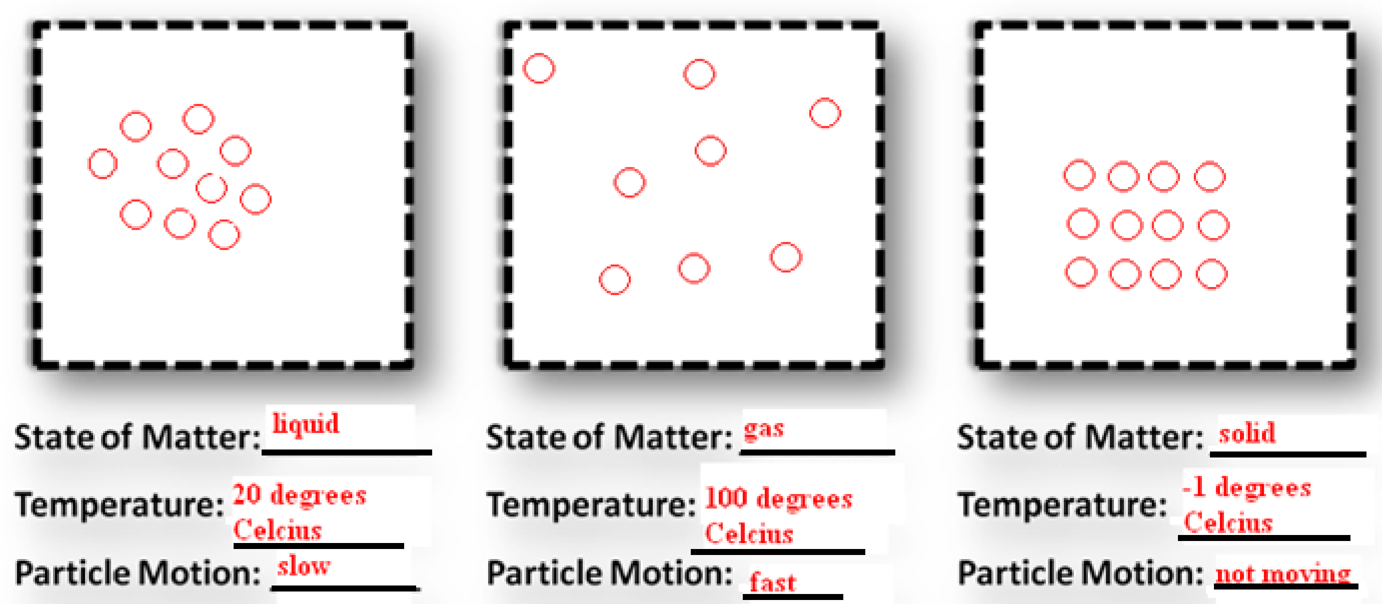
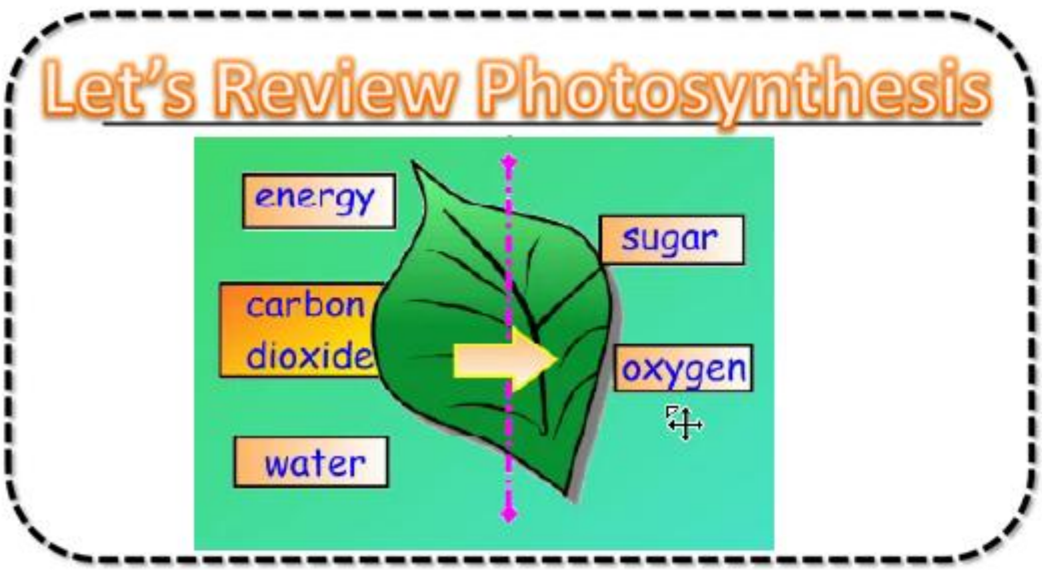
Conservation of Energy

Energy can be in many different **forms**. Students should know sources and properties of the following forms of energy:



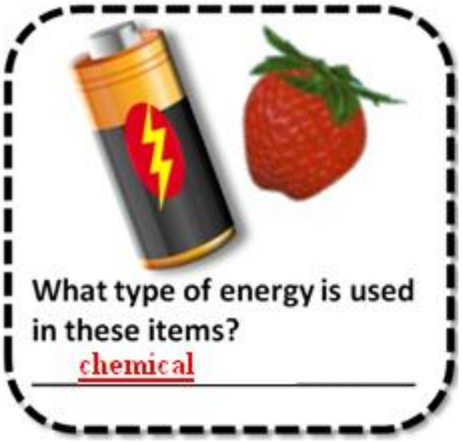
Heat energy is the transfer of **thermal** energy (energy that is associated with the **motion** of the particles of a substance).

- Remember that all **matter** is made up of **particles** too small to be seen (5th grade).
- 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.
- Material (wood, candle wax) that is burning, the Sun, and electricity are sources of heat 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.

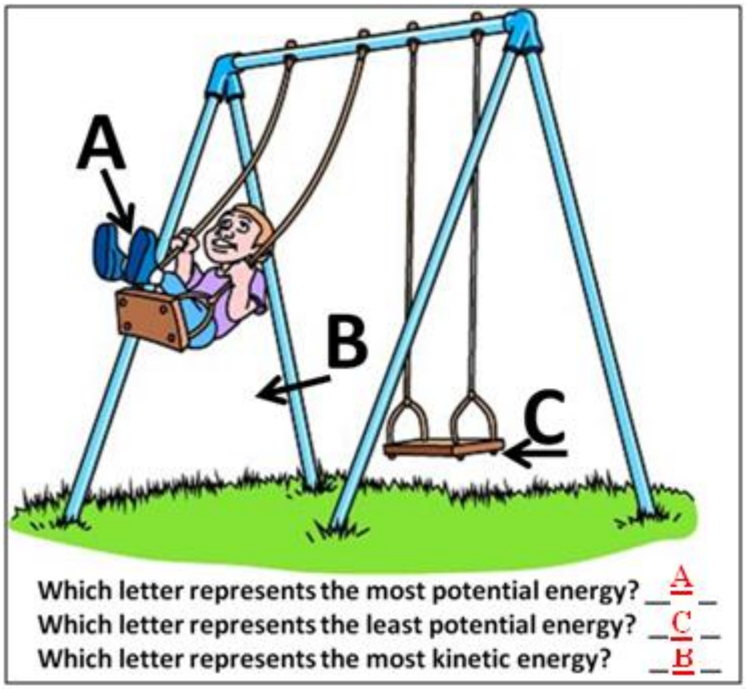


Chemical energy is energy **stored** in particles of matter.

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

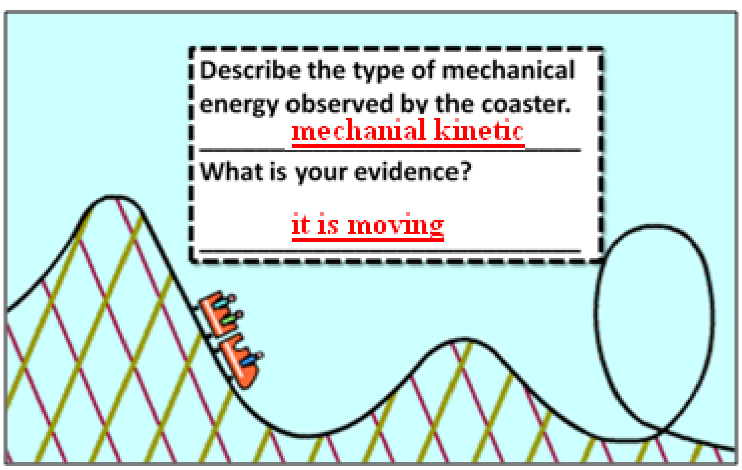
Electrical energy is the energy flowing in an **electric circuit**.

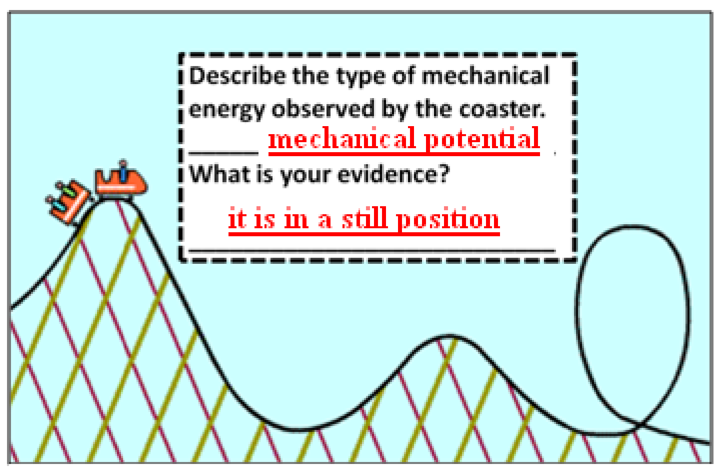
- Sources of electrical energy include: stored chemical energy in batteries; solar energy in solar cells; fuels or hydroelectric energy in generators.



Mechanical energy 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. A stretched rubber band has potential energy. Water behind a dam has potential energy because it can fall down the dam.
- **Mechanical Kinetic energy**: Kinetic energy is the energy an object has due to its **motion**.





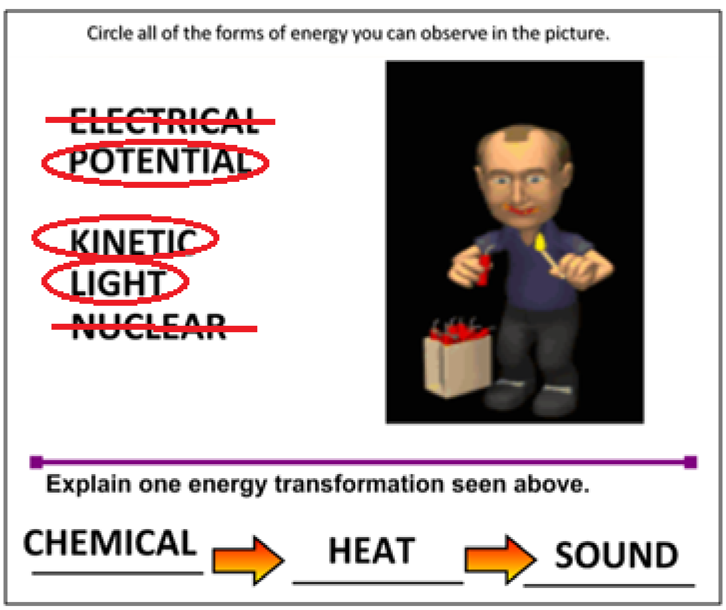
- Mechanical kinetic energy **increases** as an object moves **faster**. A moving car has kinetic energy. If the car moves faster, it has more kinetic energy.

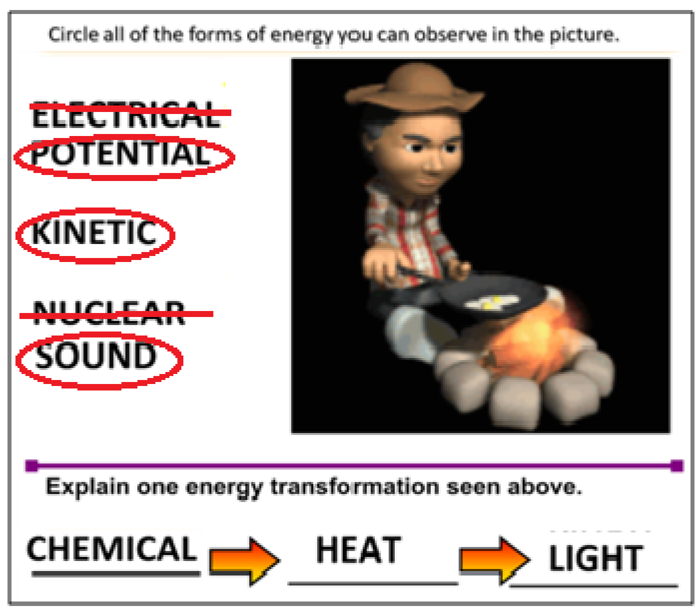
The Law of Conservation of Energy- states that energy cannot be **created** or **destroyed**. It may be **transformed** from one form into another, but the **total** amount of energy **never changes**.

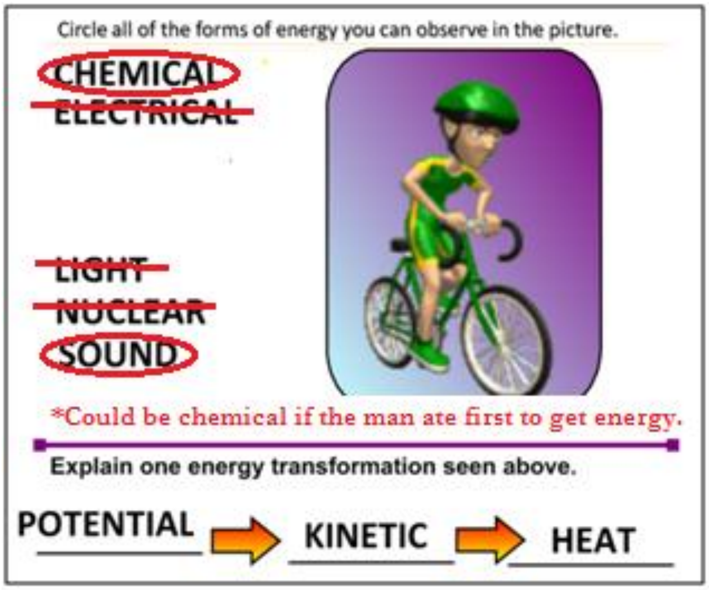
Examples of potential and kinetic mechanical transformations might include:

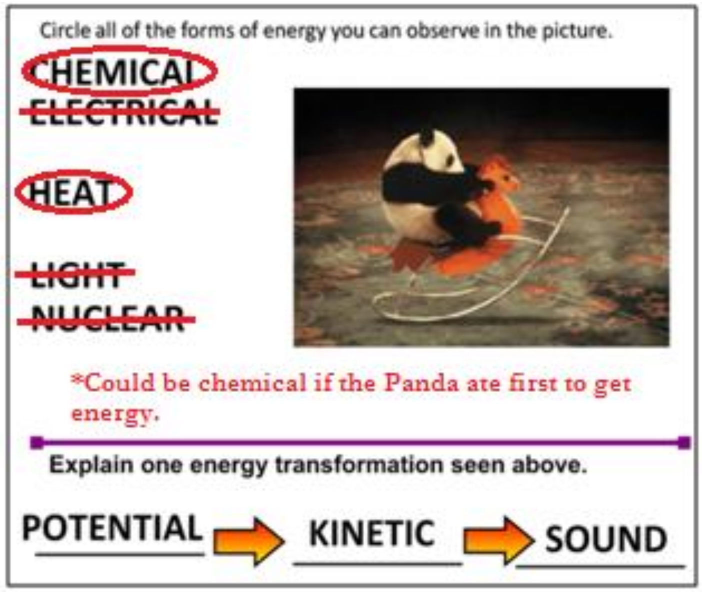
- When water is behind a dam, it has **potential** energy. The potential energy of the water changes to **kinetic** energy in the **movement** of the water as it flows over the dam.
- When a rubber band is stretched, kinetic energy is transformed into potential energy. When a stretched rubber band is released its **potential** energy is transformed into **kinetic** energy as the rubber band moves.
- When a book is lifted to a shelf, **kinetic** energy is transformed into **potential** energy.
- If the book falls off the shelf the **potential** energy is transformed to **kinetic** energy.

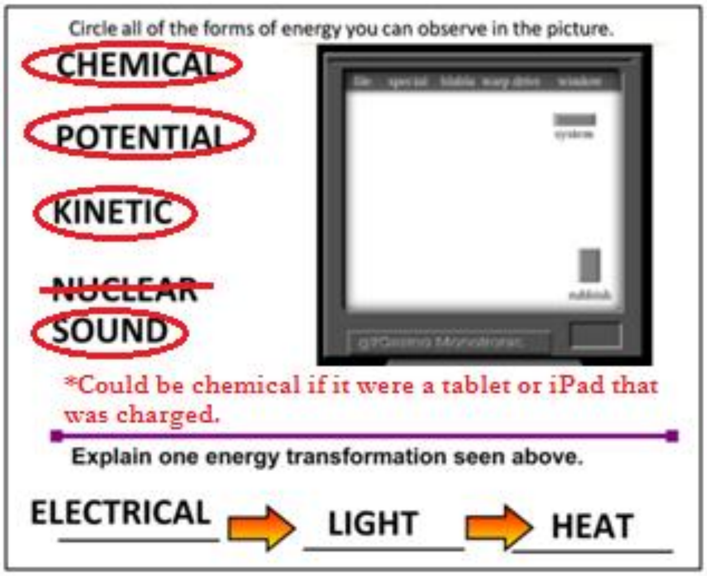
Example	Energy Transformations
Book falling	Kinetic → sound, heat
Water moving over dam	Kinetic → electrical (via generator
Green plants	Solar → stored chemical
Respiration (eating food)	Chemical → kinetic (moving)
Burning carbon-based fuel	Chemical → heat energy, electrical
Electrical circuit (using an outlet)	Electrical → mechanical, heat, sound and light

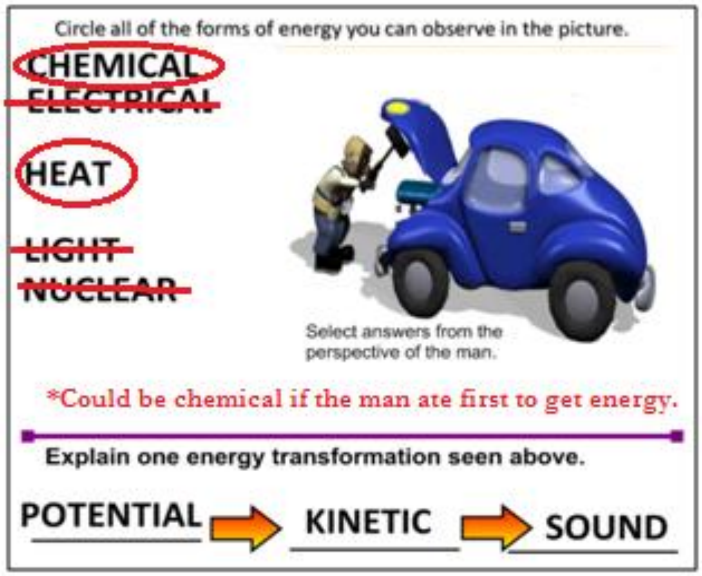




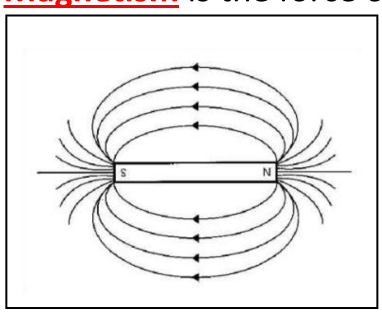








Magnetism is the force of **attraction** or **repulsion** of magnetic materials.



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**.

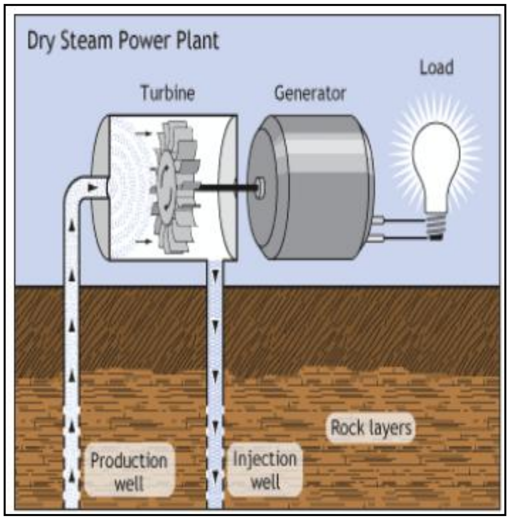
A coil of wire **spinning** around a **magnet** or a magnet spinning around a coil of wire can form an **electric current**.

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

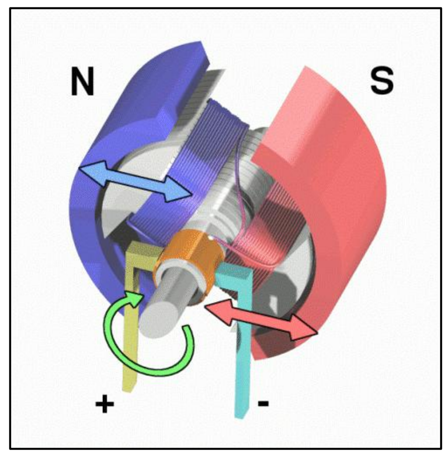
- An **electromagnet** is formed when a **wire** in an electric circuit is wrapped around an **iron core** producing a magnetic field. The

magnet that results loses its **magnetism** if the electric current stops flowing.

- 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**.
- 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.

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.

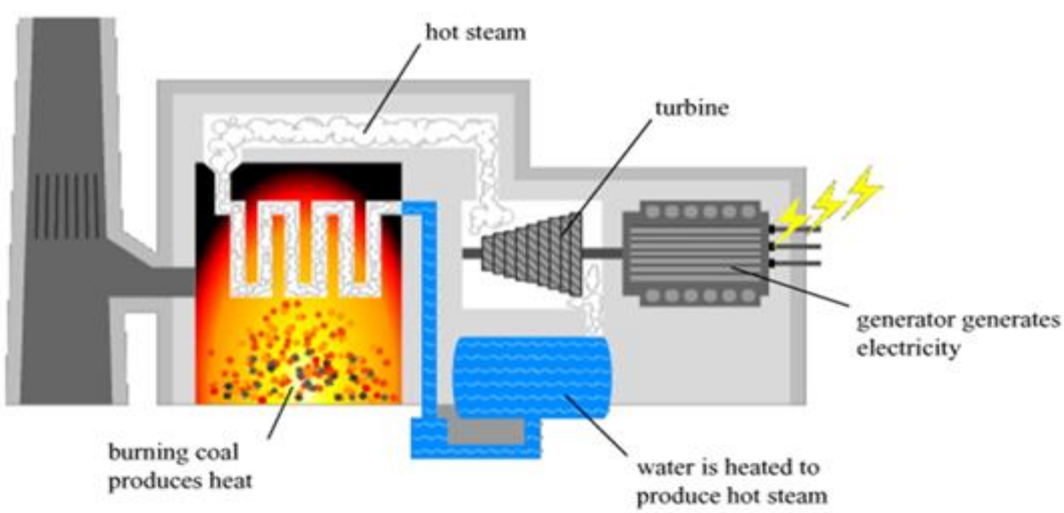
Source	Energy comes from ...
Battery	Stored chemical energy
Solar cell	Light energy from sun
Electrical outlets	**Power Plants** Chemical energy (burning coal) Nuclear energy Geothermal energy

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:

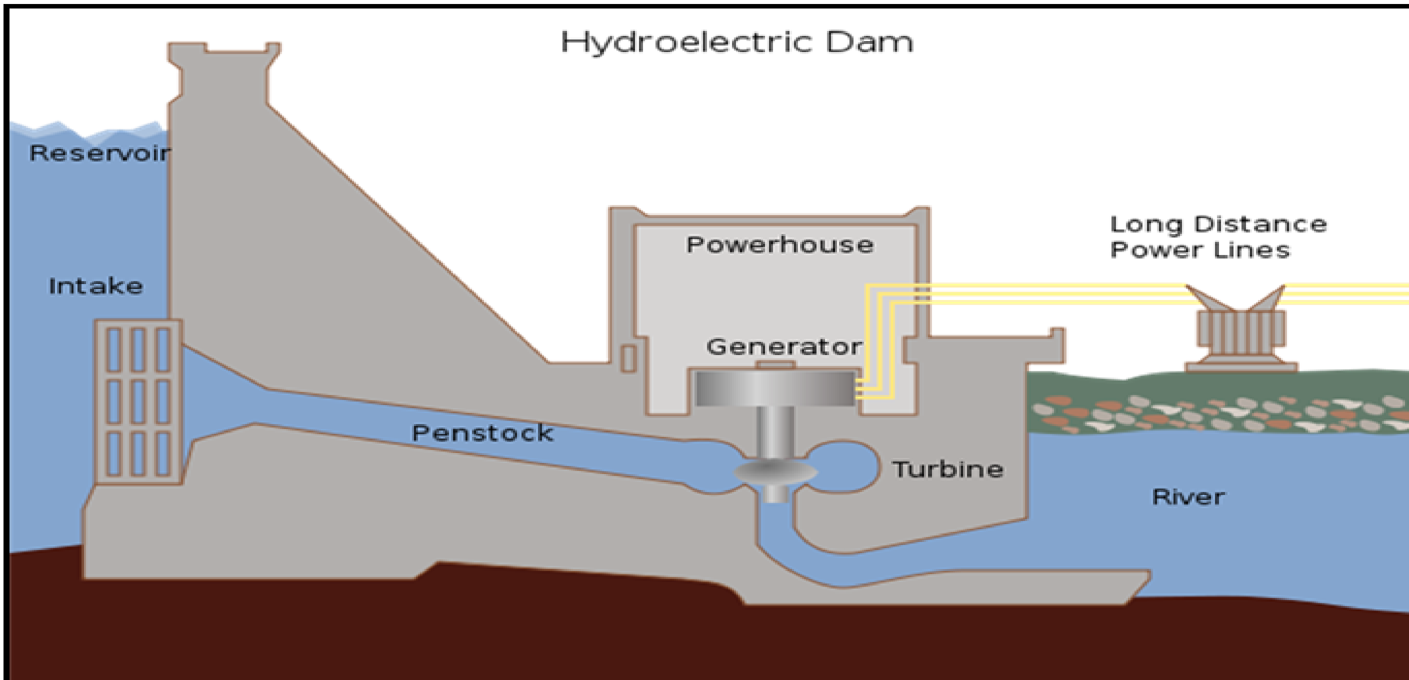
Devices used in electrical circuit	Energy Transformations
light, lightbulb	Chemical (battery) → electrical → light & heat
sound; buzzer, radio, t.v.	Chemical (battery) → electrical → sound
lamp	Electrical (outlet) → heat & light
held hand fan motor	Chemical (battery) → electrical → mechanical
Generators Coal-burning Plant	Chemical energy (coal burning) → heat (steam) → mechanical (turning turbine) → electrical
Generators Hydroelectric Plant	Mechanical energy (moving water from dam) → mechanical (turning turbine) → electrical
Generators Nuclear Plant	Heat (steam) → mechanical (turning turbine) → electrical

Coal-burning Plant



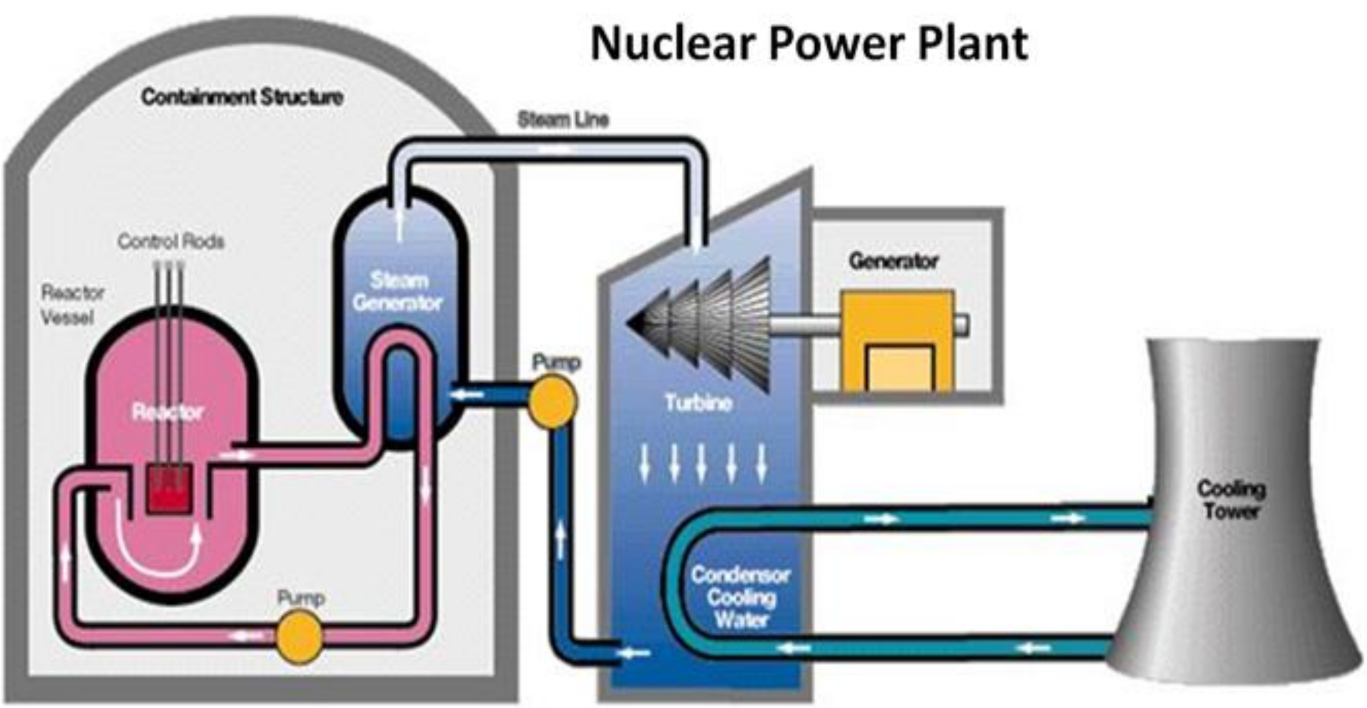
Describe the energy transformations in a coal plant.

Chemical energy (coal burning) → heat (steam) → mechanical (turning turbine) → electrical



Describe the energy transformations in a hydroelectric plant.

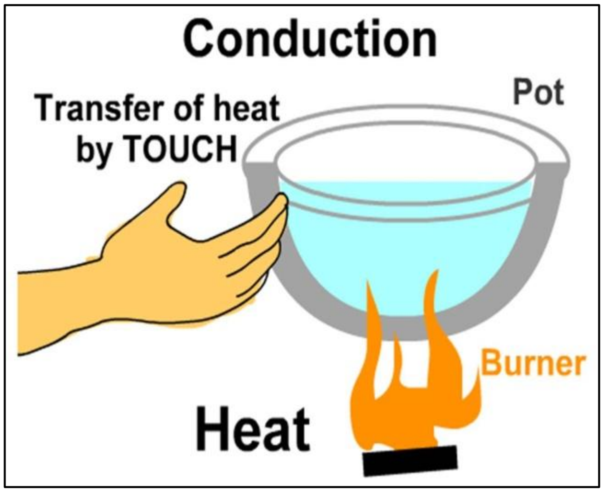
Mechanical **Potential (water behind dam)** → Mechanical (moving water from dam) → mechanical (turning turbine) → electrical



Describe the energy transformations in a nuclear power plant.

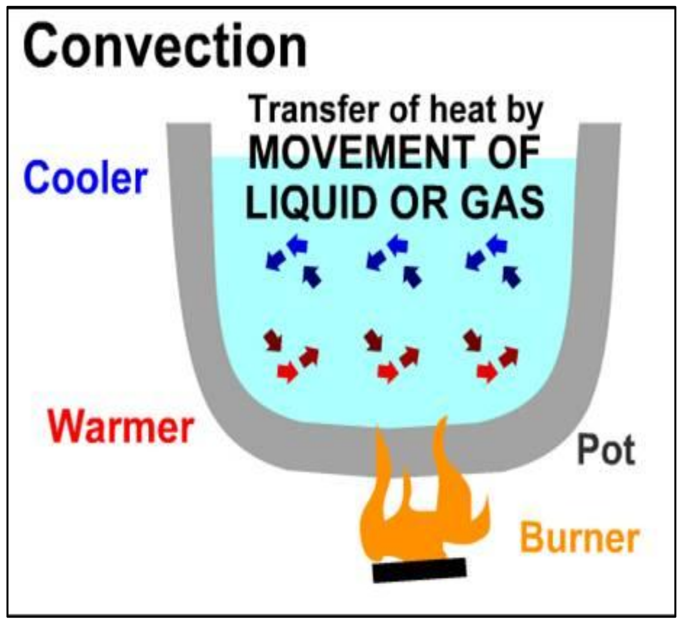
Nuclear reaction → Heat (steam) → mechanical (turning turbine) → electrical

ENERGY TRANSFER

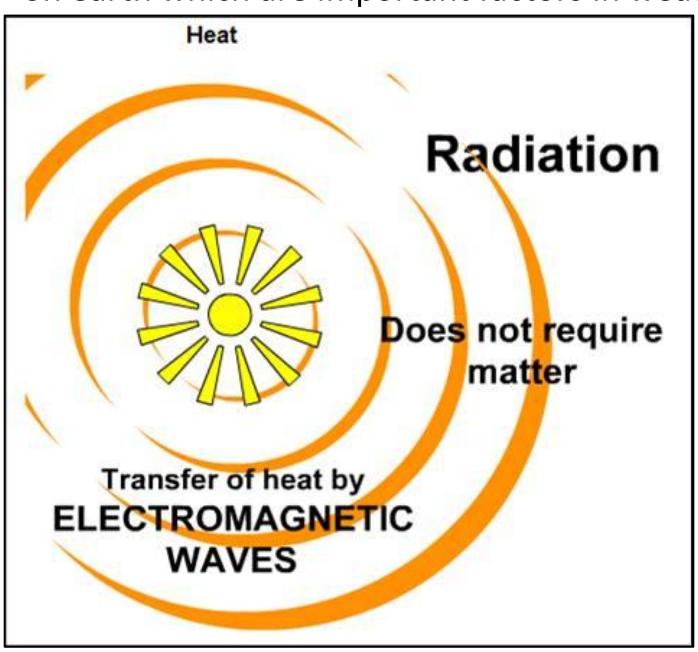


Energy transfer as **heat** can occur in three ways:

- **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).
- 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.

REVIEW MOMENT!

C.	circulating currents	A. radiation
A.	heat transfer through space	B. conduction
B.	direct contact	C. convection

ENERGY & WORK

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 is has energy.

Energy can cause **work** to be done, so when we see work done, we see evidence of energy.

An 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**.
- When a fan is connected to an electric circuit, it moves, so work was done on the fan.
- When an object is lifted, it moves, so work is done on the object.

W= F x D

Unit of force → Newton (N)

Unit of work → Joules (J)

Unit of distance → meters (m)

Directions: Write "yes" if the example demonstrates work is being done or "no" if no work is being done.

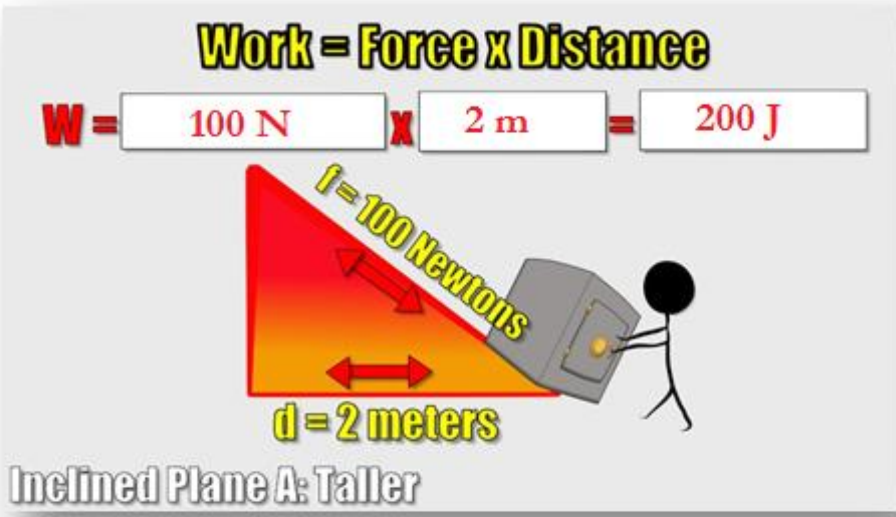
Example	Yes/No
Child playing on a swing	Yes
Mother holding a baby	No
Weight lifter holding weights over his head	No
Writing with a pencil	Yes
Thinking about a math problem	No

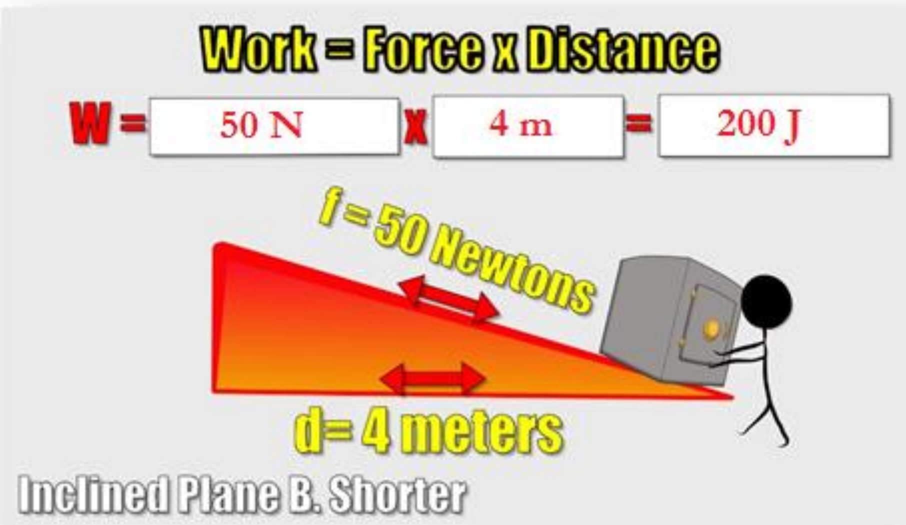
A **spring scale** is used to measure **force**. Force (including weight) is measured in SI units called **newtons (N)**.

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

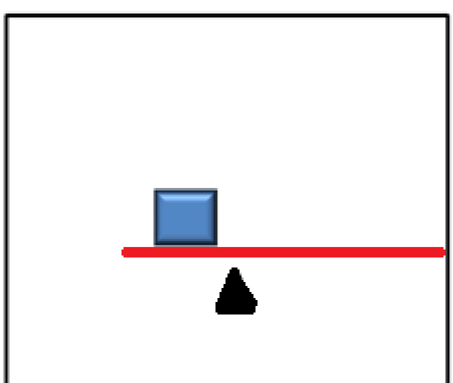
- A **lever** is a **rigid bar** or board that is free to move around a **fixed** point called a **fulcrum**.
- The fulcrum may be placed at different locations along the bar.
- A lever can be designed to **reduce** the amount of **force** required to lift a weight in two ways:



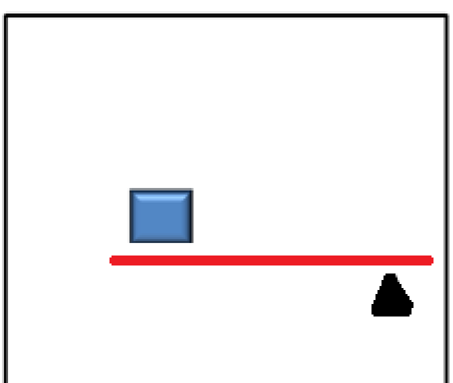


- By increasing the distance from the fulcrum to the point where the effort force is applied, or (2) by decreasing the distance the weight is from the fulcrum.
- By increasing the distance the effort force moves relative to the distance the weight moves, a lever can reduce the effort force needed.
- 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.)
    - An **inclined plane** is a sloping surface, like a **ramp**, that reduces the amount of force required to lift an object.

Draw a diagram of a lever where the fulcrum (△) makes it easier to pick up the box.



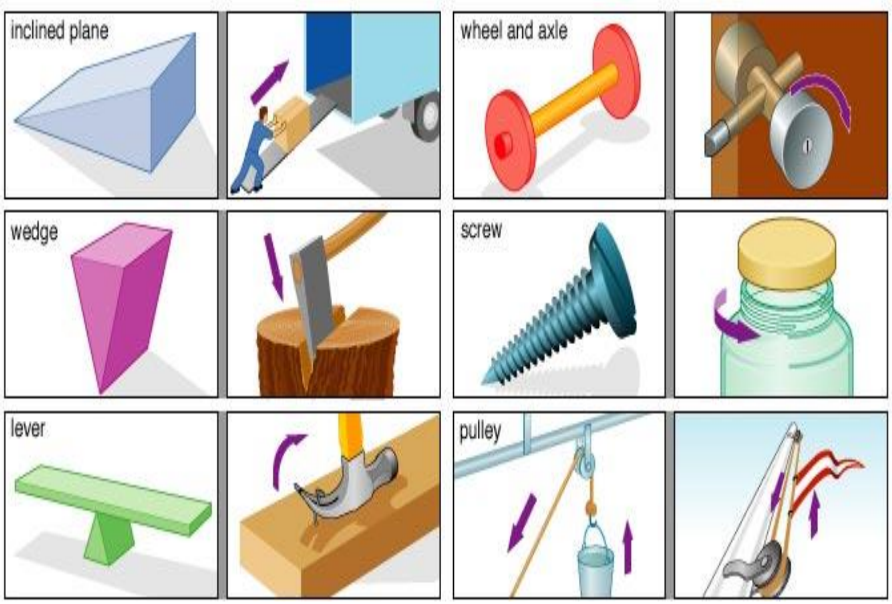
Draw a diagram of a lever where the fulcrum (△)makes it harder to pick up the box.



- An inclined plane can be designed to reduce the force needed to lift a weight in two ways: **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.

COMPOUND/COMPLEX MACHINES

- 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** 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** 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 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, 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.

Write an example of each type of simple machine.

Simple Machine	Example
Inclined plane	ramp, escalator, stairs
Lever	broom, screwdriver, see-saw
Pulley	flagpole, block & tackle
Wheel and axle	wheel, doorknob
Screw	screw, lid, soda bottle top
Wedge	axe, knife blade, scissor blades