What is Work?

If you apply force to an object and if it moves in the direction force applied then the work done by the applied force is the product of the force applied (F) and the amount of displacement (d) in the direction of force applied and is given by equation

$$W = F \times d$$

By any chance if you apply force and the object does not moves there is no work done. Unit of work is Joules (J)

What is Energy?

Energy is defined as the ability to do work. Its unit is Joules (J). It is a scalar quantity

What is the difference between work and energy?

Work refers to overcoming resistance by the application of a force. It is evident that the resistance has been overcome from the movement of application of force. Energy is the capacity to do work or perform some action and can be considered a something that is stored or possessed. It exists in several forms like heat, light, potential energy, electrical or other forms. Work and energy have same units and are closely related. Energy can be stored but work cannot. Work is energy in motion. Energy changes from one form to another by the process of doing work.

What is Law of conservation of energy?

The law of conservation of energy states that "in a closed system, the total amount of energy always remains constant, because it can neither be created nor be destroyed. It just changes its form from one form to another."

For example:

1. In an electrical bulb, electrical energy is converted to heat energy and light energy.
2. In a dynamo mechanical energy is converted to electrical energy.
3. In a clock the potential energy stored on the coiled spring is converted to kinetic energy.
4. In the sun nuclear energy is converted to heat energy and light energy.
5. In a battery chemical energy is converted to electrical energy.

The Basic formula of conservation of energy is simple:

Energy spent in one act = Energy gained in the related act

What is Power?

Power defines the rate at which work is done. Its unit is Watt (W). It is given by

$$P = \frac{W}{t}$$

Where W is the work done in time t.

Power can be also defined as rate of energy transferred.

$$P = \frac{Energy\ Transferred}{Time\ Taken}$$

In this case the unit is same, as work and energy has exactly same unit.

What are the different types of energy?

1. Heat energy

It is the energy released/ taken in the form of heat. It increases the temperature of the object.

1. Light energy

It is the energy that is released in the form of electromagnetic radiation in the form of visual light.

3. Chemical energy

Energy evolved due to a chemical reaction is called as chemical energy.

4. Electrical energy

The energy released due to the movement of electrons is called as electrical energy.

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5. Kinetic energy

The energy possessed by a moving object is called Kinetic energy. It is given as

$$KE = \frac{1}{2} m v^2$$

Where m is mass of object and v is velocity of object.

6. Potential energy

A potential energy of an object is the energy acquired by it by the virtue of its position and an energy which is readily available for use. Energy stored on a coiled spring, raised stone are examples of potential energy. There are different types of potential energy.

- Gravitational potential energy, which is the potential energy due to its position above ground

  The Gravitational Potential Energy of object at height 'h' is given as

  $$GPE = mgh$$

- Elastic potential energy, the potential energy due to the expansion or compression of an elastic object like spring or rubber band.
- Electrical Potential Energy, the energy by means of electrical voltage (also called as electric potential) that is built on an object due to electrostatic induction.
- Nuclear potential energy, the sum of potential energy of all the protons and neutrons in a nucleus due to the nuclear forces between them, excluding the electrostatic potential energy existing between them is called nuclear potential energy.
- Chemical Potential energy, the energy which is recognized when an object releases or absorbs energy if it undergoes a Chemical reaction.

7. Mechanical energy

Mechanical Energy is the energy of motion that does the work. An example of mechanical energy is the wind as it turns a windmill, wave energy or sound energy.

Let's see some examples on Energy Conversion:

1. Water producing electricity: Here the potential energy converted in to kinetic energy.
2. Car driving : Here the chemical energy converted into kinetic energy
3. Boiling water using electric kettle: Here electrical energy is converted into heat energy
4. Pushing a rock up towards the hill: Here the kinetic energy converted into potential energy.
5. Ball falling from a great height towards the ground: Here potential energy converted into kinetic energy.

What are the Sources of energy?

There are mainly two types of sources of energy

1. Non renewable sources, which cannot be renewed or which will end easily.
2. Renewable sources, which does not end easily

Sources of energy	Forms of energy	Type of source
Sun	Solar	Renewable
Petroleum, natural gas, methane gas in coal bed	Chemical	Non renewable
Running water, tides of ocean, wind mills	Kinetic	Renewable
Geysers, hot springs, volcanic gases and molten lava	Geothermal	Renewable
Uranium, thorium etc	Nuclear	Non renewable

Different types of sources of energy

Renewable energy	Non- renewable energy
Sustainable source	Non sustainable energy source
No or very less emission	Highly polluting energy sources
Output is low per unit relative to organic fuels	High output per unit of energy
High installation cost	Relatively lower installation cost
Cheap return on long run	High cost of running
Environment friendly	Environmentally harmful

Renewable vs Non renwable sources

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What is Heat?

Heat is stated as the transfer of energy across the boundary of a system because of the difference in temperature between the system and its surroundings.

What is Temperature?

Temperature is a measure of average speed of the particles in a substance. In general particles moves slowest in solid, faster in liquid, and fastest in gas. So for same material in solid state temperature is lower than liquid and gas.

Thermal Energy

Thermal energy gives the total kinetic energy the system possesses. It is used to determine the internal energy of such system. In a system it increases with increase in temperature. Hence there would be the greater speed in molecular motion in the system.

	Heat	Thermal Energy
1.	It is in transit	It is not in transit and is a potential
2.	It does not undergo the process of being transferred	It is the process of being transferred and acts as a internal energy of the system
3.	The heat flow can take place through two bodies even though they are not in contact	Here both hot body and cold body should be in contact.
4.	Heat transfer takes place due to thermal energy	Thermal energy acts as driving force for heat transfer.

There are three main units of Heat:

- Calorie – It is defined as the amount of heat needed to be transferred to increase the temperature of 1 gram of water by 1°C. It is represented by "Cal."
- British thermal unit (BTU) – It is defined as the amount of heat needed to be transferred to increase the temperature of one pound of water through 1°F. It is represented by “BTU.”
- Joules – Joules is the SI unit of heat. It is equal to the work done when a force of one Newton is applied for a distance of one meter. It is represented by “J."

Heat Transfer

Heat Transfer is defined as the transmission of energy from one region to another region as a result of the temperature difference between them.

There are three modes of Heat transfer:

1. Conduction
2. Convection
3. Radiation

Conduction: Conduction is a process where the heat transfer takes place between the two solid bodies in contact, two regions of the same solid body. This will happen because of the hot, vibrating, and rapidly moving molecules transfer the heat to their neighboring atoms. **Convection:** The convection is a type of heat transfer where the heat transfer takes place through a medium and the medium may be liquid or the gas. The heat transfer takes place by the movement of fluid from one place to another. The heat transfer here is due to the bulk motion of the fluid. **Radiation**: The Third mode of energy transfer is Radiation Heat Transfer. Radiation is the transfer of heat from hot body to a cold body with any material medium for propagation. Every object in the universe is made up of atoms and molecules. These atoms and molecules vibrate due to thermal energy present in them. Every object emits electromagnetic radiations because of the thermal vibrations of these atoms and molecules. In case of energy transfer, the radiation conversion of radiated electromagnetic energy to thermal energy takes place. Radiation Heat Transfer can also be termed as transfer of energy through waves.

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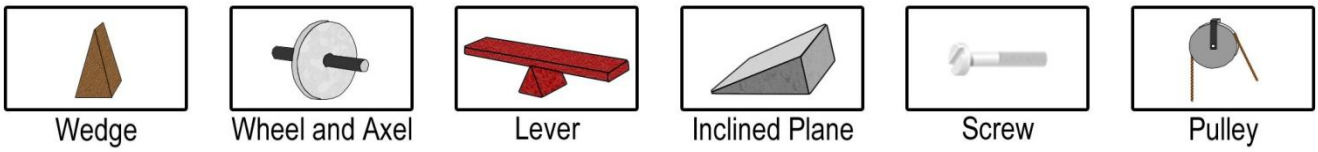
Simple Machines

A simple machine is a device that makes the work done easily in the sophisticated and systematic way. There are six simple machines namely:

1. **Pulley**: The wheels carrying system that we use in raising a bucket full of water from the well are nothing but the pulley. In fact we can raise up or move down a load easily from a larger height using it.
2. **Lever:** Lever is a simple machine which moves the load towards the pivot using the force irrespective of where the pivot is located. See-saw, hammer's claws, scissors and pliers are the common tools used in our daily activities that are nothing but the levers.
3. **Wheel and axle:** The Wheel with a rod in between at the center acts as an axle. Wheel without an axle is of no use as axle makes the wheel to turn around it. When the force is applied the wheels spins and hence load moves. The cart and the bicycle we use are nothing but the wheel and axle.
4. **Inclined plane:** The inclined plane is a nothing but a surface that is tilted. Roller coaster, staircase, skating boards, ladders and sloping sandy grounds gives the illustration for them. It is used to move the heavy load towards the ground. The ladders used to climb the height and get down from it are nothing but the inclined planes.
5. **Wedge:** A wedge is the triangle shaped weapon that separates the portion of an object when we hit by a hammer on it. It can also be used as a in between piece that stops the movement between two objects. The fork which we used in our dinner table is a wedge. Door stopper and knifes are also the examples of wedges.
6. **Screw:** A screw is nothing but in fact a incline plane where the center has a spiral core. Here the movement takes place from a lower point to the higher point. It sometimes acts as a tool that joints the separate parts, as a lid that wraps the stuff, as a tap that interlocks the water when not in use, as a tool that lifts the heavy load.

Examples of Simple machine:

Pulley: Used to load the water from the height, in elevators etc
Lever: See-saw, hammer's claws, scissors and pliers are its examples
Wheel and axle: Cart and the bicycles
Inclined plane: Roller coaster, staircase, skating boards, ladders
Wedge: Fork, Door stopper and knifes
Screw: Lid, tap etc

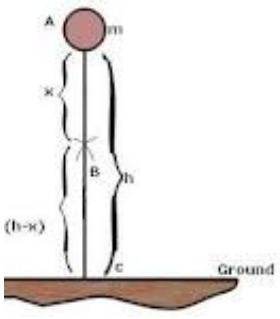


Conservation of energy on a falling object

Let us explain the law of conservation of energy for a free falling object from a height 'h'

Stage 1

Let the object be placed at a position of 'h' meters above the ground level.
Potential energy at height 'h' = mgh
Kinetic energy of the object = 1/2 mv^2 = 0 (as the object is in rest V=0)
Total energy of the object = mgh + 0 = mgh



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Stage 2
Let the object travel to a distance of 'x' to reach the position of (h-x)
Potential energy of the object = mg(h-x) (because the new height is h-x)
Kinetic energy of the object = 1/2 mv^2
but $V^2 = U^2+2gx$ and U = 0 (initial velocity)
so $V^2 = 2gx$
Applying this we will get KE= 1/2 x m x 2gx= mgx
Total energy of the object at stage 2 = mg(h-x) + mgx = mgh
Stage 3
Let the object travel the complete distance 'h' to reach the ground.
Potential energy of the object = mgh = 0 (as height becomes zero)
Kinetic energy of the object = 1/2 mv^2
But we know the $v^2 = u^2 + 2gh$ and u = 0 (initial velocity of the object)
so v^2= 2gh and KE = 1/2 x m x 2gh = mgh
Total energy at stage 3 = PE + KE = 0 + mgh = mgh

Difference between heat and temperature

Sl no	Heat	Temperature
1	Heat is the amount of energy in a system.	Temperature is the measure of the average molecular motions in a system
2	It is a measure of both Kinetic energy and Potential energy of the Molecules	It is the Measure of only average Kinetic energy associated with the molecules.
3	Heat is measured in Joules	Temperature is measured in Kelvin, Celsius and Fahrenheit.
4	Heat is energy. The substance can experience a rise in temperature. Heat is transferred through radiation, conduction and convection.	Temperature is not energy it is, a number that relates to a type of energy possessed by the molecules of a substance.
5	Denoted by the Symbol - Q	Denoted by the Symbol - T

Nuclear Reactions
In a nuclear reaction, energy can be converted to matter and matter can be converted to energy. In such processes, energy and matter are conserved, according to Einstein's formula $E = mc^2$,where E is the energy, m is the mass (matter), and c is the speed of light. A nuclear reaction is different from a chemical reaction because in a nuclear reaction, the particles in nuclei (protons and neutrons) interact, whereas in a chemical reaction, electrons are lost or gained by an atom. Two types of nuclear reactions are fusion and fission.

Fusion is a nuclear process in which two light nuclei combine to form one heavier nucleus. A fusion reaction releases an amount of energy more than a million times greater than the energy released in a typical chemical reaction. This gain in energy is accompanied by a loss of mass. The sum of the masses of the two light nuclei is lower than the mass of the heavier nucleus produced. Nuclear fusion reactions are responsible for the energy output of the sun.

Fission is a nuclear process in which a heavy nucleus splits into two lighter nuclei. Fission reaction was used in the first atomic bomb and is still used in nuclear power plants. Fission, like fusion, liberates a great amount of energy. The price for this energy is a loss in mass. A heavy nucleus that splits is heavier than the sum of the masses of the lighter nuclei that result

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