

# Lesson 1: Forms of Energy and Energy Transformations

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## Contents

- 1 Introduction
- 2 Lesson Content
  - 2.1 Heat
  - 2.2 Light
  - 2.3 Sound
  - 2.4 Electrical Energy
  - 2.5 Chemical Energy
  - 2.6 Nuclear Energy
  - 2.7 Mechanical Energy
  - 2.8 Energy Conversion

## Introduction

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Energy is the ability to do work. It is one of the basic human needs and is an essential component in any development programme. In this lesson, we are going to look at the forms that energy exists, namely: heat, light, sound, electrical, chemical, nuclear and mechanical. These forms of energy may be transformed from one form to the other, usually with losses.



## Objectives

By the end of this lesson you should be able to:

- describe the various forms of energy namely, heat, light, sound, electrical, chemical, nuclear and mechanical
- describe how energy may be transformed from one form to another

## Lesson Content

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### Heat

Heat energy, also referred to as thermal energy, is really the effect of moving molecules. Matter is made up of molecules, which are in continual motion and in a solid, vibrate about a mean position. The motion of any molecule increases when the energy of the substance is increased. This may cause an increase in the temperature

of the substance or lead to a change of state. The higher the temperature, the greater the internal energy of the substance.

Heat energy is the most easily lost or dissipated form of energy. It is also the form of energy into which other forms of energy can easily change. However, heat can be changed into other forms of energy with a lot of waste. Also called Solar Energy

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## Light



Sunset: Image provided by courtesy of Flickr- [www.flickr.com](http://www.flickr.com)

Light energy is a type of wave motion. That is, light is a form of energy caused by light waves. It enables us to see, as objects are only visible when they reflect light into our eyes.

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## Sound

Sound energy is also a type of wave motion. We are heard by others when we talk because of the sound energy we produce. It is due to the effect of the air molecules vibrating when we talk. The vibrating molecules hit our eardrums, which enable us to hear others talk. Sound energy may be converted into electrical energy for transmission, and later the electrical energy can be converted back into sound energy at the receiving end. An example of such transformations could be seen in the microphone and the loudspeaker.

Sound, like heat energy is easily lost. The transformation of one form of energy into another may be accompanied by losses in the form of sound and/or heat that are often not desirable.

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## Electrical Energy



Transmission of electrical energy: Image provided by courtesy of Flickr- [www.flickr.com](http://www.flickr.com)

Electrical energy is really the effect of moving electrical charges from one point to another in a conductor.

Electrical charges moving through a conductor is called electricity. Electrical energy may be easily changed into

other forms of energy to suit our particular needs. Lightning is an example of electrical energy. Electric current is the means by which electrical energy is most easily transported to places where it is needed and converted into other forms.

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## Chemical Energy

This is the energy stored within chemical compounds. A chemical compound is formed by the rearrangement of atoms that is accompanied by energy loss or gain. This energy is the chemical energy gained or lost in the formation of the compound.

Food, biomass, fuel and explosives have a store of chemical energy. The energy from food is released by chemical reactions in our bodies in the form of heat. Fuels like coal, oil and natural gas contain chemical energy that may be converted into other forms of energy like heat and light. The chemical energy present in a given fuel is determined by its calorific value – the heat liberated when 1 Kg of the fuel is burnt. Batteries and explosives also contain chemical energy that could be converted into other forms of energy, some beneficial, others harmful.

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## Nuclear Energy

Nuclear Energy, also known as atomic energy, is energy stored in the nucleus of an atom. It is this energy that holds the nucleus together and could be released when the nuclei are combined (fusion) or split (fission) apart. Nuclear energy can be used for peaceful purpose as well as destructive purposes (as in the atomic bomb). Considering peaceful purposes, nuclear energy is used to generate electricity in nuclear power plants, produce steam for driving machines, powering some submarines and spacecrafts. In these applications, the nuclei of uranium atoms are split in a process called fission. Nuclear energy is also the source of the sun's energy. The sun combines the nuclei of hydrogen atoms into helium atoms in a process called fusion.

Albert Einstein put forward the following equation that provides the basis for calculating the amount of energy released when the nucleus of an atom is split.  $E = mc^2$

The equation means that when the nucleus of an atom is split, the amount of energy released,  $E$ , in joules, is equal to the loss of its mass,  $m$ , in kilograms, times the speed of light squared,  $c^2$ , in  $m/s^2$ . Because  $c^2$  is a very large figure ( $300,000,000 \times 300,000,000 = 90,000,000,000,000,000$ ), a small amount of mass can be converted into an enormous amount of energy. An atom of uranium splits into two smaller atoms and loses roughly 0.1 percent of its mass that is converted into a vast amount of energy. One-kilogram mass of any substance completely converted into energy equals 90,000,000,000,000,000 J or 25 billion kilowatt hours!! This is more than the electrical energy needs of the United States for two days!!

## Mechanical Energy

Mechanical energy is the kind of energy that can do mechanical work directly. Naturally occurring sources of mechanical energy include winds, waterfalls and tides.

There are two kinds of mechanical energy, namely kinetic energy and potential energy. Kinetic energy is the energy a body possesses by virtue of its motion. A moving body of mass,  $m$  Kg and velocity  $v$  m/s possesses kinetic energy of magnitude  $mv^2$  joules. Thus, the magnitude of the kinetic energy of an object depends both the mass and the velocity of the object. Flowing water and winds have kinetic energy.

Potential energy is the energy of a body due to its position or shape. This form of energy could be considered as energy stored in a body to be released when it begins to move or change its position or shape. Quite often, potential energy changes to kinetic energy. A ball at the top of a slope, water behind a dam, a compressed spring

and a stretched elastic band possess potential energy. For a body of mass,  $m$  Kg located at a height  $h$  metres above a particular chosen level such as ground level or sea level, its potential energy is  $mgh$  joules, where  $g$  = acceleration due to gravity, in  $m/s^2$ . For an elastic spring stretched  $x$  m, its potential energy is  $(1/2)kx^2$  joules, where  $k$  = spring constant, in  $N/m$ .

## Energy Conversion

One important property of energy is its ability to change from one form to another form. For example, chemical energy from fossil fuels (coal, oil and natural gas) can be converted into heat energy when burned. The heat energy may be converted into kinetic energy in a gas turbine and finally into electrical energy by a generator. The electric energy may subsequently be converted into light, sound or kinetic energy in our homes through various household appliances.

During any energy conversion, the amount of energy input is the same as the energy output. This concept is known as the law of conservation of energy and sometimes referred to as the First Law of Thermodynamics. This law states: energy cannot be created nor destroyed but can be transformed from one form to another. Thus, the total energy of an isolated system is always constant and when energy of one form is expended an equal amount of energy in another form is produced. In every energy conversion, some high-grade energy is converted into low-grade energy as heat. Thus, the total amount of low-grade energy in the universe is increasing while high-grade energy is decreasing. Even though energy is never destroyed, we usually complain that the world is suffering from an energy shortage. Indeed we are suffering from shortage of high-grade energy that has the potential of producing useful power! Energy may change form, but the total amount of energy in the universe stays the same.



### Reflection

Let us consider the following energy transformations that we encounter on daily basis in our everyday activities.

- When we turn on our flashlight, chemical energy stored in the batteries is converted into light energy.
- When we turn on the television, electrical energy changes into light and sound. Even though undesirable, some amount of heat is also produced.
- When we move a vehicle, the engine converts the chemical energy stored in the fuel into heat, sound and kinetic energy. Note that the heat and the sound that are produced are not desirable.
- When we talk on the telephone, the sound we produce is first transformed into electrical energy by the microphone that is transmitted along wires. In the case of cellular phones, the sound is converted into electromagnetic waves and transmitted through the air. The speaker of the phone on the other end changes the electrical energy/ electromagnetic waves back into sound energy.
- An electric cooker in our homes changes electrical energy into heat and light. (As the hot plate gets hotter and hotter we see it glowing).



## Summary

In this lesson, we looked at the various forms in which energy may exist, namely: heat, light, sound, electrical, chemical, nuclear and mechanical. We also learnt that these forms of energy may be transformed from one form to the other, usually with losses.



## Assignment

Describe to your junior brother in SSS 3 the following forms of energy:

1. Heat
2. Light
3. Sound
4. Electrical
5. Chemical
6. Nuclear
7. Mechanical

[www.evaucation.weebly.com](http://www.evaucation.weebly.com)

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