ENERGY

3.1 Forms of Energy

Energy is the capacity or the ability to do work.
It is a *scalar quantity.*
The SI Unit of energy is always Joules (J).

1. **Kinetic energy:** The energy in objects with motion.
   $E_k = ½ mv^2$
   Whereby: m is mass, v is velocity and E_k is kinetic energy.

2. **Gravitational potential energy**: Energy stored in raised objects or due to its position in a gravitational field.
   $PE_{gravity} = mgh$
   Whereby: m is mass, g is acceleration due to gravity, h is height and $PE_{gravity}$ is Gravitational potential energy.

3. **Elastic potential energy**: Energy stored in compressed or stretched objects.
   $PE_{Elastic} = ½ kx^2$
   Whereby: k is spring constant, x is displacement from equilibrium and $PE_{Elastic}$ is elastic potential energy

4. **Heat/ thermal energy:** An internal energy that flows between two substances/ objects due to temperature differences. It moves from warmer objects to a cooler object. The flow of heat continues until it reaches thermal equilibrium.
5. **Chemical energy**: This is the energy stored in chemical bonds of molecules. For example, energy is stored in batteries, fuel, and food.
6. **Electrical energy**: This is the energy associated with the flow of electric charge.
7. **Sound energy**: Energy that is produced by vibrating objects. For example, thunder.
8. **Geothermal energy**: Energy from the heat within the earth.
9. **Wind energy**: Energy derived from the motion of air.
10. **Tidal energy**: Energy from the gravitational force between the earth, moon, and sun causing tides.
11. **Solar energy**: Energy from the sun.
12. **Radiant energy**: Energy transferred by electromagnetic waves.
13. **Nuclear energy**: Energy released during nuclear reaction for example nuclear fission.

3.2 Conservation of Energy

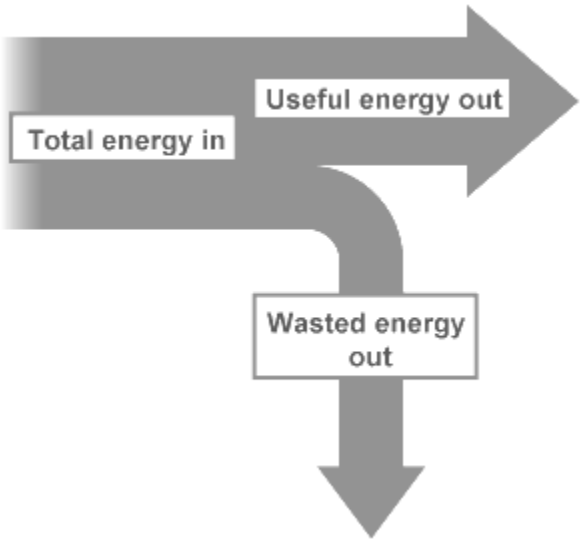
The principle of conservation of energy states that:

Energy cannot be created or destroyed, it is always conserved.

- In a closed system, the total energy before a process is equal to the total energy after the process.
- Energy can change from one form to another, but the total amount remains constant.

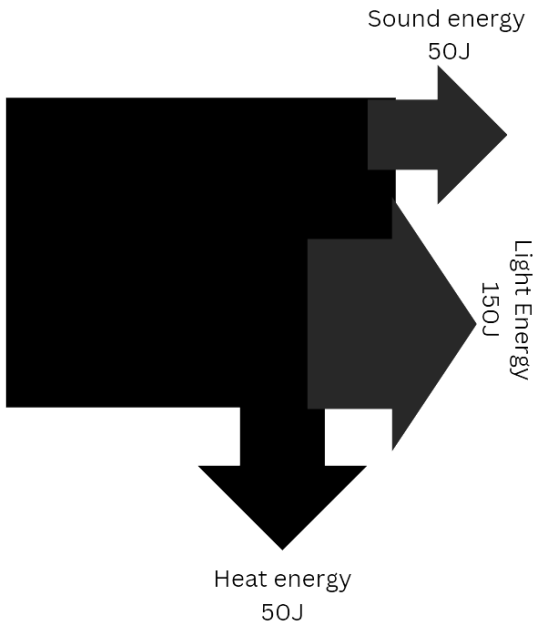
Sankey Diagram

A Sankey diagram is a type of flow diagram that displays the flow of energy. They display the useful and unwanted energy of the system.



- The arrow that goes horizontally is the energy useful. The arrow that goes downwards bends downwards is the unwanted energy.
- The width of the arrow represents the amount of energy flow.
- The thicker the horizontal arrow, the more efficient the system is.

For example: This is a Sankey diagram for a television.



Sound and light energy are useful energy. Heat is the unwanted energy.

Efficiency

Efficiency: This measures how well a system converts input energy into useful output.

Efficiency (n)= $\frac{Useful\ output\ energy}{Input\ energy}$x 100

For example:
Calculate the efficiency of the television, shown in the Sankey diagram above.

Efficiency (n)= $\frac{Useful\ output\ energy}{Input\ energy}$x 100

Efficiency (n)= $\frac{50J+150J}{250J}$x 100
Efficiency (n)= 80%

The television is 80% efficient.

3.3 Work, Power, and Energy

Work

The **work done** is the measure of the product of force and the distance moved in the direction of the force.

Note: No work is done if the object is stationary, r.g. No work is done if someone is standing while carrying a pile of books.

It is the work done when a force of 1 newton (N) moves through 1 meter (m)

Work done = Force x distance moved in the direction of force.

W=Fxd

$W=\Delta E$
W= Change in Energy

E is energy

The Unit of work done is Joule(J)

Joule = Newton x metre

Power

Power is the rate at which work is done.

Power is the rate at which energy is transferred.

Power is work done per unit of time.

Power is energy transferred per unit of time.

The unit of power is watt (W). It is the rate of working of 1 Joule Per Second.

Larger units:

Kilowatts → kW
Megawatts → mW
1kW= 1000W= 10^3W
1 mW= 1,000,000W= 10^6W

Power= $\frac{Work\ done}{Time\ taken}$

Power= $\frac{Energy\ transferred}{Time\ taken}$

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

P=$\frac{F\ x\ d}{t}$

P= F x $\frac{d}{t}$

P= F x Speed

Energy Resources

There are two types of energy resources:

- Renewable energy sources
- Non-renewable energy sources

Renewable energy sources

Renewable sources can be replaced or replenished by nature where they are used.

They cannot be exhausted and are generally non-polluting

Examples of renewable energy Sources

- **Solar energy:** Energy falling on earth from the sun is transferred mostly by light and visible infrared radiation the energy transferred by electromagnetic waves from the sun is stored as internal energy in solar panels.
  It can be used as an electricity generator, heater, or cooler, for education Purposes, and remote power Systems.

- **Wind energy**: Harnesses Kinetic energy of the moving air. For example, wind turbines convert the mechanical energy of the wind to electrical power.

- **Wave energy:** This is the Kinetic energy from the movement of ocean waves. It can be used to generate electricity and can help power small islands providing

- **Geothermal energy:** This is an energy that is derived from the Earth's internal heat. For example, dry steam power Plants extract High-temperature steam directly from underground reservoirs to drive turbines connected to generators.

- **Biofuels:** Fuels that are produced from organic materials: For example, biomass, can include organic matter such as Plants, crops, and organic waste.

- **Chemical energy**: can be stored in biofuels such as alcohol (ethanol). Biogas is a mix Of methane and carbon dioxide with an energy content of about ⅔ that of natural gas.

Non-renewable energy

Non-renewable energy sources cannot be replaced once used up.

- **Fossil fuels**: such as coal, oil (petroleum), and natural gas are non-renewable. They are used to generate electricity, for transportation purposes, and for industrial processes. When burnt, they release carbon dioxide and other pollutants.

- **Nuclear fuels**: These are materials that can Undergo nuclear fission reactions releasing a significant amount of energy. It can be used to produce electricity. They do not pollute the atmosphere with carbon dioxide or Sulfur dioxide but they generate radioactive waste materials. **Radioactive**: Materials that emit radiation.