter book moving at the same speed. Also, a book that is thrown will have more kinetic energy than a book that is dropped.

3.6 Kinetic Energy and Work

We already saw in the last chapter that energy is the ability to do work. When a rubber band is stretched across the prongs of a slingshot, it has elastic potential energy. When the rubber band is released, the elastic potential energy is transferred to the pellet in the slingshot as the pellet is propelled toward the

target. The pellet now has kinetic energy. All, or almost all, of the potential energy that was in the slingshot is now kinetic energy in the pellet.

What happens to the kinetic energy in the pellet when it hits the target? The kinetic energy is converted to other forms of energy, such as heat and sound. As a result, the energy is transferred to the target in the form of work as it pushes on the target.

We say that:

The pellet is doing work on the target.

3.7 Summary

Here are the main points to remember from this chapter:

- Potential energy is energy that has the potential to do work.
- A book on a table has gravitational potential energy.
- The energy in a stretched rubber band is called elastic potential energy.
- Kinetic energy is the energy of motion.
- Potential energy can do work only when it is converted into another form of energy, such as kinetic energy.