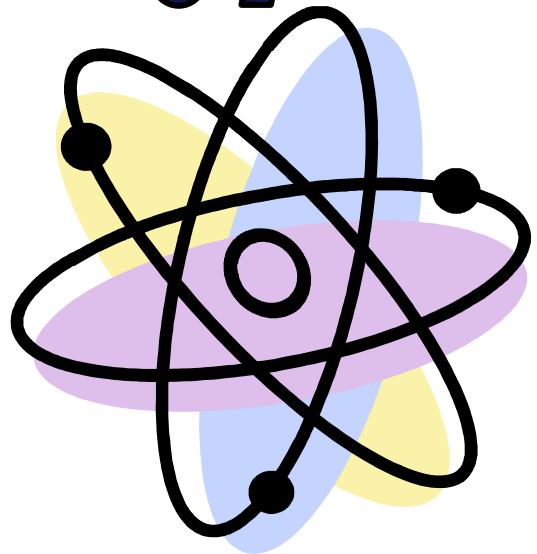


Conservation of Energy



Types of Energy

Heat energy

- Heat energy is the transfer of thermal energy (associated with the motion)
- All matter is made up of particles too small to be seen.
- As heat energy is added to a substance, the temperature goes up indicating that the particles are moving faster. The faster the particles move, the higher the temperature.
- Sources of heat energy: burning material, the sun, and electricity

Solar energy

- *Solar energy* is the energy from the Sun, which provides heat and light energy for Earth.
- Solar cells can be used to convert solar energy to electrical energy.
- Green plants use solar energy during photosynthesis to produce sugar, which contains stored chemical energy.
- Most of the energy that we use on Earth originally came from the Sun.

Chemical energy

- *Chemical energy* is energy stored in particles of matter.
- Chemical energy can be released, for example in batteries or sugar/food, when these particles react to form new substances.

Electrical energy

- *Electrical energy* is the energy flowing in an electric circuit.
- Sources of electrical energy include: stored chemical energy in batteries; solar energy in solar cells; fuels or hydroelectric energy in generators.

Mechanical energy

- *Mechanical energy* is the energy due to the motion (kinetic) and position (potential) of an object. When objects are set in motion or are in a position where they can be set in motion, they have mechanical energy.

- Mechanical Potential energy: Potential energy is stored energy.

Mechanical potential energy is related to the position of an object.

Examples: A stretched rubber band, and water behind a dam

Mechanical Kinetic energy: Kinetic energy is the energy an object has due to its motion. Mechanical kinetic energy increases as an object moves faster. Example: a moving car

The Law of Conservation of Energy

- States that energy cannot be created or destroyed. It may be transformed from one form into another, but the total amount of energy never changes. Energy can be changed from one form to another as follows:

Mechanical energy transformations

Examples of potential ↔ kinetic mechanical transformations might include:

Potential Energy	Kinetic Energy
Water behind a dam	Water flowing over a dam
Stretched rubber band	Released rubber band
Book resting on shelf (position)	Book falling from shelf

Energy transformations may involve other kinds of energy. Examples might include:

Book falling	kinetic → sound, heat
Water moving over dam	Kinetic → electrical (via generator)
Green plants	solar → stored chemical (sugar)

Animals eating food	chemical → kinetic (moving)
Burning carbon-based fuel	chemical → heat energy → electrical
Electrical circuit(plugging electronics into an outlet)	electrical → mechanical, heat, sound, light

***The total amount of energy is conserved.**

Magnetism and Electricity

Magnetism is the force of attraction or repulsion of magnetic materials.

- Surrounding a magnet is a magnetic field that applies a force, a push or pull, without actually touching an object.
- An electric current flowing through a wire wrapped around an iron core forms a magnet.
- A coil of wire spinning around a magnet or a magnet spinning around a coil of wire can form an electric current.

Examples of how magnetism and electricity are interrelated can be demonstrated by the following devices:

Electromagnets

- An electromagnet is formed when a wire in an electric circuit is wrapped around an iron core producing a magnetic field.
- The magnet that results loses its *magnetism* if the electric current stops flowing.

Generators

- A generator produces an electric current when a coil of wire wrapped around an iron core is rotated near a magnet.
- Generators at power plants produce electric energy for our homes.

- A generator contains coils of wire that are stationary, and rotating magnets are rotated by turbines. Turbines are huge wheels that rotate when pushed by water, wind, or steam.
- Thus mechanical energy is changed to electrical energy by a generator. Smaller generators may be powered by gasoline.

Simple electric motors

- An electric motor changes electrical energy to mechanical energy.
- It contains an electromagnet that rotates between the poles of a magnet.
- The coil of the electromagnet is connected to a battery or other source of electric current.
- When an electric current flows through the wire in the electromagnet, a magnetic field is produced in the coil.
- Like poles of the magnets repel and unlike poles of the magnets attract.
- This causes the coil to rotate and thus changes electrical energy to mechanical energy.
- This rotating coil of wire can be attached to a shaft and a blade in an electric fan.

Conservation of Energy

- electrical energy can be transformed to light, sound, heat, and mechanical motion in an electric circuit.
- An electric circuit contains a source of electrical energy, a conductor of the electrical energy (wire) connected to the energy source, and a device that uses and transforms the electrical energy.
- All these components must be connected in a complete, unbroken path in order for energy transformations to occur.

The electrical energy in circuits may come from many sources including:

Source	Energy comes from...
Battery	Stored chemical energy
Solar cell	Light energy from sun
Electrical outlets	Chemical energy (burning fuels)

Electrical energy can be transformed to other forms of energy in a circuit.

Devices used in electrical circuit	Energy Transformations
<u>Light</u> : Light bulb	chemical (battery) → electrical → light & heat
<u>Sound</u> : buzzer, radio, tv	chemical (battery) → electrical → sound
<u>Heat</u> : toaster, stove, or heater	Chemical (fuel) → heat → mechanical (to turn a generator) → electrical → heat (used in device)
<u>Mechanical (kinetic)</u> : fan, motor	Chemical (battery) → electrical → mechanical

Types of Energy Transfer: Conduction, Convection & Radiation

- **Conduction** involves objects in direct contact.
- The transfer of energy as heat occurs between particles as they collide within a substance or between two objects in contact.
- All materials do not conduct heat energy equally well.
- Poor conductors of heat are called insulators.
- The energy transfers from an area of higher temperature to an area of lower temperature.

- For example, if a plastic spoon and a metal spoon are placed into a hot liquid, the handle of the metal spoon will get hot quicker than the handle of the plastic spoon because the heat is conducted through the metal spoon better than through the plastic spoon.
- **Convection** is the transfer of energy as heat by movement of the heated substance itself, as currents in fluids (liquids and gases).
- In convection, particles with higher energy move from one location to another carrying their energy with them.
- Heat transfer occurs when particles with higher energy move from warmer to cooler parts of the fluid.
- Uneven heating can result in convection, both in the air and in water. This causes currents in the atmosphere (wind) and in bodies of water on earth which are important factors in weather and climate.
- **Radiation** is the transfer of energy through space without particles of matter colliding or moving to transfer the energy.
- This radiated energy warms an object when it is absorbed.
- Radiant heat energy moves from an area of higher temperature to an area of cooler temperature.

Energy is a property that enables something to do work.

- **Work** means to (1) apply a force to an object over a distance, and (2) the object moves in response to the force.
- If something has the ability to cause a change in motion, it has energy.
- Energy can cause work to be done, so when we see work done, we see evidence of energy.

Evidence of energy is when work is being done. For example:

- When a toy car at rest is pushed, work is done on the car if it moves. This work (or movement) is evidence of energy.
- When a fan is connected to an electric circuit, it moves, so work was done on the fan. This work (or movement) is evidence of energy.
- When an object is lifted, it moves, so work is done on the object. This work (or movement) is evidence of energy.

A spring scale is used to measure force. Force (including weight) is measured in SI units called newtons (N).

Simple Machines

- A simple machine is a device that helps reduce the amount of force required to do work. Work is done when a force (*effort force*) is applied over a distance.
- A simple machine allows the user to apply a smaller force over a larger distance to move an object.
- Simple machines can also change the direction of the force applied.
- If the distance over which the effort force is exerted is increased, the same amount of work can be done with a smaller effort force.
- This is the principle that simple machines use to reduce the amount of effort force needed to do work.

The design of the simple machines can reduce the amount of force required to do work:

Lever

- A lever is a rigid bar or board that is free to move around a fixed point called a fulcrum.
- The fulcrum may be placed at different locations along the bar.

- A lever can be designed to reduce the amount of force required to lift a weight in two ways:

(1) By increasing the distance from the fulcrum to the point where the effort force is applied, or (2) by decreasing the distance the weight is from the fulcrum.

- By increasing the distance the effort force moves relative to the distance the weight moves, a lever can reduce the effort force needed.

Pulley

- A pulley has a grooved wheel with a rope running along the groove.
- Pulleys can change the amount and/or the direction of the force applied (*effort force*).
- By arranging the pulleys in such a way as to increase the distance that the effort force moves relative to the distance the weight moves, a pulley can reduce the effort force needed.
- Movable pulleys are used to reduce the effort force.
- A single fixed pulley changes only the direction of the force (you pull down and the weight goes up.)

Inclined plane

- An inclined plane is a sloping surface, like a ramp, that reduces the amount of force required to lift an object.
- An inclined plane can be designed to reduce the force needed to lift a weight in two ways:
(1) increase the length of the ramp or (2) decrease the height of the ramp.

- By increasing the distance the effort force moves (length of the ramp) relative to the distance the weight is lifted (height of the ramp), an inclined plane can reduce the effort force needed.

Simple machines, are found in common tools and in complex (compound) machines. For example:

Levers

- Levers that have the fulcrum between where the effort force is applied and the weight is located can be found in tools, for example, scissors (two levers working together) and crowbar.
- Levers that have the fulcrum on the end and the effort is applied in the middle to lift a weight on the other end can be found in tools, for example, tweezers (two levers working together) or a broom.
- Levers that have the fulcrum on the end and the effort force are applied on the other end to lift a weight in the middle can be found in tools, for example, a wheelbarrow, or a bottle opener.

Pulleys

- Pulleys that are fixed, meaning that they are attached to a structure, can be found on the top of a flag pole and on window blinds.
- Pulleys that are moveable, meaning that they are not attached to a structure, can be found on construction cranes and as part of a block and tackle system.

Inclined planes

- Inclined planes with a sloping surface can be found as *ramps* on a truck or wheelchair ramp and stairs.

- Inclined planes that are wedges, one inclined plane or two back-to-back inclined planes that can move are found as knife blades or nails.
- Inclined planes that are wound around a post or cylinder are called screws. Screws can be found in bolts and jar lids.

Wheel and axles

- Wheel and axles consist of two circular objects: a central shaft, called an axle, inserted through the middle of a wheel.
- Wheel and axles can be found as door knobs, steering wheels, screwdrivers, gears, and bicycles wheels.

Complex machines

Complex machines, also known as compound machines, consist of two or more simple machines.

Examples may include:

- scissors consisting of two levers and two inclined planes (wedges);
- a fishing pole consisting of a lever, a wheel and axle and a pulley;
- a bicycle consists of levers (handlebars and handbrakes), wheel and axles (gears, wheels, and pedals), and a number of screws.

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