Heat and Energy

Heat and Temperature

On returning from school, when Ravi touched the iron gate of his house, he found it to be extremely hot. Later, he touched other things made of iron present inside his house and found that they were not hot. Then, he touched other substances (not made of iron) present in his house to determine whether they were hot or cold. He listed the various substances observed in the table given below.

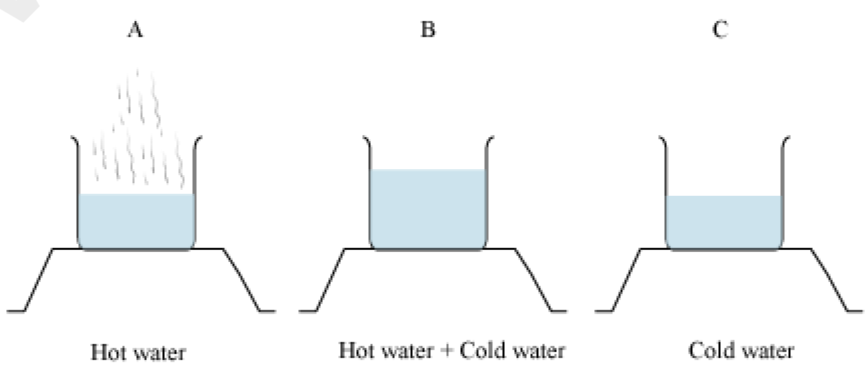
Substances	Hot/ Cold
Tea	Hot
Coffee	Hot
Ice	Cold
Ice cream	Cold
Cooked rice	Hot
Frozen meat	Cold

Try to make a table listing some other substances, which are present in your house and classify them as hot or cold. **But how do you decide whether a substance is hot or cold? Can you always tell whether a substance is hot or cold simply by touching it?** The following activity will help you understand better.

Measurement of Temperature

Activity:

Take three containers and label them as **A, B**, and **C**. Take hot water in container **A**, and cold water in container **C.** In container **B**, mix hot and cold water in equal amounts. Now, place your left hand in container **A** and right hand in container **C** for two minutes. Then, dip both your hands in container **B**.



What can you say about the water present in all three containers? Note your observations in the table given below.

Container	**Hot/Cold**
A	
B	
C	

What is your observation for container B? Is the water in container B hot or cold?

When you dip your hands in container **B**, your left hand will tell you that the water is cold, while your right hand will tell you that the water is hot. Thus, you will not be able to distinguish whether the water present in container **B** is hot or cold.

From this activity, we can conclude that we cannot decide whether a substance is hot or cold just by touching it. Thus, we need something more reliable than our sense of touch to decide whether a substance is hot or cold.

The measure that can be used to detect the degree of hotness and coldness of a substance is called temperature. More the temperature of a substance, the hotter it will be.

Thermometer

The device that is used to measure the temperature is called a **thermometer.**

The scales used to measure temperature can either be degree Celsius or degree Fahrenheit.

The thermometer in which liquid is used as a thermometric fluid is called a liquid thermometer. The two most commonly used liquids are mercury and alcohol.

Use of mercury in thermometers

1. Mercury has a very high boiling (357 ºC) and freezing point (-39 ºC). Thus it can be used over a wide range of temperature.
2. Mercury has a large expansion over a small change in temperature.
3. It does not stick to the glass of the capillary tube.
4. It is an opaque and shiny liquid and thus it can be easily seen through the glass tube.

Use of alcohol in thermometers

1. The freezing point of alcohol is very low (-100 ºC). Thus, it can be used to measure temperature in regions such as Arctic and Antarctic.

2. Alcohol expands more quickly than mercury.

3. Alcohol is brightly coloured. Hence, it can be easily seen in the capillary glass tube.

Types of thermometer

There are two types of thermometers: **clinical thermometers and laboratory thermometers**. The table given below tells us the difference between them.

Types of Thermometers	
Clinical thermometer	**Laboratory thermometer**
This thermometer is used in homes. It is basically used to measure the temperature of humans. A clinical thermometer has a temperature range of only 35 ºC to 42 °C. Can you tell the reason why? This is because our body temperature never goes below 35 °C or above 42 °C. 	This thermometer is used to measure the temperature of all things, except the human body. It is a complex device. A laboratory thermometer has a temperature range of -10 ºC to 110 ºC. 

Why can we not use a laboratory thermometer to measure the body temperature of humans? Let us perform a small activity to understand.

Activity:

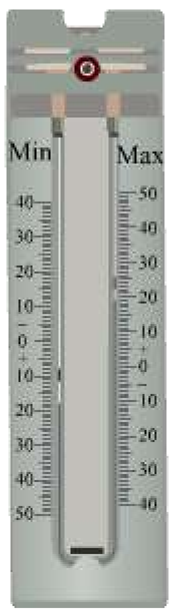
Take a beaker full of water. Now, dip a laboratory thermometer in it. Make sure that it touches neither the bottom of the beaker, nor the walls of the beaker. You will see that the mercury line rises for some time, but then ceases to rise. Note the reading where the mercury stagnates. This is the temperature of water. Take out the thermometer.

What do you observe? The mercury starts falling rapidly. This means that with a laboratory thermometer, temperature has to be read when placed in water. On the other hand, to measure the body temperature, the thermometer has to taken out of the mouth to note the reading. Thus, it is not convenient to use a laboratory thermometer.

Do You Know?

Mercury is a very toxic substance. Hence, now-a-days digital thermometers have become more popular, which do not contain mercury.

There is another thermometer which is particulary used to measure maximum and minimum temperatures of a day. Thia thermometer is known as Maximum-minimum thermometer.



Temperature Scale

The three temperature scales that are in use are Celsius scale, Fahrenheit scale, and Kelvin scale. However, the SI unit of temperature is Kelvin (K).

0 K = -273 ^{o}C

273 K = 0 °C

373 K = 100 °C

Conversion of Temperature Scale

- Degree celsius to Kelvin scale

  Temperature in Kelvin = Temperature in °C + 273

  For example 40°C = (40 + 273) K = 313 K

Conversely, 343 K = (343 − 273) K = 70 °C

- Degree celsius to Fehrenheit

Temperature in Fehrenheit (°F) = °C × 9/5 + 32
or, Temperature in degree celsius (°C) = (°F – 32) × 5/9
For example human body temperature is 37 °C = 37 × 9/5 + 32 = 98.6 °F

Precautions while using thermometer

- Thermometer used be washed well before and after every use with an antiseptic like alcohol.
- Washing should not be done in hot water.
- Keep the mercury level straight or along the line of sight while reading the thermometer.
- Do not hold the thermometer by its bulb while taking the readings.
- handle the thermometer with care as it is made up glass.

How is temperature a measure of heat?

In the SI system, the unit of temperature is Kelvin, whereas the unit of heat is joule (J). Still temperature measurement can tell us about the heat energy contained in a body.

$$Q = m \times C \times t$$

Other common units of heat are calorie (cal) and kilocalorie (kcal).
1 calorie is the amount of heat energy required to increase the temperature of 1 g of water by 1 ^{o}C.

1 kcal = 1000 cal
1 cal = 4.2 J

Thus, we can define heat and temperature as follows —

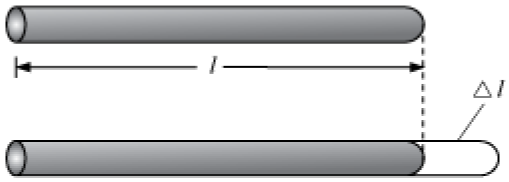
Heat − It is a form of energy which causes in us the sensation of hotness or coldness.

Temperature − It is measure of the degree of hotness or coldness.

Expansion of Solids

Linear Expansion of Solids (Δ*l*)

It is also known as expansion of length.



Linear expansion

Linear expansion ∝ Original length × Temperature change

$\Delta l \propto l\Delta T$

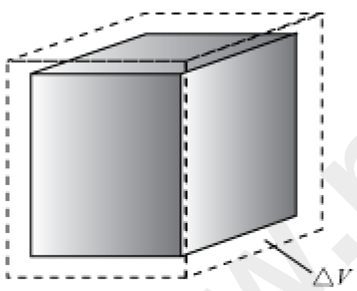
$$\frac{\Delta l}{l} = \alpha_l \Delta T$$

α_l → Coefficient of linear expansion (characteristic property of material)

Generally, metals have high α_l values.

Volume Expansion of Solids (Δ*V*)

It is also called cubical expansion. It occurs in complete volume of body.



Volume expansion

ΔV ∝ Original volume × Temperature change

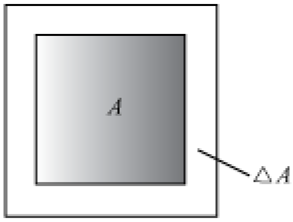
$\Delta V \propto V\Delta T$

$$\frac{\Delta V}{V} = \alpha_V \Delta T$$

α_V → Coefficient of volume expansion

α_V varies with temperature. It becomes constant at high temperature.

Area Expansion of Solids (ΔA)



Area expansion

$\Delta A \propto$ Original area × Temperature change

$\Delta A \propto A\Delta T$

$$\frac{\Delta A}{A} = \alpha_a T$$

$\alpha_A \rightarrow$ Coefficient of area expansion

Relationship between α_l, α_A and α_V

For a solid cube of length l,

Volume, $V = l^3$

Area, $A = l^2$

∴ Change in volume, $\Delta V = (l + \Delta l)^3 - l^3$

$\simeq 3l^2\Delta l$ [In eq.$\Delta l^2$and Δl^3 have been neglected]

Since Δl is small compared to l,

$\Delta V = \frac{3V\Delta l}{l} = 3V\alpha_l \Delta T$

Which gives,

$$\therefore \alpha_V = 3\alpha_l$$

Change in area, $\Delta A = (l + \Delta l)^2 - l^2$

$\simeq 2l\Delta l$

$\Delta A = \frac{2A\Delta l}{l}$

$\Delta A = 2A\alpha_l$

$\boxed{\therefore \alpha_A = 2\alpha_l}$

Thus,
$\alpha_l : \alpha_A : \alpha_V = 1 : 2 : 3$

Expansion of Liquids and Gases

Expansion of Liquids

How is expansion in fluids different from solids?

Liquids do not have linear or surface dimensions as they acquire the shape of the containing vessel.

We can only record the thermal expansion of liquids relative to the container.

Because liquids have definite volume, so we can define only the volumetric expansion coefficient for a liquid.

$V_2 = V_1(1 + \beta\Delta T)$
where, V_2 = Final volume of liquid

V_1 = Initial volume of liquid
ΔT = Change in temperature

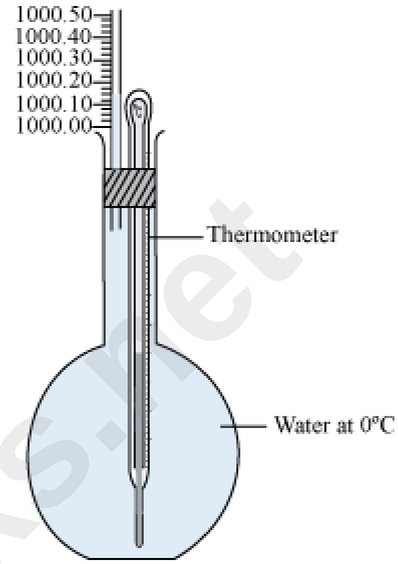
β = Volumetric expansion coefficient of liquid

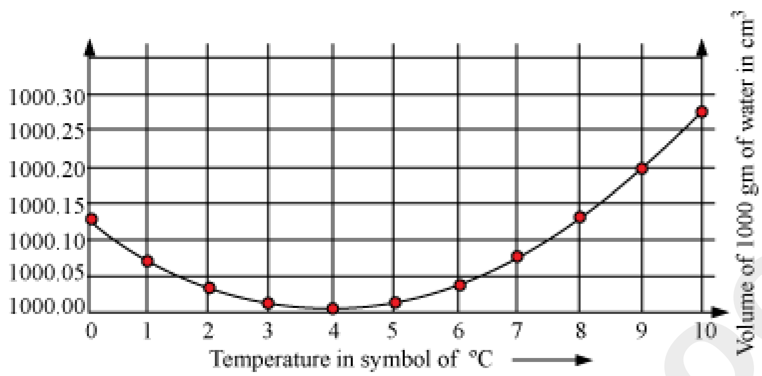
Anomalous Expansion of Water

Liquids generally expand on heating and contract on cooling whereas water shows a peculiar behaviour of expanding above and below 4°C.

Let us perform an experiment to see the peculiar behaviour of water around 4°C.

Take 1 kg of water at 0°C in a flask. Put a fine capillary tube and a sensitive thermometer into this flask. Volume of water is found to be 1000.14 cm^3. Now heat the water up to 4°C. You will observe that the volume of the water now becomes 1000 cm^3. Now, plot a volume versus temperature curve on a graph. The graph will look as follows.

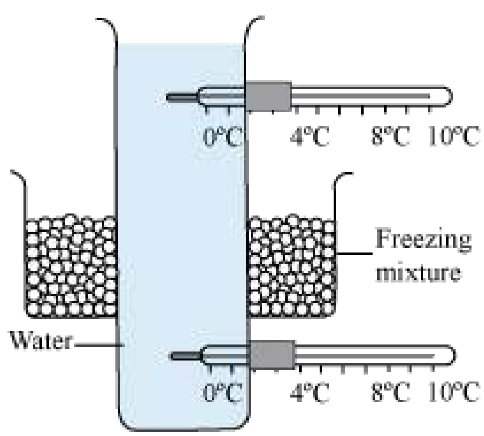




Hope's Experiment

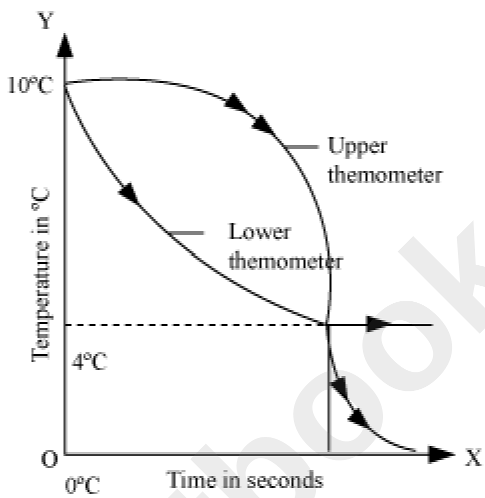
Set up

The experimental set up consists of a metal cylinder, having circular trough around its middle. It has two openings on the same side for putting two thermometers into the cylinder. The cylinder is filled with water at about 10°C and the trough contains freezing mixture of ice and salt.



Observations

- Readings of the upper thermometer do not alter whereas readings of the lower thermometer fall rapidly.
- The reading of the lower thermometer stabilises at 4°C whereas reading of upper thermometer starts falling till 0°C.
- A thin crust of ice forms at the top of water in the cylinder.



Explanation

Water around the ice region cools down to 4°C and gets heavier. As the density of water is the maximum at 4°C, the water from the middle portion settles down near the bottom of the cylinder. Thus, the temperature at the lower thermometer is found to be 4°C. As the water from the middle portion settles down to the bottom, warm and lighter water from the bottom portion blows up to fill up the place. Therefore, convection current is set up at lower portion of the cylinder.

Because of this convection current, the temperature of the water gradually goes down to 0°C towards the upper portion of the trough. Hence, the reading of the upper thermometer gradually goes down to 0°C.

Conclusions:

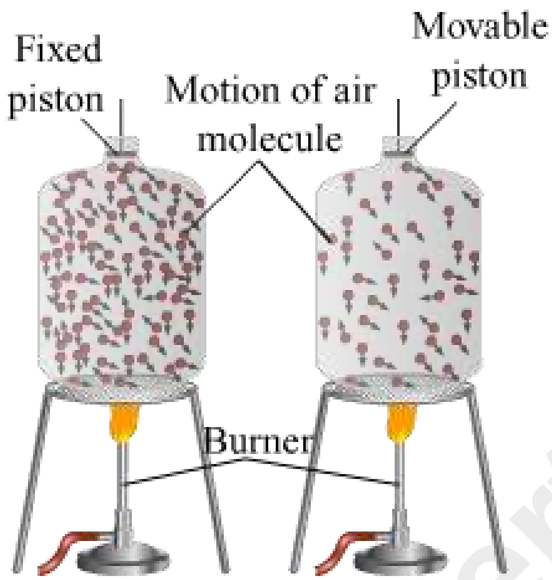
1. Density of water is the maximum at 4°C.
2. Ice formed at 0°C is lighter than water at the same temperature.
3. Freezing of water will start from top to bottom, but water in lower regions will stay at 4°C.

Let us see how this anomalous expansion of water affects living organisms.

Expansion of Gases

- Gases do not have fixed volumes and shapes and gases expands on heating.

  Suppose a gas of equal volumes is kept in two vessels. The first vessel has a fixed piston and the second one has a movable piston as shown. Now, heat the two vessels for some time. We will observe that the volume of the gas in first vessel does not increase; instead its pressure increases. In the second vessel, the volume increases.



  Thus, in case of gas, its expansion is measured by keeping its pressure constant. Volumetric expansion of a gas is given as
  $V_2 = V_1(1 + \beta\Delta T)$

  where, V_2 = Final volume of gas
  V_1 = Initial volume of gas

  ΔT = Change in temperature
  β = Constant pressure expansion coefficient of gas

- Gases expand on heating provided its pressure is kept constant. They undergo cubical expansion on heating.

- Increase in volume of different gases for the same rise in temperature is the same.

- Density of a gases decreases appreciably with increase in temperature. This is because of the increase in the the volume of the gases in appreciable amount with temperature.

- The force of attraction between the molecules of a gas is negligible. Thus on heating, the molecules' average kinetic energy increases further because of which they move violently in all the space available. Due to this, the inter-molecular separation increases further. Hence, the gas expands on heating.

Energy Flow and Its Importance

Ecosystem

An ecosystem is composed of biotic and abiotic components. Biotic components are producers, consumers and decomposers. Abiotic components are light, heat, rain, humidity, inorganic and organic substances.

Sun is the most significant source of energy for all ecosystems. The energy received on the Earth from the Sun is consumed in different ways. A handsome amount of the incident energy is absorbed by the Earth's atmosphere itself.

Out of the remaining portion, some is utilised in heating of land and water and the rest falls on plants. Plants use only about 0.02% of the energy falling on it for producing their food and thus are called producers.

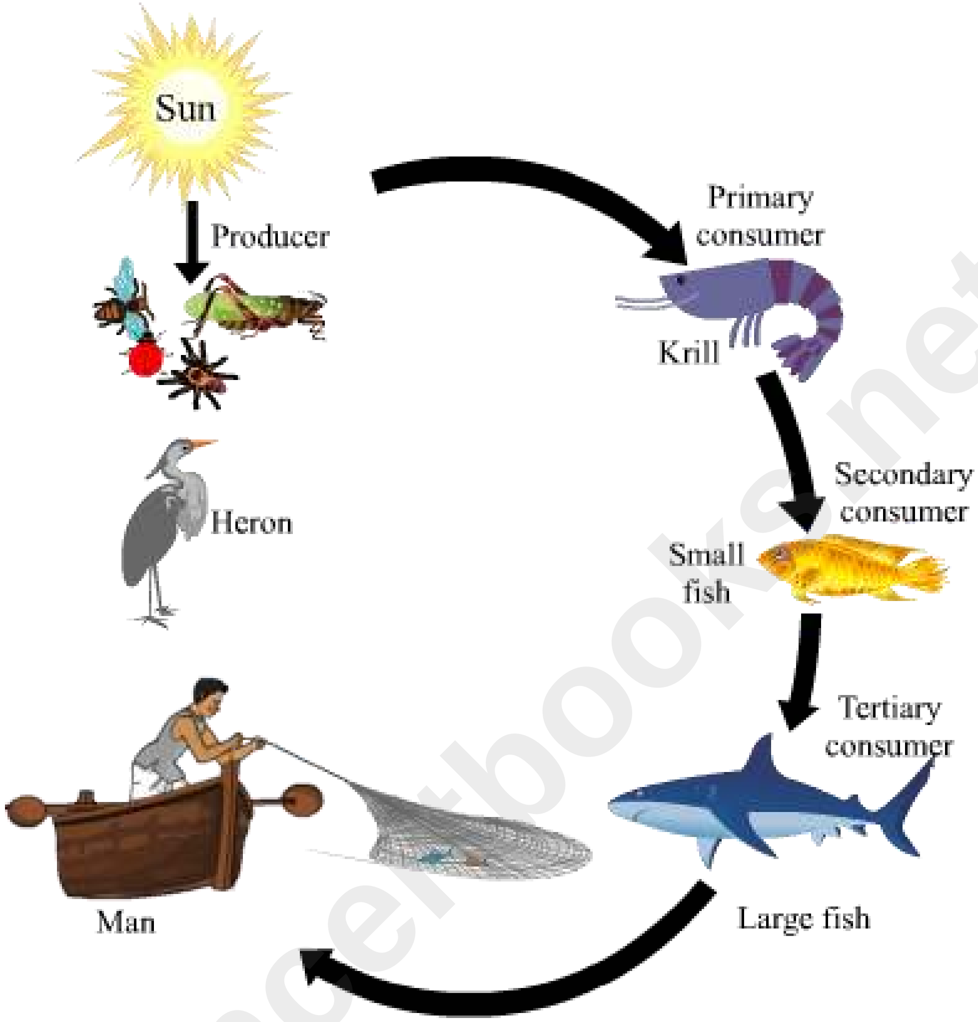
Food Chain

Food chain is a link in which unidirectional flow of food energy takes places from producers to different consumers.

Main producers are photosynthetic plants and bacteria. Food synthesized by the producers is first utilised by primary consumers (e.g. krill).

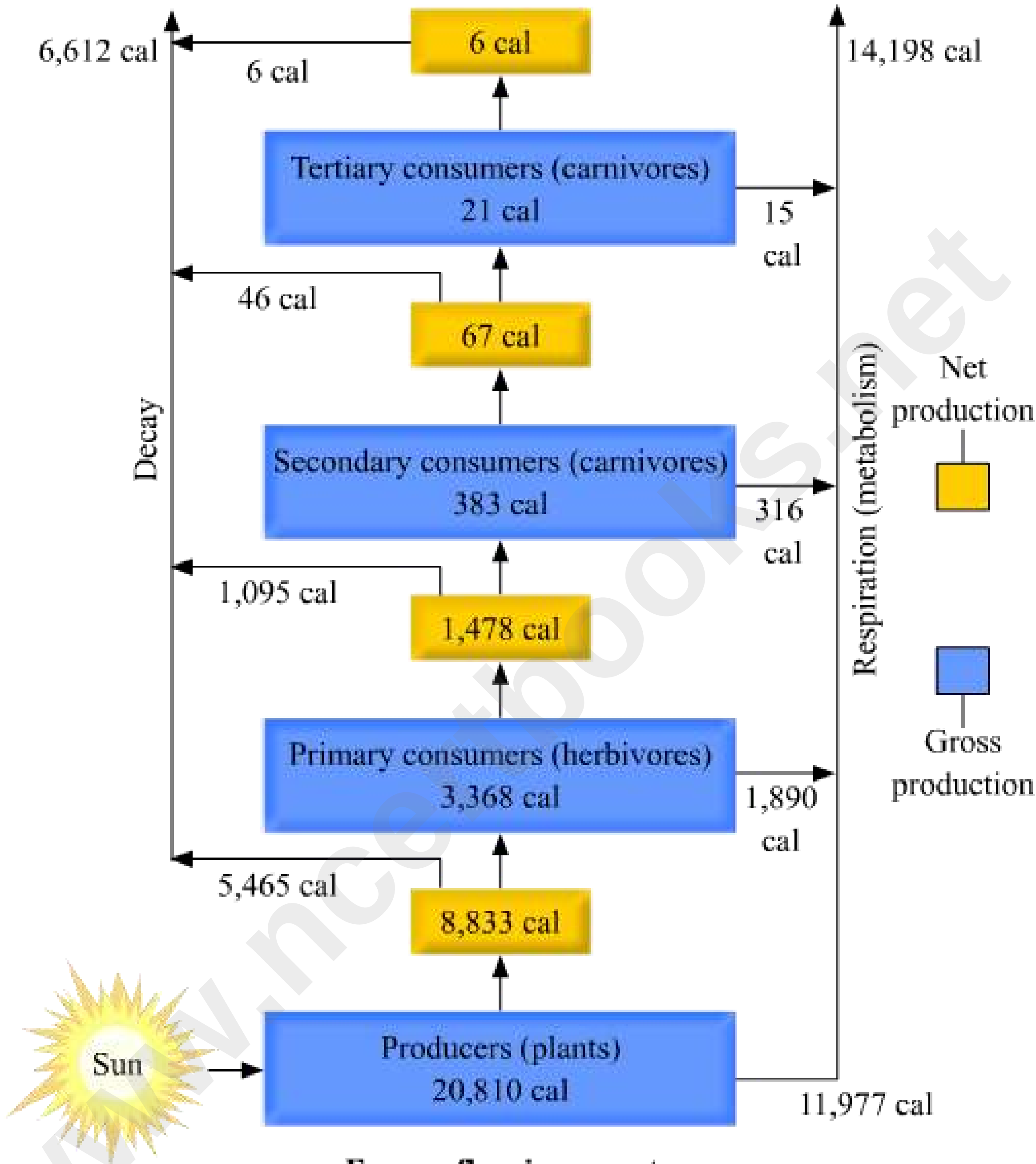
These primary consumers are then eaten up by the secondary consumers (e.g small fish) which in turn are consumed by the tertiary consumers (e.g. big fish).

The humans may be considered as the last consumers in this chain of energy transfer when he eats the fish.



Energy Flow in Ecosystem

Plants first synthesize food through photosynthesis. The chemical energy thus gets stored in them and is known as gross primary production.



Energy flow in ecosystem

Firstly, the producers themselves uses the energy stored in them for respiration. Then the rest of energy, known as net primary production, is stored in them for their growth, development and other important metabolic processes.

Next, the primary consumers (herbivores) consume these producers and obtain a small part of energy from them. The rest of the energy gets wasted in decay of the producers.

Now, a small part of the energy obtained by the primary consumers is used up in respiration to perform their various metabolic activities. The remaining part of the obtained energy is stored in them as food.

Now, the secondary consumers (carnivores) consume a small part of the energy stored as food in primary consumers and rest of the energy is wasted in decay of primary consumers.

The secondary consumers make use of a small part this obtained energy in respiration through which they can perform their metabolic processes. The rest of the energy is stored in them as food.

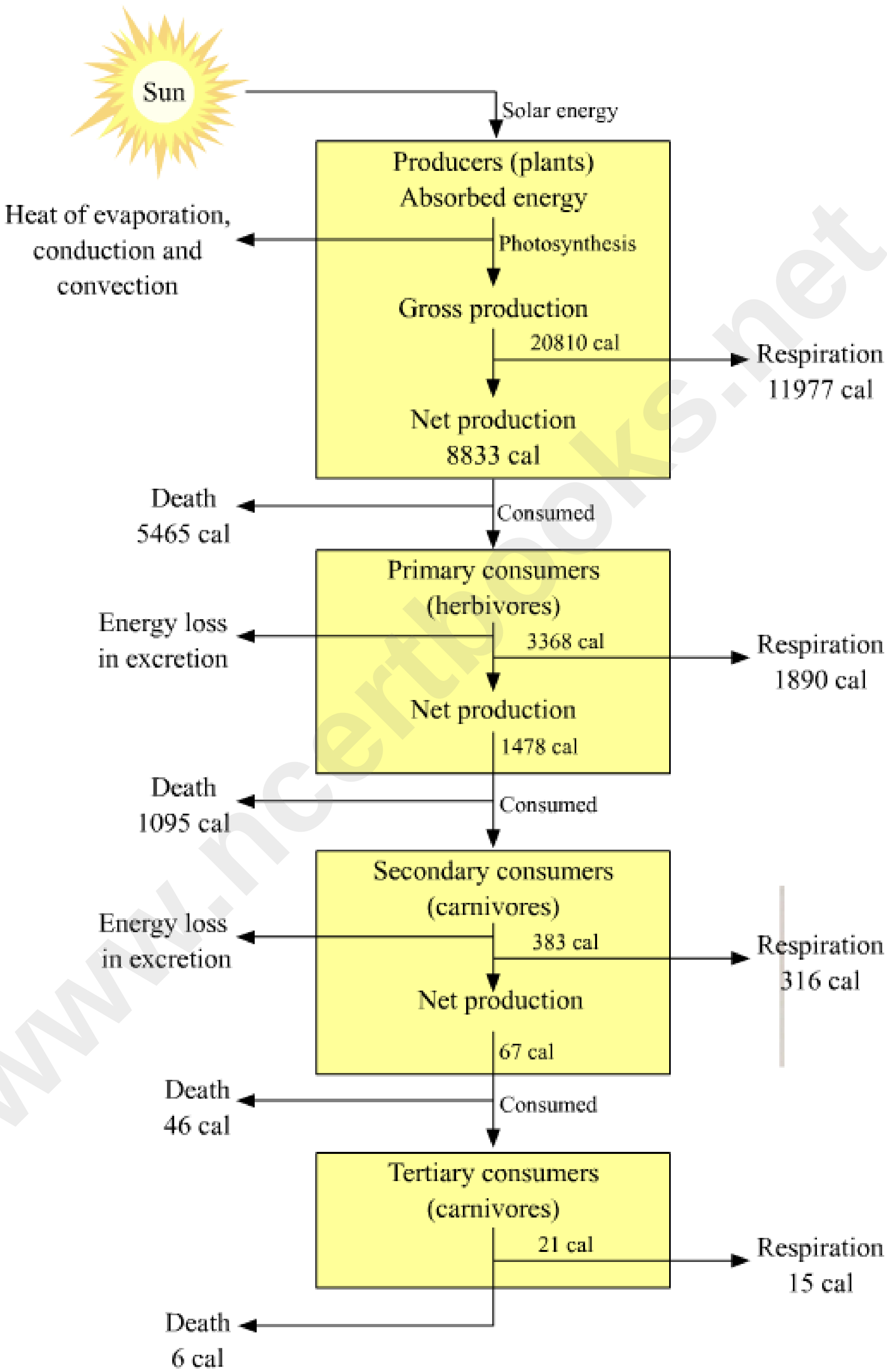
Lastly, the tertiary consumers (carnivores) obtain a small amount of energy as food from the secondary consumers and remaining is wasted in decay and decomposition of secondary consumers.

A small part of the energy obtained by tertiary consumers is used up in respiration and the rest is utilised in their decay.

This shows that the energy flow in the ecosystem is linear and moves in a fixed direction.

But at the end, energy reaches to an un-useful state which can never return to the Sun to make the process of energy flow cyclic.

A simple illustration of energy flow in the form of food chain is shown below


Sun
Solar energy
Producers (plants)
Absorbed energy
Heat of evaporation, conduction and convection
Photosynthesis
Gross production
20810 cal
Respiration 11977 cal
Net production 8833 cal
Death 5465 cal
Consumed
Primary consumers (herbivores)
Energy loss in excretion
3368 cal
Respiration 1890 cal
Net production
1478 cal
Death 1095 cal
Consumed
Secondary consumers (carnivores)
Energy loss in excretion
383 cal
Respiration 316 cal
Net production
67 cal
Death 46 cal
Consumed
Tertiary consumers (carnivores)
21 cal
Respiration 15 cal
Death 6 cal

Good Source of Energy

We are familiar with the term energy. Everyday, we hear about the scarcity of energy and a looming crisis caused by the rapid depletion of energy reserves. Energy can be neither created nor destroyed. Hence, it should be conserved.

Energy is the ability or the capacity of a physical system to do work.

Are there different forms of energy? Can each form of energy be changed into another form?

Yes, energy exists in various forms such as kinetic energy, heat energy, chemical energy, etc. We can change energy from one form to another. For example, when a candle is burned, it produces heat and light. Here, we can see that the chemical energy in the candle is converted to light and heat energy.

Thus, we can say that a candle is a source of both light and heat. On the other hand, burning of coal produces heat. Does it also produce light?

What makes some forms of energy good while others bad?

Let us answer the question using light and coal as examples. Which of the two will you use as a source of heat energy to cook food?

You will use coal as a source of heat energy to cook food. **But, why coal and not candle? After all, both sources of energy produce heat.**

This is because the heat from the candle is not sufficient to cook.

This implies that specific sources of energy are used for specific purposes, which we refer to as **good sources of energy** for that particular task.

Good sources of energy exhibit some special characteristics that are listed below.

- It should possess a **high calorific value**, i.e., the amount of energy obtained by burning one kilogram of the fuel should be high
- It should not leave residue after burning, i.e., it should burn completely
- It should burn without producing too many pollutants
- It should be **easily available and accessible**
- It should be **economical**
- It should be **easy to store and transport**

Coming back to our earlier discussion,

When we compare coal and candle as sources of heat energy, we find that both are easily available, economical, and easy to store. However, coal is more efficient than candle, i.e., coal has a higher calorific value. One kilogram of coal will provide more energy as compared to one kilogram of candle-wax. Therefore, we prefer coal to candle when we require heat energy.

Let us further understand some characteristics of a good fuel.

In addition to a high calorific value, a good fuel must also have a fairly low ignition temperature. **What will happen if the ignition temperature of a substance is lower than the normal room temperature?**

The fuel will be very difficult to store and transport. Any thermal contact with the atmosphere will ignite the fuel and it may result in an explosion.

Calorific value *is defined as the amount of heat energy obtained by burning one gram of a substance. The unit of calorific value is kJ/g*.

The ***ignition temperature*** *of a substance is defined as the temperature at which the substance starts burning. It is measured in °C, °F, or K.*

Calorific values and ignition temperatures of some common fuels are listed in the following table.

Fuel	**Ignition temperature (°C)**	**Calorific value (in kJ/g)**
Methane	580	50
LPG	400	55

Petrol	280	45
Kerosene	210	45
Biogas	580	35 − 40
Diesel	260	45
Coal	300	25 − 33
Wood	300	17 − 22

Now, can you distinguish a good fuel from a bad fuel?

You can see that methane has the highest calorific value but it has a very high ignition temperature. Petrol has high calorific value as well as low ignition temperature. Hence, petrol is the best fuel among those listed in the above table. Now you know why most cars use petrol as a source of energy (fuel).

Renewable and Non-Renewable Sources of Energy

Natural resources are the materials that occur in nature and are useful to humans. These resources may be either living or non living.

Living resources includes living organisms like forests and wildlife or the products derived form these living organisms like leather, wood etc. It also includes the fossil fuels like coal, petroleum, natural gas etc.

that are derived from remains of dead and decayed living organisms over a long period of time.

Non living resources include the land, water, soil, air and mineral ores.

Based on whether a source of energy can be replenished, it can be classified as a

- Renewable source of energy

- Non-renewable source of energy

Renewable sources of energy are those that are replenished at a rate faster than that at which they are consumed. About 13 percent of the primary energy comes from renewable resources. Renewable resources of energy are known as **inexhaustible** sources of energy as they can be easily regenerated at a constant rate.

Examples of renewable sources of energy include sunlight, wind, tides, and geothermal energy.

Non-renewable sources of energy are those that are consumed at a rate faster than that at which they are replenished. Non-renewable resources of energy are known an **exhaustible** sources of energy as they can be easily exhausted.

Examples of non-renewable resources of energy are fossil fuels, which include coal, petroleum, and natural gas. These resources are widely used. In addition to being an exhaustible source of energy, fossil fuels also release polluting emissions on burning.

Coal: It is a non-renewable source of energy made up of complex compounds of carbon, hydrogen and oxygen along with some free carbon and compounds of nitrogen and sulphur. It is found in mines under the Earth's surface. In India, coal is found in abundance in Jharkhand, West Bengal, Orissa and Chattishgarh. It is a most common source of energy for us.

Petroleum: It is a dark coloured viscous liquid also known as crude oil or black gold. It is a complex mixture of many hydrocarbons with water, salt, earth particles and other compounds of carbon, oxygen, nitrogen and sulphur. We obtain petroleum by drilling oil wells into earth's crust at its reservoirs. Assam and Mumbai are the two petroleum reservoirs of India. The petroleum extracted from wells has to be purified to obtain different useful components.

The process of separating useful components from the crude oil is called refining and this process is done by fractional distillation in big refineries. The petroleum gas obtained as a by-product from the fractional distillation of petroleum majorly contains butane and a small quantity of propane and ethane.

These gases generate a lot of heat on burning and can be liquefied easily under pressure. This petroleum gas liquefied under pressure is known as LPG (liquefied petroleum gas) which we use it in domestic gas stoves as fuel.

Gas cylinders are used to store LPG and a strong smelling substance called ethyl mercaptan C_2H_5SH is added in this gas to detect any leakage.

Natural Gas: Same as petroleum, natural gas is also found deep under the Earth's crust either alone or above the petroleum reservoirs. The main constituents of natural gas are methane (upto to 95%), ethane and propane. It easily burns to produce heat. In India, there are number of reservoirs of natural gas such as in Tripura, Jaisalmer, offshore area of Mumbai and Krishna-Godavari delta.

Different Sources of Energy

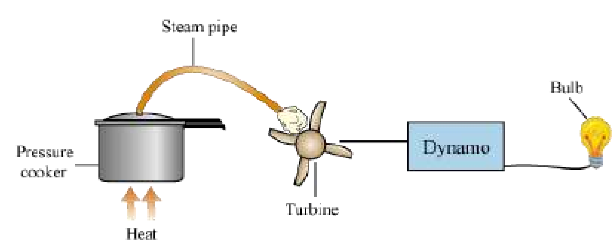
Thermal and Hydro Power Plants

Power plants generate power. You may have seen smoke coming out of the chimneys of power stations. These power stations use coal or petroleum as fuel to produce steam by heating water. The steam is then used to rotate a turbine, which drives a generator. Electric energy thus generated is known as thermal power and such power stations are known as **thermal power plants**.

Steam is passed through the turbine and is allowed to condense in a condenser. Since a thermal power plant uses coal or petroleum as fuel, it releases huge amounts of smoke from its chimneys.

Make your own power station

You can make your own miniature thermal power plant at home using a bicycle dynamo, pressure cooker, turbine, and bulb as illustrated in the figure.



Heat is used to make steam from water in the pressure cooker. Steam spins the turbine, which in turn spins the dynamo. The dynamo generates electricity and this lights the bulb.

Since it is more convenient to transport electricity rather than fossil fuels such as coal, many thermal power plants are set up near coal or oil fields.

Hydro power plants

Instead of using steam to spin a turbine, **hydro power plants** use the potential energy of water accumulated at a height to spin a turbine.

Biomass

Biomass refers to those living and non-living organic materials that can be used as sources of energy in the form of fuel. Some examples of biomass fuels are wood, crops, and organic garbage. The chemical energy in biomass is released as heat on burning.

Biomass can also be converted to other usable forms of energy such as methane gas or transportation fuels such as ethanol and biodiesel. It is a renewable source of energy.

We know that photosynthesis is a process in which plants absorb solar energy and convert it into chemical energy. Scientists too have developed technologies that enable us to trap solar energy to produce heat energy or electricity.

Solar Energy

Let us understand the uses of solar energy through an animation.

Solar electricity is mainly produced by using **photovoltaic cells or solar cells**. Such cells are made up of semi-conductors that convert solar energy directly into electricity.

How does a photovoltaic solar cell work?

Photovoltaic (PV) cells are made of special materials called semi-conductors such as silicon. When light strikes the solar cell, a certain portion of it is absorbed by the semi-conductor material. This means that the energy of the absorbed light is transferred to the semi-conductor.

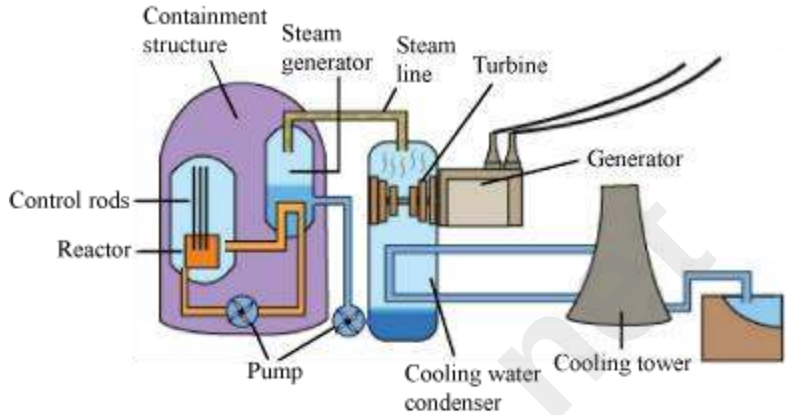
This energy loosens the electrons from the atoms in the semi-conductor material and allows them to flow freely. This produces direct current (DC) or electricity.

Nuclear Power Plant

How is electricity produced in nuclear power plants?

Nuclear power plants consist of nuclear reactors. These reactors use uranium rods as fuel and heat is generated by the process of nuclear fission.

Neutrons smash into the nucleus of the uranium atoms, which roughly split into half and release energy in the form of heat.



Carbon dioxide gas is pumped through the reactor to take the heat away. The hot gas then heats water to form steam. This steam drives the turbines of generators to produce electricity.

Ocean Energy

Sea water is a highly potential resource of energy. Some forms of energy that can be obtained from sea water are tidal energy, wave energy, and ocean thermal energy.

Tidal Energy

Tides are the daily rise and fall of ocean levels relative to coastlines. They are a result of the gravitational forces of the moon and the sun on earth, and also the revolution of the earth. A large amount of energy is stored in tides. They can be used as renewable sources of energy to generate electricity.

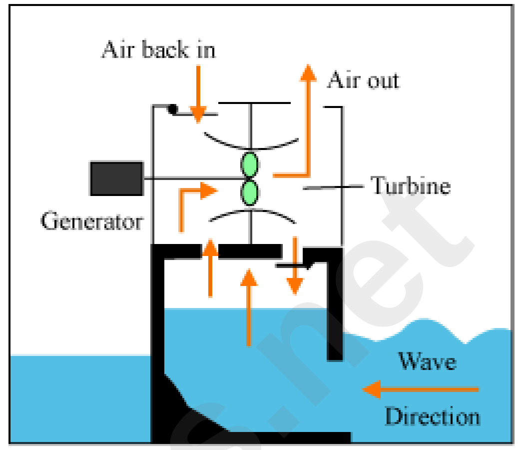
Tidal electricity generation involves the construction of a barrage across deltas, estuaries, beaches, or other places that witness increased tidal action.

Wave energy

Ocean waves are caused by winds as they blow across the sea. Waves are a powerful source of energy. Electricity can also be produced from wave energy.

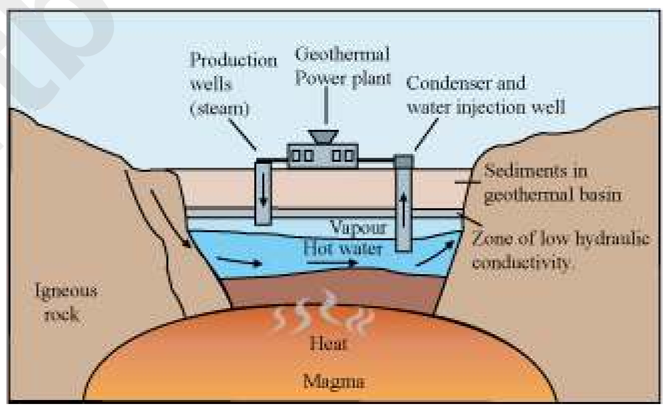
How is electricity produced from wave energy?

At a wave power station, waves cause the water in the chamber to rise and fall, which means that air is forced in and out of the hole located at the top of the chamber. A turbine placed in this hole is turned by the movement of air rushing in and out. The turbine turns a generator to produce electricity.



Geothermal Energy

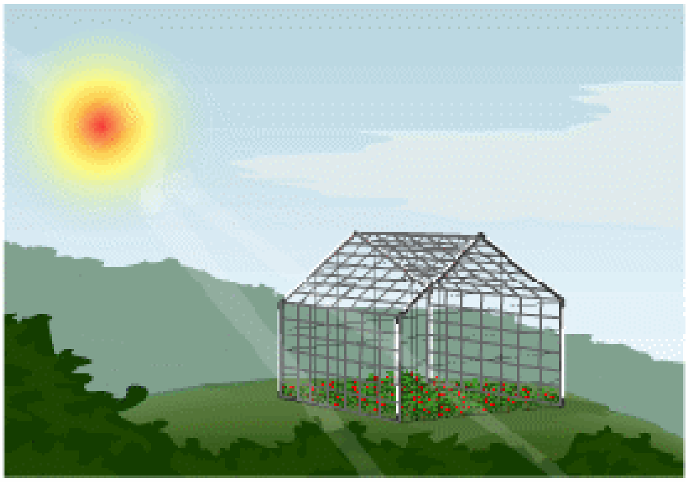
Geothermal energy is the heat energy in the earth's interiors. The temperature at the centre of the earth is about 6000°C. In some areas, molten rock (magma) is found very close to the surface of the earth. This hot rock meets underground water and heats it up. This produces steam. Such a place is known as a **hot spot**. Sometimes, this heated underground water finds an outlet through which it comes out on the surface of the earth. Such outlets are known as **hot springs**.



Holes are drilled down to the regions through which steam comes up. This flow of steam is used to drive the turbines of generators to produce electricity. One important use of geothermal energy is to heat buildings.

Greenhouse Effect

What is a greenhouse?



You may have seen **transparent structures made of plastic or glass that house small plants**. These transparent structures are called greenhouses. A greenhouse allows sunlight to enter, but prevents the heat from escaping. This results in an increase in the temperature inside the greenhouse.

Greenhouses help maintain climatic conditions such as temperature and humidity at the levels that are conducive for the optimum growth of plants. Specially designed greenhouses keep tropical plants warm during the winters in colder climates. Apart from this, greenhouses also provide protection to plants against factors that are adverse to their growth, for example, pests and strong winds.

Greenhouse effect

Greenhouse effect is an atmospheric phenomenon named after the heat-trapping transparent structures.

Sunlight passes through Earth's atmosphere to warm Earth's surface, but the heat radiated back from the warmed surface is absorbed by certain gases present in the atmosphere.

This trapping of heat increases Earth's temperature, much the same way as the temperature inside a greenhouse rises. This is called greenhouse effect and the gases responsible for this phenomenon are called **greenhouse gases**.

Greenhouse Effect: Causes

The amount of greenhouse gases in the atmosphere has been on the rise for centuries. This has in turn increased Earth's average temperature and resulted in the phenomenon known as **global warming**.

Some of the factors responsible for this increase in greenhouse gases in the atmosphere.

- **Deforestation**: The cutting down of trees on a large scale negatively affects the amount of carbon dioxide getting converted into oxygen. This increases the concentration of carbon dioxide in the atmosphere.
- **Burning of fossil fuels**: The burning of fossil fuels such as coal and petroleum releases greenhouse gases such as carbon dioxide and methane into the atmosphere.
- **Industrial emissions**: Gases released by various industries also contribute to the rise in the amount of greenhouse gases in the atmosphere.

CO_2 Concentration in Atmosphere

Judicious Use of Energy

It is very difficult to fulfil all the energy requirements of human beings from the non-conventional source of energy, so we have to move towards the conventional sources of energy also. But conventional sources are limited and non-renewable and if we use them constantly at large scale, there will be the energy crisis in the near future. To control this situation following measures should be taken for the judicious use of energy.

1. Wastage of energy must be minimised.

2. Encourage reforestation and discourage deforestation.

3. Efforts must be made to make use of energy in groups.

4. Coal, petroleum, etc. should be consumed only when no other alternative sources of energy is available

5. Rate of energy consumption in urban areas is much more than that in rural areas. But in rural areas, the consumption of renewable source of energy is easier than the urban areas. So, we should try to frequently use of renewable resources such as biogas, wind energy, hydro energy etc. for generating electricity in rural areas.

6. Techniques should be developed by which we can encourage the use of renewable energy as much as possible to meet our demands.

7. Research and efforts should be made to develop nuclear energy by the controlled nuclear fusion of deuterium nuclei present in heavy water available in sea. This can become an endless source of energy.

Energy Degradation

Ideally it is believed that a form of energy gets transformed to other form of energy (desired form) without any loss of it. But practically, it has been observed that the entire energy does not change into desired form, but a part of it changes into some undesired form.

This conversion of energy to some undesirable form is known as energy dissipation and since this undesirable form of energy cannot be used by us to do any productive work, so it is regarded as the degraded form of energy. The rate of generation of degraded form of energy increases with more and more use of energy.

Few examples of degraded form of energy:

- In bulbs, only 25% of electrical energy converts into the light energy and remaining portion of energy is either wasted in heating the filament and or gets converted to other invisible radiation.

- In vehicles, a small part of the energy obtained from the burning fuel is used up in running the vehicle while the major part of the energy is wasted in heating the moving parts of the vehicles, in overcoming friction between the ground and its tyres, etc.

- While cooking food, a significant part of energy is radiated in the atmosphere. This energy is of no use to us.