Energy

What is Energy?

The simplest definition of energy is "the ability to do work". Energy is how things change and move. It's everywhere around us and takes all sorts of forms. It takes energy to cook food, to drive to school, and to jump in the air.

Units of Measure for Energy

In physics, the standard unit of measure for energy is the joule which is abbreviated as J. There are other units of measure for energy that are used throughout the world including kilowatt-hours, calories, newton-meters, therms, and foot-pounds.

Law of Conservation of Energy

This law states that energy is never created or destroyed, it is only changed from one state to another. One example is the chemical energy in food that we turn into kinetic energy when we move.

Renewable and Nonrenewable

As humans we use a lot of energy to drive our cars, heat and cool our houses, watch TV, and more. This energy comes from a variety of places and in a number of forms. Conservationists classify the energy we use into two types: renewable and nonrenewable. Nonrenewable energy uses up resources that we cannot recreate. Some examples of this are gas to run our car and coal burned in power plants. Once they are used, they are gone forever. A renewable energy source is one that can be replenished. Examples of this include hydropower from turbines in a dam, wind power from windmills, and solar power from the sun.

The more renewable power we use the better for our planet and for future generations as they won't run out of resources someday.

1. Kinetic Energy

What is kinetic energy?

Kinetic energy is the energy an object has due to its motion. As long as an object is moving at the same velocity, it will maintain the same kinetic energy. The kinetic energy of an object is calculated from the velocity and the mass of the object. As you can see from the equation below, the velocity is squared and can have a significant impact on the kinetic energy.

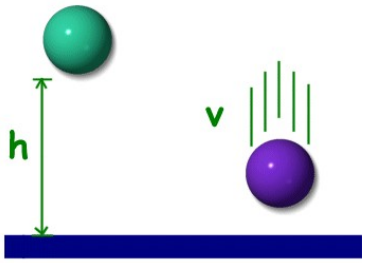
Here is the equation for calculating kinetic energy (KE): $\mathbf{KE = 1/2 * m * v^2}$
Where: m = mass and v = velocity

How to Measure Kinetic Energy

The standard unit for kinetic energy is the joule (J). The joule is the standard unit for energy in general. Other units for energy include the newton-meter (Nm) and the kilogram meter squared over seconds squared (kg m^2/s^2).
Kinetic energy is a scalar quantity, which means it only has a magnitude and not a direction. It is not a vector.

How is it different from potential energy?

Kinetic energy is due to an object's motion while potential energy is due to an object's position or state. When you calculate an object's kinetic energy, its velocity is an important factor. Velocity, however, has nothing to do with an object's potential energy.



The green ball has potential energy due to its height.
The purple ball has kinetic energy due to its velocity.

Example

One way to think of potential and kinetic energy is to picture a car on a roller coaster. As the car travels up the coaster it is gaining potential energy. It has the most potential energy at the top of the coaster. As the car travels down the coaster, it gains speed and kinetic energy. At the same time it is gaining kinetic energy, it is losing potential energy. At the bottom of the coaster the car has the most speed and the most kinetic energy, but also the least potential energy.

2. Potential Energy

What is potential energy?

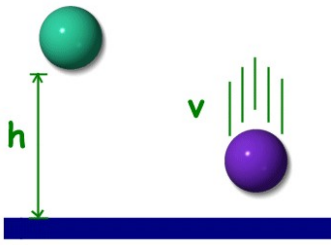
Potential energy is the stored energy an object has because of its position or state. A bicycle on top of a hill, a book held over your head, and a stretched spring all have potential energy.

How to Measure Potential Energy

The standard unit for measuring potential energy is the joule, which is abbreviated as "J."

How is it different from kinetic energy?

Potential energy is stored energy while kinetic energy is the energy of motion. When potential energy is used it is converted into kinetic energy. You can think of potential energy as kinetic energy waiting to happen.



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Example

We can compare potential and kinetic energy by considering a car on a hill. When the car is at the top of the hill it has the most potential energy. If it is sitting still, it has no kinetic energy. As the car begins to roll down the hill, it loses potential energy, but gains kinetic energy. The potential energy of the position of the car at the top of the hill is getting converted into kinetic energy.

Gravitational Potential Energy

One type of potential energy comes from the Earth's gravity. This is called gravitational potential energy (GPE). Gravitational potential energy is the energy stored in an object based

on its height and mass. To calculate the gravitational potential energy we use the following equation: **GPE = mass * g * height**

GPE = m*g*h

Where "g" is the standard acceleration of gravity which equals 9.8 m/s^2. The height is determined based on the height the object could potentially fall. The height may be the distance above the ground or perhaps the lab table we are working on.

Potential Energy and Work

The potential energy is equal to the amount of work done to get an object into its position. For example, if you were to lift a book off the floor and place it on a table. The potential energy of the book on the table will equal the amount of work it took to move the book from the floor to the table.

3. Heat

Heat is the transfer of energy from a one object to another due to a difference in temperature. Heat can be measured in joules, BTUs (British thermal unit), or calories.

Heat and temperature are closely related, but they are not the same thing. The temperature of an object is determined by how fast its molecules are moving. The faster the molecules are moving the higher the temperature. We say objects that have a high temperature are hot and objects with a low temperature are cold.

Transferring of Heat

When two items are combined or touching each other, their molecules will transfer energy called heat. They will try to come to a point where they both have the same temperature. This is called equilibrium. Heat will flow from the hotter object to the colder. The molecules in the hotter object will slow down and the molecules in the colder object will speed up. Eventually they will get to the point where they have the same temperature.

This happens all the time around you. For example, when you take an ice cube and put it into a warm soda. The ice cube will become warmer and melt, while the soda will cool down.

Hot Objects Expand

When something gets hotter it will expand, or get bigger. At the same time, when something gets colder it will shrink. This property is used to make mercury thermometers. The line in the thermometer is actually liquid mercury. As the liquid gets hotter, it will expand and rise in the thermometer to show a higher temperature. It's the expansion and contraction due to temperature that allows the thermometer to work.

Heat Conduction

When heat transfers from one object to another, this is called conduction. Some materials conduct heat better than others. Metal, for example, is a good conductor of heat. We use metal in pots and pans to cook because it will move the heat from the flame to our food quickly. Cloth, like a blanket, isn't a good conductor of heat. Because it's not a good conductor, a

blanket works well to keep us warm at night as it won't conduct the heat from our bodies out to the cold air.

Matter Changing State

Heat has an impact on the state of matter. Matter can change state based on heat or temperature. There are three states that matter can take depending on its temperature: solid, liquid, and gas. For example, if water is cold and its molecules are moving very slow, it will be a solid (ice). If it warms up some, the ice will melt and water becomes a liquid. If you add a lot of heat to water, the molecules will move very fast and it will become a gas (steam).

4. Light

What is light made of?

Light has no mass and is not really considered matter. Today scientists say light is a form of energy made of photons. Light is unique in that it behaves like both a particle and a wave.

Why does light go through some things and not others?

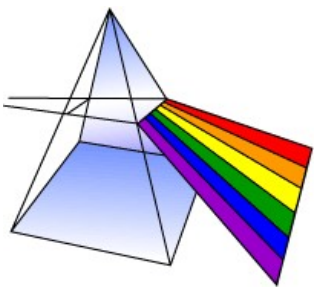
Depending on the type of matter it comes into contact with, light will behave differently. Sometimes light will pass directly through the matter, like with air or water. This type of matter is called transparent. Other objects completely reflect light, like an animal or a book. These objects are called opaque. A third type of object does some of both and tends to scatter the light. These objects are called translucent objects.

The speed of light

Light moves at the fastest known speed in the universe. Nothing moves faster than (or even close to) the speed of light. In a vacuum, where there is nothing to slow it down, light travels 186,282 miles per second! Wow, that's fast! When light travels through matter, like air or water, it slows down some, but it's still pretty fast.

Refraction

Normally, light travels in a straight path called a ray, however, when passing through transparent materials, like water or glass, light bends or turns. This is because different materials or mediums have different qualities. In each type of medium, whether it is air or water or glass, the wavelength of the light will change, but not the frequency. As a result, the direction and speed of the traveling light wave will change and the light will appear to bend or change directions.



One example of refraction is a prism. Prisms are unique in that each color of light is refracted to a different angle. So it can take white light from the Sun and send out light of various colors.

Lenses use refraction to help us see things. Telescopes help us to see things far away and microscopes enable us to see very small things. Even glasses use refraction so that we can see everyday things more clearly.