KIPS CSS-PMS SERIES

GENERAL SCIENCE AND ABILITY

For CSS, PMS & Other Competitive Exams

KIPS EASY TIPS

Owais Safdar
Dr. Aqeela Syed (PSP)

In line with the newly revised syllabus
Clear and self-explanatory arrangement covering basic principles of Science, Mathematics, Logical & Analytical reasoning.
Concepts supported by visual illustrations.

KIPS PUBLICATIONS

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PREFACE

General Science and Ability, previously Everyday Science, has always been a high scoring subject for successful candidates. It has allowed candidates to enhance their overall score, and opt for their desired posts. The significance of this subject has further been enhanced after the introduction of a 40 marks General Ability section based on mathematics and reasoning. However, in order to maximize their marks in the General Science and Ability paper, it is important that the students have the appropriate material to prepare for the exam.

Taking this into consideration, we have authored this book, which contains the material indispensable for a good score. This book is compiled to assist the students in grabbing the crucial scientific ideas in minimum possible time and to save them from painstaking research from multiple sources. It is comprehensive enough to cover all the aspects of the topics, yet is precise and interesting. Further, in order to assist the candidates in understanding and retaining maximum information, the content is supported by visual illustrations, diagrams, flowcharts, and tables. Moreover, the book contains the concepts regarding basic mathematics and reasoning supported by appropriate examples and exercises.

We thank Allah Almighty for making us successful in carrying out this task. We are also grateful to our parents for their prayers and wishes. We extend our special gratitude to Mr. Abid Wazir Khan and Dr. Shahid Wazir Khan for their continuous guidance and support. In the end, we also thank our friends—Dr Tahreem Ali, Hina Zahid, Amir Iqbal, Umer Saeed, Usman Tipu, Sara Sarwar, Mubashar Rizvi, Dr. Aqsa Ashraf, Dr. Zari Salahuddin, Dr. Farheen Ijaz, Adnan Hashim, and Sana Amjad— and entire KIPS NDC team and Arooj Butt Printers for their contribution in preparation of the book.

We encourage and highly appreciate the feedback and wish all the students success in their endeavours.

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GENERAL SCIENCE & ABILITY: REVISED SYLLABUS

PART-I (GENERAL SCIENCE) 60 MARKS

I. PHYSICAL SCIENCES

- **Constituents and Structure**
  Universe, Galaxy, Light Year, Solar System, Sun, Earth, Astronomical System of Units.
- **Process of Nature**
  Solar and Lunar Eclipses, Rotation and Revolution, Weather Variables (Global Temperature, Pressure, Circulation, Precipitation, Humidity) and Weather Variations.
- **Natural Hazards and Disasters**
  Earth Quake, Volcanic Eruption, Tsunami, Floods, Avalanche, Travelling Cyclone (Tropical Cyclone, Middle Latitude Cyclone and Tornadoes), Drought, Wildfire, Urban Fire. Disaster Risk Management.
- **Energy Resources**
  Sources of Energy (Renewable i.e. LED Energy, Solar Energy, Wind Energy and Non-Renewable Energy conservation and its sustainable use.
- **Atomic Structure**
  Atomic Structure, Chemical Bonding, Electromagnetic Radiations.
- **Modern Materials/Chemicals**
  Ceramics, Plastics, Semiconductors. Antibiotics, Vaccines, Fertilizers, Pesticides.

II. BIOLOGICAL SCIENCES

- **The Basis of Life**
  Cell Structures and Functions (Subcellular Organelles such as Nucleus, Mitochondria and Ribosomes).
- **Biomolecules**
  Proteins, Lipids, Carbohydrates and Enzymes.
- **Plant and Animal Kingdom**
  A brief survey of plant and animal kingdom to pinpoint similarities and diversities in nature.
- **A Brief Account of Human Physiology**
- **Common Diseases and Epidemics**
  Polio, Diarrhea, Malaria, Hepatitis, Dengue their Causes and Prevention.
- **New Model Concept of Producing BIO Fuel Method**

III.ENVIRONMENTAL SCIENCE

- **Environment**
  The Atmosphere (Layered Structure and Composition), Hydrosphere (Water Cycle, Major Water Compartments), Biosphere (Major Biomes) and Lithosphere (Minerals and Rocks, Rock Types, Plate Tectonics).
- **Atmospheric Pollution**
  Types, Sources, Causes and effects of major air pollutants (COx, Particulate Matter, NOx, SOx, Tropospheric Ozone, Volatile Organic Compounds, Dioxins). Regional and Global air pollution issues (Acid-rain, Ozone Depletion, Greenhouse Effect and Global Warming). International agreements on air pollution control (Montreal Protocol and Kyoto Protocol).

- **Water Pollution**
  Types, sources, causes and effects of major water pollutants (Synthetic Organic Chemicals, Oxygen Demanding Wastes, Plant Nutrients, Thermal Pollution, Infectious Agents, Sediments, Radioactivity, Heavy Metals and Acids). Drinking water quality and standards.
- **Land Pollution**
  Solid waste management and disposal.
  Role of Remote Sensing and GIS in Environmental Science.Population Planning.

IV. FOOD SCIENCE

- **Concept of Balance Diet**
  Vitamins, Carbohydrates, Protein, Fats and oil, Minerals, Fiber.
- **Quality of Food**
  Bioavailability of Nutrients, Appearance, Texture, Flavor, Quality of Packed and Frozen Food, Food Additives, Preservatives and Antioxidants
- **Food Deterioration and its Control**
  Causes of Food Deterioration, Adulteration, Food Preservation.

V. INFORMATION TECHNOLOGY

- **Computer (Hardware & Software Fundamentals)**
  I/O Processing and data storage, Networking & Internet Standards, Application and business Software, Social Media Websites. Information Systems. Fundamentals of artificial intelligence.
- **Telecommunications**
  Basics of Wireless Communication (Mobile, Satellite, Surveillance and GPS and Fiber Optic etc.

PART-II (GENERAL ABILITY) 40 MARKS

VI. QUANTITATIVE ABILITY/REASONING

- Basic Mathematical Skills.
- Concepts and ability to reasons quantitatively and solve problems in a quantitative setting.
- Basic Arithmetic, Algebra and Geometry (Average, Ratios, Rates, Percentage, Angles, Triangles, Sets, Remainders, Equations, Symbols, Rounding of Numbers
- Random Sampling

VII. LOGICAL REASONING AND ANALYTICAL REASONING / ABILITY

- **Logical Reasoning**
  Logical Reasoning includes the process of using a rational, systematic series of steps based on sound mathematical procedures and given statements to arrive at a conclusion
- **Analytical Reasoning/Ability**
  Analytical Reasoning/Ability includes visualizing, articulating and solving both complex and uncomplicated problems and concepts and making decisions that are sensible based on available information, including demonstration of the ability to apply logical thinking to gathering and analyzing information.

VIII. MENTAL ABILITIES

Mental Abilities Scales that measures specific constructs such as verbal, mechanical, numerical and social ability.

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PART-1
(GENERAL SCIENCE)

PHYSICAL SCIENCES

CHAPTER 1

CONSTITUENTS AND STRUCTURE

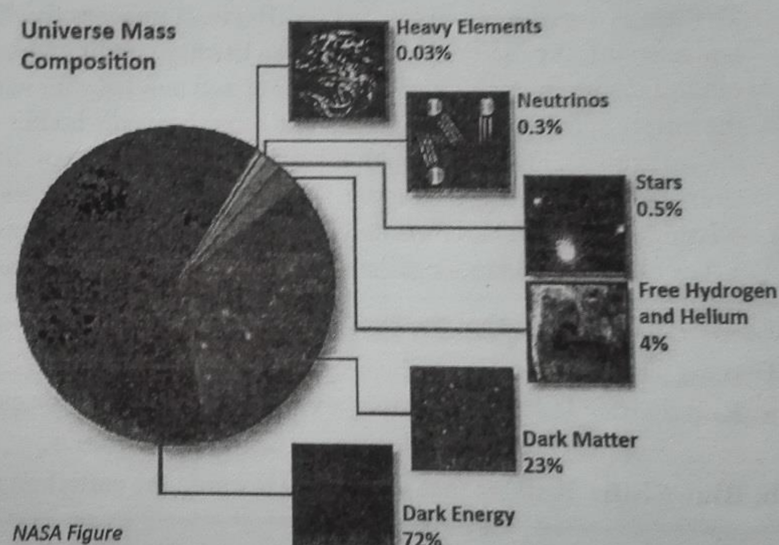
UNIVERSE

The Universe and its Composition

In simple terms, the Universe can be defined as anything that can be touched, felt, measured or detected. *It is totality of all matter and energy that presently exists or has existed both in space and time.* Hence it can be said that time, space and all of contents within it, make up the universe. The study of objects and matter outside the Earth's atmosphere and of their physical and chemical properties is called **Astronomy**. The branch of science that deals with the study of the Universe—the study of how the universe began, what it is made of and how it continues to evolve and change—is known as **cosmology**. The universe is thought to consist of three types of substances: normal matter, dark matter and dark energy. Normal matter is believed to account for the smallest proportion of the universe. This is astonishing because it is normal matter that makes up the galaxies, stars, planets and other astronomical bodies. The universe is extremely huge, and is thought to contain over 100 billion galaxies. The size of the universe can also be imagined from the fact that its diameter is measured in terms of light years.

Composition

According to the latest observational evidence, **ordinary matter**, including stars, planets, dust and gas, only make up a tiny fraction of the universe **(5%).** The rest is the elusive **dark matter,** which is about **23%,** and about **72%** is the **dark energy**.



Dark energy: A mysterious (and as yet hypothetical) form of energy which is spread out uniformly throughout space (and time) and which has anti-gravitational properties: it is one of the possible explanations for the current accelerating rate of expansion of the universe.

Dark matter: Matter not visible to us because it emits no radiation that we can observe, but it is detectable gravitationally.

Ordinary matter

- **Hydrogen & helium gas**: Hydrogen and Helium are the most abundant elements in the universe. This element is found in great abundance in stars and gas giant planets.
- **Star**: A ball of mostly hydrogen and helium gas that shines extremely brightly. Sun is a star.
- **Neutrino**: A small particle that has no charge and is thought to have very little mass. Neutrinos are created in energetic collisions between nuclear particles. The universe is filled with them but they rarely collide with anything.
- **Heavy elements**: Planets like Earth.

Theories about Origin of Universe

Scientists have proposed different theories about the origin of universe. Some of them are as under:

1. **Creation Theory**
   It states that the Universe is created by God. Religion and mythology have long proposed this.
2. **Big Bang Theory**
   It is the most widely accepted. This theory states that the Universe started as a big ball in which the entire energy, forces of nature, matter and space were wrapped up. 15 to 20 billion years ago, this ball exploded with a gigantic explosion known as big bang. Since then, the Universe is expanding. The explosion led towards formation of matter—ranging from nuclei of hydrogen and helium to galaxies and stars. This theory assumes that celestial bodies and galaxies are still being formed. Echo of big bang can still be heard in the form of microwave radio signals from the space. Other evidences include the discovery of background radiation of explosion and red shift (explained later) of stars and galaxies.
3. **Pulsating Theory**
   In this theory it is assumed that there is continuous expansion and contraction in universe. Pulsating theory states that it is the possibility that after some passage of time the expansion in the universe may stop. Then there may be the possibility of contraction. When this contraction approaches to a particular size, the explosion will take place. As a result of this explosion the expansion of universe will start again. Hence it results in a pulsating universe in which there is alternate expansion and contraction of universe.
4. **Steady State Theory**
   The theory was proposed by Sir Fred Hoyle. It opposes the Big Bang theory. It states that Universe had been infinite in time and it had been in same condition before and now. It states that the counting of the galaxies in our Universe is constant and new galaxies which are forming continuously are filling the empty spaces which are created by those heavenly bodies which have crossed the boundary lines of observable Universe. Though it had been in the same condition over time, theory proposes that the Universe is expanding. However, it says that there are no new galaxies are being formed between the existing galaxies. Therefore, density of Universe is same. However this theory has many loopholes in it. For example evidences gathered prove that new stars are being born.

Edwin Hubble found that the Universe was expanding. This is supported by phenomenon called the Doppler Shift.

a. Red Shift: It states that stars are moving away from the earth and their light becomes dimmer. This gives support to expanding of universe.

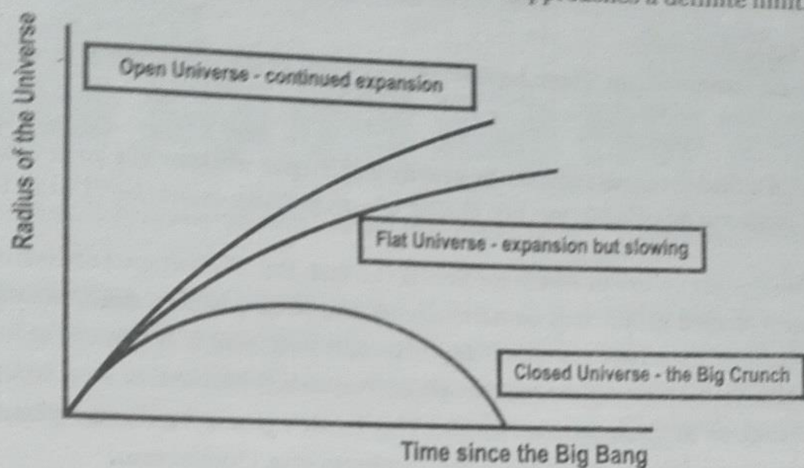
b. Blue Shift: It states that stars move towards the earth and their light becomes brighter.

The Future of the Universe

The fate of the universe will be decided by gravity and ultimately depends on how much matter there is in the universe. There are 3 possible scenarios regarding future of the universe

1. **The Open or Unbound Universe**
   This means that the universe will continue to expand forever. For this to happen there must be so little matter in the universe that gravitational attraction will never have enough effect to stop it expanding.
2. **The Closed or Bound Universe**
   This means that the universe will stop expanding at some point in the future, and begin to contract again until it ends up at a singularity again at the big crunch. For this to happen there must be more than a certain critical amount of matter in the universe. Amount of gravity will slow its expansion down until it collapse by itself.

3. **The Flat or Marginally Bound Universe**
This means that there is just enough matter, that is, perfect amount of gravity in the universe to stop it expanding but not sufficient to start it contracting. If this is the case then it will take forever to stop expanding, but the rate of expansion will slow down as it approaches a definite limit.



LIGHT YEAR

Light year is a distance light can travel in vacuum in one year. Light year is one of the units of distance used for astronomical objects. More precisely, one light-year is equal to 9,500,000,000,000 kilometers. Andromeda galaxy is 2.5 million light years away from Milky Way. It is pertinent to mention the need for such a big unit of distance. On Earth, a kilometer may be just fine. It is a few hundred kilometers from New York City to Washington, DC; it is a few thousand kilometers from California to Maine. In the universe, the kilometer is just too small to be useful. For example, the distance to the next nearest big galaxy, the Andromeda Galaxy, is 21 quintillion km. That is 21,000,000,000,000,000,000 km. This is a number so large that it becomes hard to write and hard to interpret. So astronomers use other units of distance. For distances to other parts of the Milky Way Galaxy (or even further), astronomers use units of the light-year or the parsec. The parsec is equal to 3.3 light-years. Using the light-year, we can say that:

1. The Crab supernova remnant is about 4,000 light-years away.
2. The Milky Way Galaxy is about 100,000 light-years across.
3. The Andromeda Galaxy is about 2.5 million light-years away.

GALAXY

Galaxy is grouping of millions and billions of stars kept together by gravity. It consists of thousands of stars together with interstellar gas and dust. Galaxies are formed by group of starts, gases, and dust particles all are together by strong gravitational forces. There are 3 categories of galaxies:

1. **Spiral Galaxies**
They often appear bluish because they contain many young stars (young middle age stars give blue light). These are disk shaped with spiral arms of dust and gas. Our galaxy is spiral and contains 100 billion planets and between 200 and 400 billion stars within diameter of 10^5 light years and it is called **Milky Way**. **Andromeda Galaxy** is the nearest spiral galaxy to the Milky Way it is 2.5 million light years away from us.

2. **Elliptical Galaxies**

They often appear reddish because they contain many old stars (old stars give red light). These are most common type. These are spherical and egg shaped. These have no spiral arms, and have little dust and gas.

3. **Irregular Galaxies**

These are least common type. These have no well-defined shape or structure. Some have little dust or gas, and some have lots of dust and gas.

Cluster

It is a collection of galaxies bound together by gravity and **Super cluster** is a large collection of galaxies. Milky Way and Andromeda galaxies are in a cluster of ~45 galaxies called the **"Local Group"**.

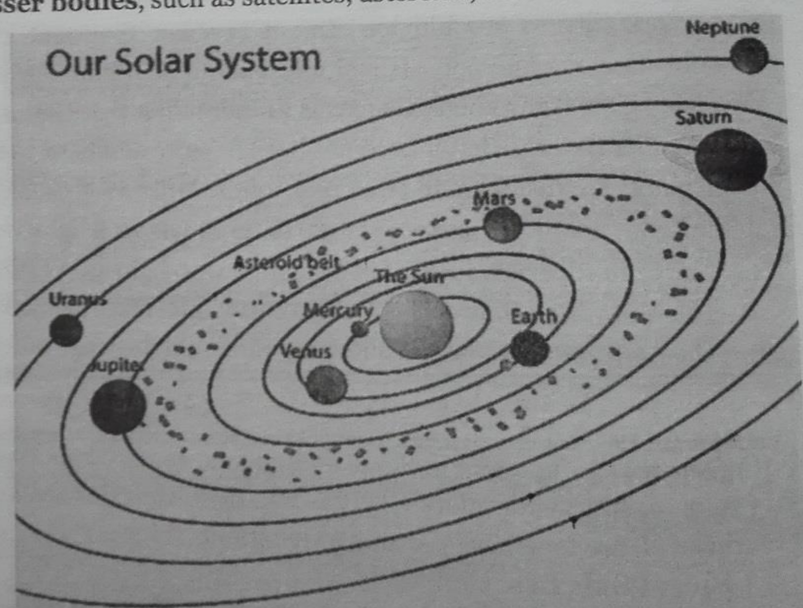
Milky Way

The Milky Way is the galaxy in which we live. It is a fast, flat, disc-shaped collection of gas, dust and stars. It is a spiral shaped galaxy that contains about 200 to 400 billion stars, including our Sun. It is about 100,000 light-years across and about ***10,000*** light-years thick. If you are at a place which has a very dark night sky, you can sometimes see the Milky Way as a thick band of stars in the sky.

- **Location:** A region in the space where Milky Way located is called **galactic plane**.
- **Major Arms:** Pursues arm, Sagittarius arm, Centaurs arm, Cygnus arm.
- **Minor Arm:** Orion is a minor arm where our solar system exists.

SOLAR SYSTEM

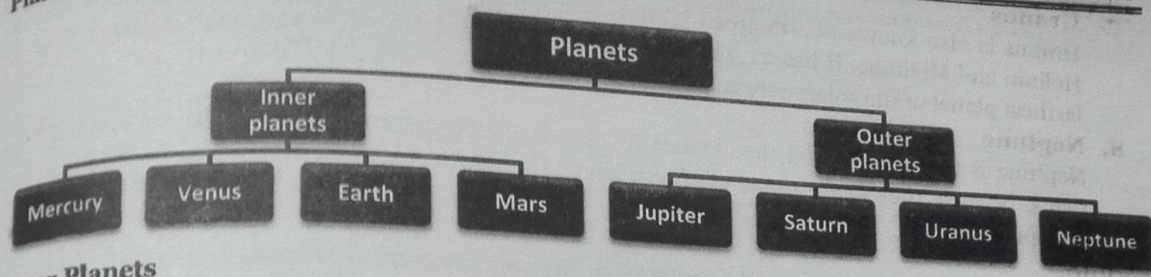
The solar system is the only part of universe which we can explore with the space craft of the kind we have. It is made up of **one star** (*Sun*), **eight planets** (*Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune*) and various **lesser bodies**, such as satellites, asteroids, comets and meteoroids.



The sun is a normal star, but it is the supreme controller of the solar system. The age of earth is known to be 4.6 billion years, and the solar system must be older than this. It is very noticeable that the solar system is divided into two parts. First, there are four small solid (rocky) or terrestrial planets: Mercury, Venus, Earth and Mars. Then comes a wide gap, in which move thousands of widgets and minor planets. Then there are four giants: Jupiter, Saturn, Uranus and Neptune. Pluto is too small and lightweight to be classed as bona-fide planet.

Sun

The Sun is the central and most important part of the solar system. It is the largest and heaviest body in the entire system, and this allows it to have a gravitational force that keeps all the objects in orbit around it. The planets around the sun can be divided into two categories: inner planers and outer planets.



Inner Planets

Inner planets include first four planets nearest to the sun: Mercury, Venus, Earth and Mars.

1. **Mercury**

   Mercury is the smallest and the fastest revolving planet. It is closest to the sun. It is a dead planet since it cannot hold onto its atmosphere, so no life is possible there. The volcanic and seismic activities appear to have ceased more than 3 billion years ago. It is not the hottest of the planets. It spins and rotates on its axis approximately once every 59 days and completes its revolution around the sun every 88 days.

2. **Venus**

   Venus is the hottest, brightest, and the slowest rotating planet. It is often called as earth's twin because the two planets have much closeness in size and mass. It is the hottest of all planets because of dense atmosphere. Rapidly spinning clouds of CO_2 covers its surface; that is why the Venus gets so hot. These clouds reflect sunlight, making Venus the brightest. Venus has always been the third brightest object in the sky after the sun and the moon. Violent volcanism is wide spread and there are highly varied landforms across the planet's flat surface. It is the only planet to rotate in the direction opposite to that of its orbital revolution—it rotates East-to-West (all other planets rotate West-to-East).

3. **Earth**

   Earth is the third planet from the Sun, and the densest and fifth-largest of the eight planets in the Solar System. It is the only planet in the Sun's solar system where life is known to exist. (Detail is discussed later)

4. **Mars**

   Mars is also known as the Red Planet due to presence of red dust. It is the only planet that gives some encouragement about the idea of life on other planets as well. Although the Earthly life is not possible at this time, its surface almost certainly possessed substantial supplies of water in the past.

The Outer Planets

5. **Jupiter**

   Jupiter is the biggest and the fastest rotating planet. It is two and half times more massive than all the other planets in the solar system combined. It is made primarily of gases and is therefore known as a "gas giant". It is also the most rapidly spinning planet, and requires less than 10 hours to complete its rotation.

6. **Saturn**

   Saturn is the 2nd largest planet and sometimes known as the ring planet. It is the lightest planet. It has 18 moons and largest of them is known as Titan. Titan is the only moon which has its own atmosphere.

7. **Uranus**

Uranus is also known as the green planet. The atmosphere of Uranus is composed of Hydrogen, Helium and Methane. It has 27 moons. Temperature in the Uranus is very cold because it is the 2nd farthest planet of the solar system.

8. **Neptune**

Neptune is the coldest, and the slowest revolving planet. Neptune and Uranus are often called as twins, because they share many characteristics. Its biggest moon Triton is the 6th largest in solar system

Pluto

It was once considered the farthest planet in the solar system. It is treated separately from other planets, because of its small size and it is a fact that very little is known about it. It has single large moon (Charon) about half of its size.

The figure below summarizes the characteristics of all planets:

Celestial Object	Mean Distance from Sun (million km)	Period of Revolution (d=days) (y=years)	Period of Rotation at Equator	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm³)
SUN	—	—	27 d	—	1,392,000	333,000.00	1.4
MERCURY	57.9	88 d	59 d	0.206	4,879	0.06	5.4
VENUS	108.2	224.7 d	243 d	0.007	12,104	0.82	5.2
EARTH	149.6	365.26 d	23 h 56 min 4 s	0.017	12,756	1.00	5.5
MARS	227.9	687 d	24 h 37 min 23 s	0.093	6,794	0.11	3.9
JUPITER	778.4	11.9 y	9 h 50 min 30 s	0.048	142,984	317.83	1.3
SATURN	1,426.7	29.5 y	10 h 14 min	0.054	120,536	95.16	0.7
URANUS	2,871.0	84.0 y	17 h 14 min	0.047	51,118	14.54	1.3
NEPTUNE	4,498.3	164.8 y	16 h	0.009	49,528	17.15	1.8
EARTH'S MOON	149.6 (0.386 from Earth)	27.3 d	27.3 d	0.055	3,476	0.01	3.3

SUN

The sun is the central and dominant part of the solar system. It accounts for 99.8% of the mass of the entire solar system. The sun's diameter is 1.3914 million km, which is 109 times that of earth. It weighs about 333,000 times as much as Earth. This enables the sun to extend its gravitational field far out into the space, and it holds the other objects together. The energy in the sun is due to nuclear fusion, composed mainly of superheated hydrogen and helium gasses mixed in ratio of 3:1. Its surface temperature is about 5500°C. Our planet earth is about 150 million km from the sun. The sun has a 27 day solar rotation period, and its speed of revolution is 18km/sec.

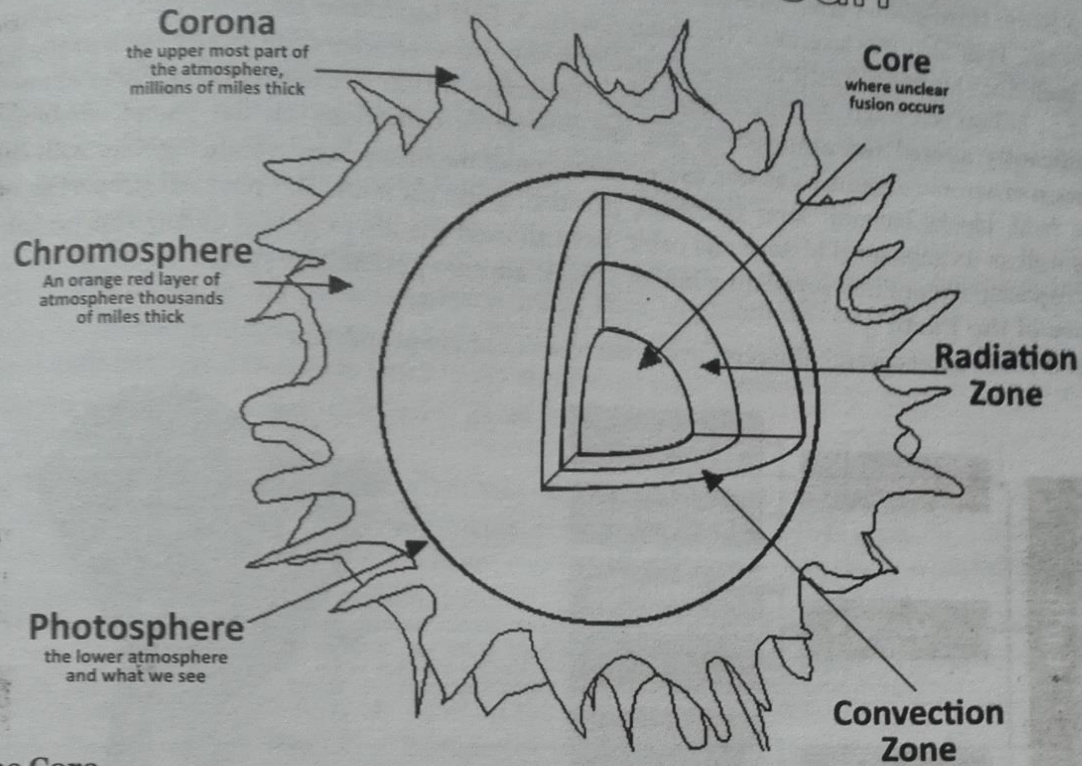
Composition of Sun

Sun is the biggest object in our solar system and contains more than 99% of the solar system's mass. The sun is mainly composed of Hydrogen (91.2%), Helium (8.7%) and Others (0.1%)

Physical Constants of Sun

1. Mass	2×10^{30} kg (330,000 times that of Earth)
2. Diameters	104 Million Km
3. Distance from earth	150 million Km
4. Average density	1.4 g/cm³

Structure of the sun



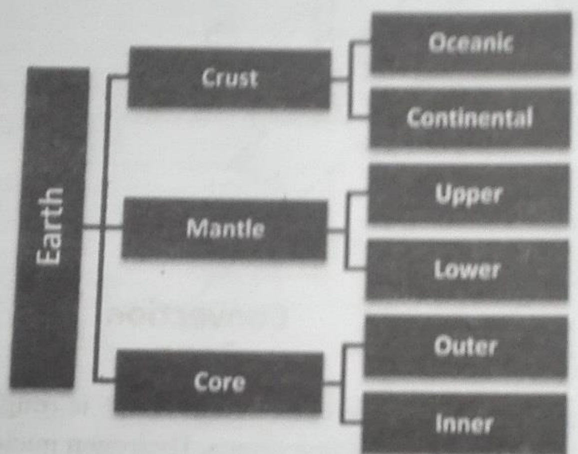
1. **The Core**
   The temperature is tremendously high in the core of the sun. Here, the temperature is roughly 15 million Centigrade. At such a high temperature nuclear fusion reaction occurs. Hydrogen nuclei fuse to form helium nucleus and tremendous amount of energy is released.
2. **The Photosphere**
   Photosphere is known as lower atmosphere of the sun. Its thickness is about 300 miles. Temperature in the photosphere is 5500 Ċ. Photosphere lies between chromospheres and the central core.
3. **The Chromosphere**
   Chromosphere is the reddish layer of the sun which lies outside the photosphere. Temperature is the region is 6000°C to 50,000°C. Its thickness is few thousand miles. Reddish appearance of chromospheres is due to excited state of hydrogen atoms. It is visible during solar eclipse (as moon obscures the photosphere).
4. **The Corona**
   The outer layer of the sun's atmosphere is known as corona. It extends millions of miles from sun's surface. Temperature in this region is one million centigrade.
5. **Solar Wind**
   Solar wind is a stream of charged particles. These winds are generated due to presence of plasma and extend up to the whole solar system. It takes the solar winds 5 days to reach Earth with velocity of 800 km/sec.
6. **Sunspots**
   They are cool dark patches on sun's surface. These spots are caused by disturbance in the sun's magnetic field. The larger sunspots are wider than the earth. Sunspots have about half the temperature of the surroundings.

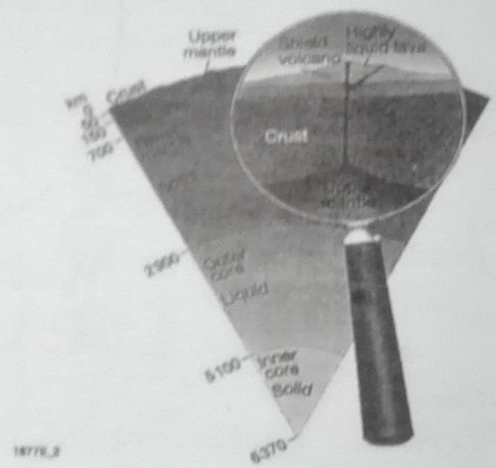
EARTH

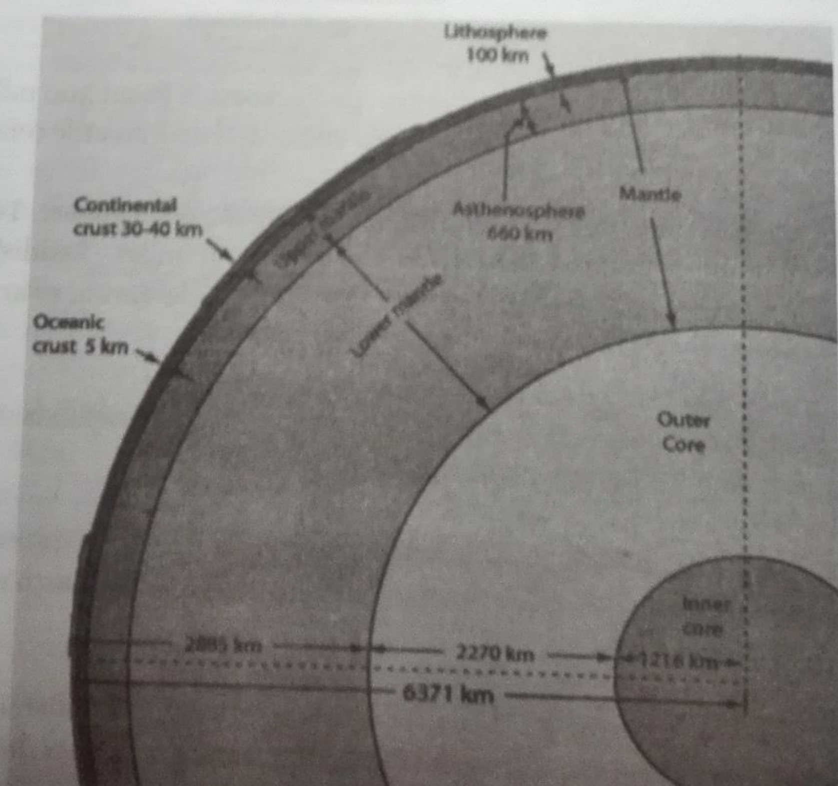
Earth is the third planet from the Sun, and the densest and fifth-largest of the eight planets in the Solar System. It is also the largest of the Solar System's four terrestrial planets. Home to millions of species, including humans, Earth is the only place in the universe where life is known to exist. It was formed 4.54 billion years ago, and life appeared on its surface within one billion years. Earth's biosphere has significantly altered the atmosphere and other a biotic conditions on the planet, enabling the proliferation of aerobic organisms as well as the formation of the ozone layer which, together with Earth's magnetic field, blocks harmful solar radiation, permitting life on land. The physical properties of the Earth, as well as its geological history and orbit, have allowed the life to persist during this period. The planet is expected to continue supporting life for at least another 500 million years.

Structure of the Earth

Earth is made up of several different layers, each with unique properties







The Core

The core is divided into two different zones. The inner core is solid and mostly made of iron and nickel. The outer core is a liquid (liquid metal which conducts electricity) because the temperatures there are adequate to melt the iron-nickel alloy. The temperature of core is too high, reaching approximately 5500 degrees. However, the inner core is a solid even though its temperature is higher than the outer core. The pressure on the inner core is greater than the pressure on the outer core and the melting point of iron (main constituent of the inner core) increases as the pressure goes up. As pressure effect overrides the temperature effect, the inner core is solidified. The liquid convects, generating magnetic field. Though the flow of liquid is very slow (about a few kilometers a year), it is what produces Earth's magnetic field. Our North and South Poles exist because of this liquid outer core, even though it's almost 2,900 miles below us.

Mantle

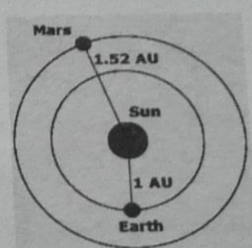
The mantle can also be divided into two portions, the upper mantle and the lower mantle. The upper mantle is also known as the **asthenosphere**, which flows as convection currents. The rocks in the upper mantle are cool and brittle, while the rocks in the lower mantle are hot and soft (but not molten). Rocks in the upper mantle are brittle enough to break under stress and produce earthquakes. However, rocks in the lower mantle are soft and flow when subjected to forces instead of breaking.

The Crust

There are two different types of crust: thin oceanic crust that underlies the ocean basins and thicker continental crust that underlies the continents. These two different types of crust are made up of different types of rocks. The thin oceanic crust is composed of primarily of basalt rocks and the thicker continental crust is composed primarily of granite rocks.

ASTRONOMICAL UNIT (AU)

It is a unit of length effectively equal to the average or mean, distance between Earth and the Sun. The **International Astronomical Union** defined the distance to be 149,597,870,700 meters (149,597,870.7 km or 92,955,807.3 miles). Alternately, it can be considered the length of the semi major axis i.e. the length of half of the maximum diameter of Earth's elliptical orbit around the Sun (or the average radius of the Earth's orbit).



The astronomical unit provides a convenient way to express and relate distances of objects in the solar system and to carry out various astronomical calculations. For example, stating that the planet Jupiter is 5.2 AU (5.2 Earth distances) from the Sun and that Pluto is nearly 40 AU gives ready comparisons of the distances of all three bodies.

Comparison with the Light Year

1 light-year = 63240 AU (astronomical units). Astronomical Units (AU) and Light-Years are both measurements of distance, generally used to show large amounts of distance between points. Light-years are better suited for calculating the vast distances between stars and galaxies, while AUs are better suited for calculating distance inside the (relatively) smaller space of a solar system.

The astronomical system of units

It is a **tridimensional system**, in that it defines units of length, mass and time. The astronomical unit of **time** is the **day**, defined as 86400 seconds. The symbol **D** is used in astronomy to refer to this unit. The astronomical unit of **mass** is the **solar mass**. The symbol **M** is often used to refer to this unit. The solar mass, which is 1.98892×10^{30} kg (or 2×10^{30} kg), is a standard way to express mass in astronomy. It is used to describe the masses of other stars and galaxies. It is equal to the mass of the Sun, about 333000 times the mass of the Earth. The astronomical unit of length is defined as the mean Earth-Sun distance. It is exactly 149,597,870,700 meters.

CHAPTER 2

PROCESSES OF NATURE

ROTATION AND REVOLUTION

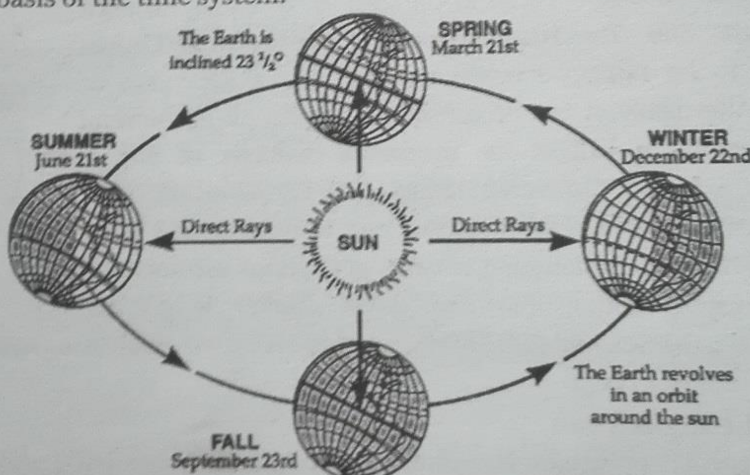
In chapter 1, we discussed how the earth is present in the space, within the boundaries of the Solar System. While it is in space, the earth goes through complex motions. These are known as rotation and revolution.

Revolution

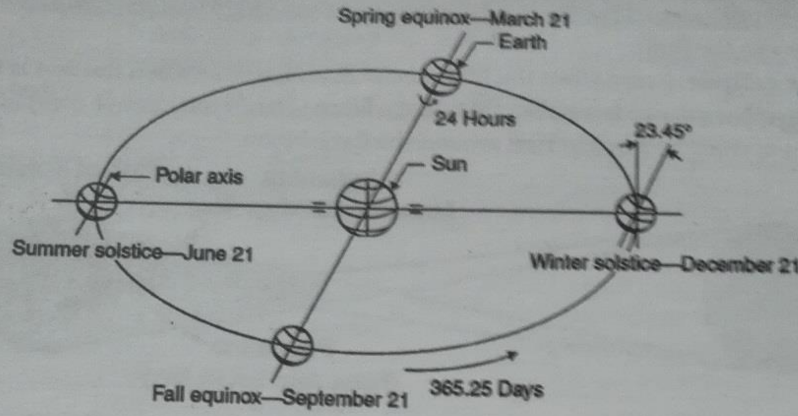
In astronomy, revolution is used when one body moves around another. For example Moon revolves around the Earth, and the Earth revolves around the Sun. Revolution refers to the movement of the earth around the sun. The earth revolves around the sun in an elliptical path. The revolution of the Earth is the basis of the calendar, and one complete revolution takes 365.25 days. To make things easy, the calendar assigns 365 days to each year. This is the reason why every fourth year has 366 days. This is known as a leap year.

Rotation

In astronomy, Rotation is used to mean the movement of body around its own axis. For example, rotation is the movement of the earth on its axis. The axis is an imaginary line that extends from the North Pole to the South Pole, through the center of the Earth. The Earth rotates in a west-to-east direction. The rotation of the Earth is the basis of the alternations of day and night. One rotation takes approximately 24 hours, and is the basis of the time system.



Rotation of Earth	Revolution of Earth
Spinning of Earth on its axis	Movement of the Earth around the sun
Completed in approximately 24 hours	Takes around 365 days to complete
Causes day and night	Causes different seasons
Causes tides, currents and winds	Causes equinox and solstice
Relative speed of rotation is maximum at the equator and slowest at the poles.	Speed is similar at all parts of the Earth
The direction of rotation of earth occurs from West to East	The direction of revolution occurs in counter clockwise direction or from right to left.
The Earth's axis of rotation is tilted by 23.5 degrees. This tilt causes the different seasons of the year.	The path of the Earth moving around the Sun is called an orbit. The Earth's orbit is elliptical.



Solstice means unequal day length. **Equinox** means days and nights are of equal length.

ECLIPSES

An eclipse happens when an astronomical object is completely or partially blocked from view. This happens when the object passes through the shadow of another object, or another body passes in front of it. Although eclipse can happen anywhere in the Solar System, we are only interested in the eclipses formed by the Sun, Earth and the Moon.

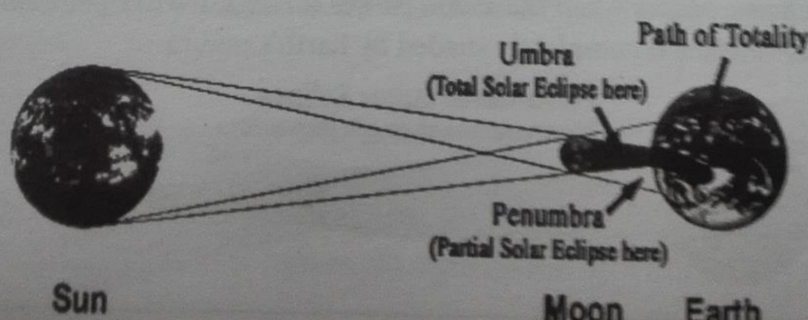
Solar Eclipse

Eclipse of Sun occurs when the moon comes between the Sun and the Earth. A solar eclipse happens when the moon gets in the way of the suns' light and casts its shadow on the Earth. The moon moves around the earth; the earth moves around the sun. Therefore, there must be time when these three are in same line, with the moon in the middle. It occurs at the time of new moon. New moon happens every month, but not solar eclipse. The reason is simple: the Moon's orbit around Earth is not in the same plane as Earth's orbit around the Sun–it is tilted by 5 degrees. So, most of the time the Moon either passes above or below the ecliptic and is not in a position to block the Sun. Only when the Earth, the Moon and the Sun are in a straight line, then solar eclipse occurs.

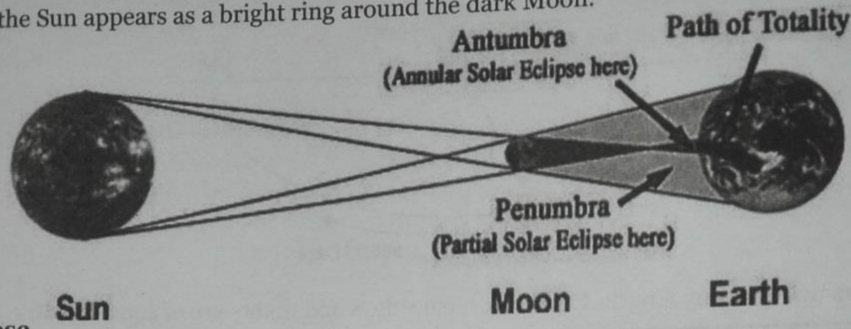
The shadows cast by the Moon have two parts: the darker central region called the **umbra**, and another one is the lighter outer region known as **penumbra.**

Solar eclipse is of 3 different types depending on the distance of the Sun and the Moon from Earth and keeping in view that orbits are elliptical and not in the same plane:

1. **Total solar eclipse** occurs when the Moon completely obscures the Sun. This can happen either when the Moon is near to Earth so it'll look bigger than the Sun or when the Sun is far from Earth so it'll look smaller than the Moon. It happens when Umbra reaches the earth, as shown in the figure above. However, total solar eclipse is visible only to those who are in the umbra region. In the penumbra region, only a **partial solar eclipse is visible.**

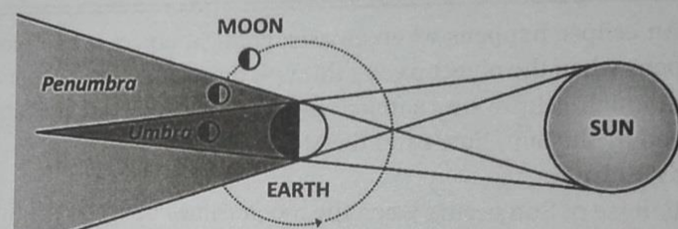


2. **Partial solar eclipse** also can occur without total solar eclipse because the umbra does not reach the Earth. This happens when the Earth, the Moon and the Sun are not exactly in line and the Moon only partially blocks the Sun.
3. **Annular solar eclipse** occurs when the Moon is far from Earth or when the Sun is near to Earth so that the Moon's apparent size is smaller than that of Sun. The Moon cannot completely obscure the Sun and the Sun appears as a bright ring around the dark Moon.



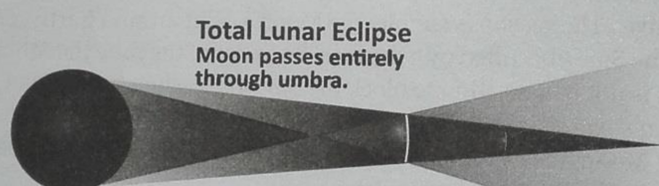
Lunar Eclipse

It occurs when the earth comes between the sun and the moon. As a result, the Earth casts a shadow on the Moon. In fact, there is a large conical shadow in space as shown in the figure. This shadow is large enough to cover the whole moon. Lunar eclipses always occur at full moon and they are less frequent than solar eclipses.

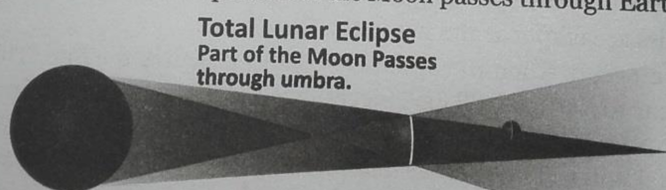


There are three types of lunar eclipses: total, partial and penumbral.

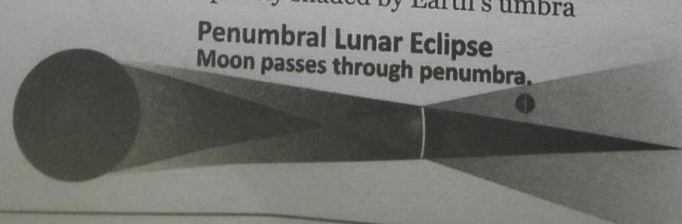
A **total lunar eclipse** occurs when the entire Moon passes through the Earth's umbra shadow.



A **partial lunar eclipse** occurs when a portion of the Moon passes through Earth's umbral shadow.

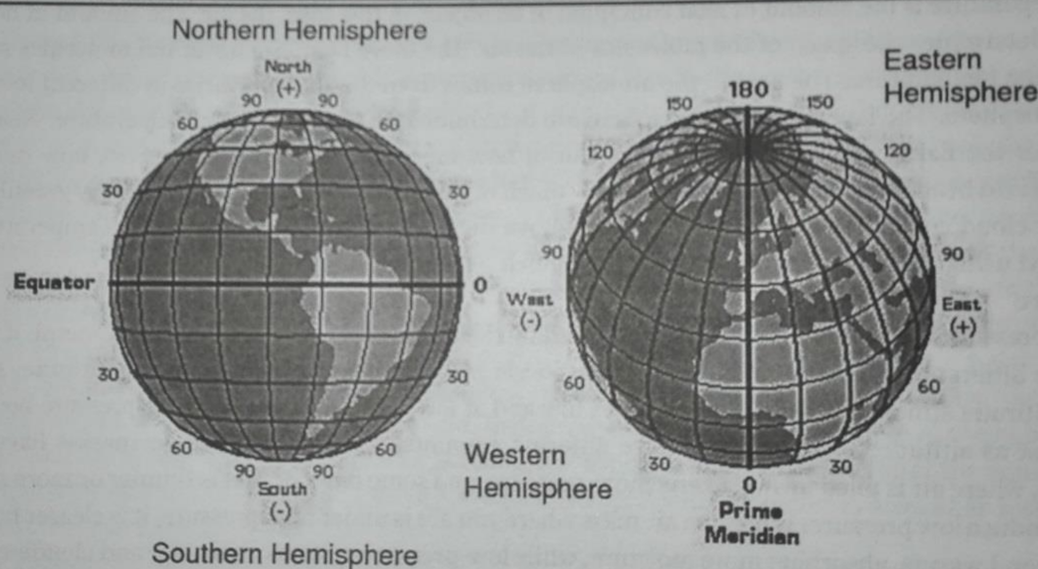


Penumbral lunar eclipse occurs when the Moon passes through Earth's penumbral shadow. In this eclipse, none of the lunar surface is completely shaded by Earth's umbra



	Solar Eclipse	Lunar Eclipse
Health risk	Retina gets damaged if Sun seen directly with a naked eye	Safe to look at moon during eclipse
Position of earth and moon	Moon lies between Sun and Earth	Earth lies between the Sun and Moon
Types	Total, Partial, Annular	Total, Partial, Penumbral
Occurrence	During day time	At night
Frequency of occurrence	A few every year, total being less frequent	Twice a year or more
Visibility	Sun gets blocked by moon; eclipse visible only in some areas	Moon completely obscured, visible partially or in an orangish hue; visible from all night time places
Duration	Usually a few (7) minutes	A few hours (nearly 2hrs)
	Localized to one spot on the Earth	Any one facing the moon can see it

LATITUDE AND LONGITUDE



Latitude

These are the imaginary lines running horizontally around the globe. Also called **parallels**, latitude lines are **equidistant** from each other. The Equator is the line of 0° latitude, the starting point for measuring latitude. The latitude of the North Pole is 90° N, and that of the South Pole is 90° S. Each degree of latitude is about 69 miles (110 km) apart. Each degree is further divided into smaller lines. There are 60 minutes in one degree. Zero degrees (0°) latitude is the equator, the widest circumference of the globe. Latitude is measured from 0° to 90° north and 0° to 90° south—90° north is the North Pole and 90° south is the South Pole.

Longitude

These are imaginary lines, also called **meridians**, running vertically around the globe. Unlike latitude lines, longitude lines are not parallel. Meridians meet at the poles and are widest apart at the equator. Zero degrees longitude (0°) is called the **prime meridian** (an imaginary line running from north to south through Greenwich, England). The degrees of longitude run 180° east and 180° west from the prime meridian.

WEATHER VARIABLES

Weather is simply the current state of the atmosphere at a specific location at any given point in time or over a short period of time. It changes from day to day, even from hour to hour. It can be sunny and hot in the morning and cold and wet in the evening. *So **weather** reflects the short-term conditions of the atmosphere*. This is different than **climate**, *which refers to the long-term average of the daily weather for that location. It is weather over a long period of time.* There are five factors that determine the state and condition of the atmosphere and, therefore, influence and determine the weather. These factors are known as weather variables. They include:

1. Global Temperature
2. Pressure
3. Circulation
4. Precipitation
5. Humidity

Global Temperature

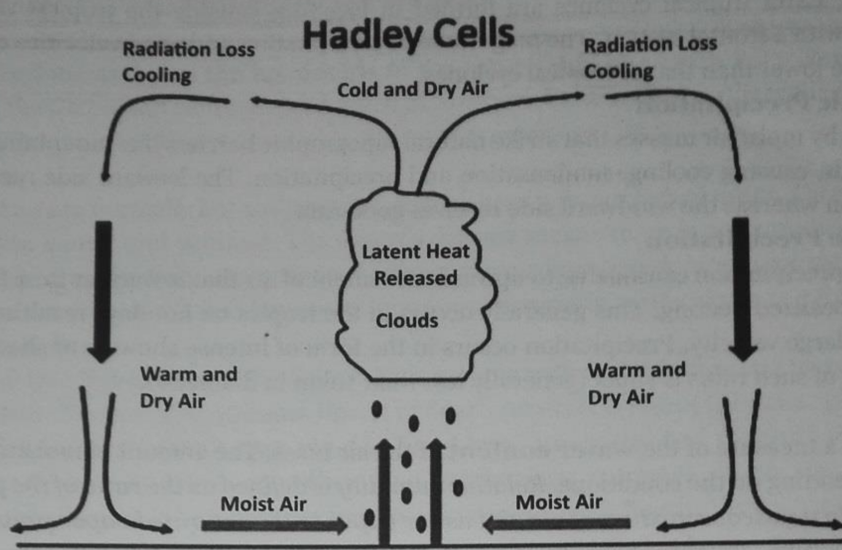
Temperature is the amount of heat contained in an object, in this case, the air. The amount of heat in the air determines the speed of the molecules in the air. The more heat, the faster the molecules move, raising the temperature. The heat in the atmosphere comes from the sun and varies at different levels in the atmosphere. The layers of the atmosphere are determined generally by their temperature. Near the surface of the Earth, the temperature is a factor of how much sunlight an area receives, how much is changed into heat at the earth's surface and how much of that heat is held near the surface by greenhouse gases or cloud cover. The higher the elevation above the ground, the cooler the air is. Temperature is measured using a thermometer in degrees, Fahrenheit or Celsius.

Pressure

Air pressure is the amount of pressure exerted by the air in a particular air mass. In general, it is the pressure differences in space and time. Atmospheric pressure changes with changing altitude. At the higher altitude atmospheric pressure becomes low and at lower altitudes atmospheric pressure becomes high. Just as altitude, air masses can have differing amounts of pressure. Some air masses have high pressure, where air is piled up and exerts more pressure, and some have air that is thinner or more spread out to produce low pressure. When the air mass where you are is under high pressure, it is clearer because air sinks and warms, absorbing more moisture, while low-pressure systems are cooler and cloudier, often producing storms. Usually, rising pressure brings fair weather and falling pressure brings poor weather. Air pressure is also called barometric pressure because it is measured using a barometer and commonly measured in inches of mercury. The units of pressure are pascals (Pa).

Circulation

The worldwide system of winds, which transports warm air from the equator where solar heating is greatest towards the higher latitudes, is called the general circulation of the atmosphere, and it gives rise to the Earth's climate zones. The general circulation of air is broken up into a number of cells, the most common of which is called the Hadley cell. Sunlight is strongest nearer the equator. Air heated there rises and spreads out north and south. After cooling the air sinks back to the Earth's surface within the subtropical climate zone between latitudes 25° and 40°. This cool descending air stabilises the atmosphere, preventing much cloud formation and rainfall. Consequently, many of the world's desert climates can be found in the subtropical climate zone. Surface air from subtropical regions returns towards the equator to replace the rising air, so completing the cycle of air circulation within the Hadley cell.



Although the physical reality of Hadley Cells has been questioned, they provide an excellent means for describing the way in which heat is transported across the Earth by the movement of air. Other circulation cells exist in the mid-latitudes and Polar Regions. The general circulation serves to transport heat energy from warm equatorial regions to colder temperate and polar regions. Without such latitudinal redistribution of heat, the equator would be much hotter than it is whilst the poles would be much colder.

Without the Earth's rotation, air would flow north and south directly across the temperature difference between low and high latitudes. The effect of the Coriolis force as a consequence of the Earth's rotation however, is to cause winds to swing to their right in the Northern Hemisphere, and to their left in the Southern Hemisphere. Thus the movement of air towards the equator swings to form the northeast and southeast trade winds of tropical regions. Air flowing towards the poles forms the Westerlies associated with the belt of cyclonic low pressure systems at about 50 to 60° north and south. In general, where air is found to descend, high pressure develops, for example at the subtropical latitudes and again near the poles. Where air is rising, atmospheric pressure is low, as at the equator and in the mid-latitudes where storms or frontal systems develop. An anemometer is a weather instrument that measures wind speed.

Precipitation

Precipitation is any liquid or solid aqueous deposit from the atmosphere. This includes rain, drizzle, snow, ice, hail, diamond dust, snow grains, snow pellets, ice pellets, rime, glaze, frost and dew, and any deposit from fog. For precipitation to occur, the moist air mass should condense. This occurs when the air is cooled so that it is saturated with the same amount of moisture. This is generally accomplished by lifting of the air mass to higher altitudes. After that the product of condensation reaches the ground in the form of precipitation. There are three methods by which air mass gets lifted up resulting in precipitation. The following are the types of precipitation, depending on the way in which air is cooled and condensed to cause precipitation:

1. **Cyclonic Precipitation**

   It is caused by the lifting of air mass due to pressure difference. A cyclone is a large low pressur region with circular wind motion. There are two types of cyclones – viz. tropical cyclones and extr tropical cyclones. Tropical cyclones originate in summer months in the open ocean at around 5 to 1 degree latitude and move at about 10-30kmph to higher latitudes. They are associated with intens depression. Extra tropical cyclones are formed in locations outside the tropical zone. These are associated with a frontal system. The magnitude of precipitation and wind velocities of extra tropical cyclones are lower than that of tropical cyclones.

2. **Orographic Precipitation**
   It is caused by moist air masses that strike natural topographic barriers like mountains, causing them rise upwards, causing cooling, condensation and precipitation. The leeward side receives very little precipitation whereas the windward side receives good rain

3. **Convective Precipitation**
   Convective precipitation caused due to upward movement of air that is warmer than the surrounding air due to localized heating. This generally occurs in the tropics on hot days resulting in vertical air currents of large velocity. Precipitation occurs in the form of intense showers of short duration. The areal extent of such rains is small (generally less than 10km in diameter).

Humidity

Humidity is a measure of the **water content** of the air mass. The amount of moisture in the air can vary widely depending on the conditions. *Relative humidity is defined as the ratio of the partial pressure of water vapor in a gaseous mixture of air and water vapor to the saturated vapor pressure of water at a given temperature.* Relative humidity is expressed as a percentage. Relative humidity is often mentioned in weather forecasts and reports, as it is an indicator of the likelihood of precipitation, dew or fog. In hot summer weather, it also increases the apparent temperature to humans (and other animals) by hindering the evaporation of perspiration from the skin as the relative humidity rises. A **hygrometer** is an instrument used to measure relative humidity. Associated with relative humidity is dew point (If the dew point is below freezing, it is referred to as the frost point). **Dew point** is the temperature at which water vapor saturates from an air mass into liquid or solid usually forming rain, snow, frost, or dew. Dew point normally occurs when a mass of air has a relative humidity of 100%. This happens in the atmosphere as a result of cooling through a number of different processes. Psychrometer is an instrument alternative to hygrometer to measure dew point humidity.

CLIMATE VARIATIONS

Weathers around the world differ greatly and do not easily fit into precise climatic categories. Large variations in climate occur across relatively small distances. However, it is useful to split different weather types into a number of categories according to describable weather patterns. Climate zones can be categorised in a number of different ways but commonly used climate zones include: temperate, polar, arid, mediterranean, tropical and mountainous.

Temperate Climate

Temperate climate zones lie between the tropics and the polar circles. In these regions the changes between summer and winter are not extreme but temperate climates can have very unpredictable weather. Temperate zones cover about 7% of the world's land surface but are by far the most popular areas in which to live—providing a home to around four-tenths of the Earth's population. This is largely due to the mildness of the climate, the plentiful supply of rain and generally very fertile soils. Countries with temperate climates include the UK, New Zealand, eastern Asia and southern Chile as well as much of northwest Europe and coastal areas of North America.

Polar Climate

Polar climates are located in the high latitudes of the world and are marked by a permanent covering of snow and ice throughout the year. The high latitude of the Polar Regions means that the sun's warming effect is diminished and this results in the temperatures rarely reaching above freezing. In winter, the Polar Regions are covered in darkness and temperatures can fall as low as -80°C in the Antarctic and -

50°C in the Arctic. The summer temperatures can reach 10°C in the Antarctic and up to 30°C in some areas of the Arctic. The average annual rainfall in Polar Regions is very low - often less than 250 mm. This makes these regions as dry as the hot deserts of the sub-tropics. The north Polar Regions include the Arctic Ocean, the Greenland continent and much of Northern Canada and Northern Siberia while the vast mountainous Antarctic continent dominates the southern polar region.

Arid Climate

Arid climates are normally hot and very dry, so they have a severe lack of water. There are two seasons in arid climates: winter and summer. The desert's dryness means there is no humidity and so the skies are clear. *They have big daily and seasonal temperature ranges, with high daytime temperatures in summer up to a very hot 50°C, and low night-time temperatures in winter down to a freezing cold 0°C or in the Gobi much lower.*

Deserts fall into this category. The Sahara Desert along with Saudi Arabia and large parts of Iran and Iraq all have arid climates. The Atacama Desert in South America is one of the driest places on earth and some parts of this desert haven't seen any rain for at least 400 years. And the Gobi Desert in Northern China is characterized by harsh conditions and temperature extremes which can push most living organisms to their limits. When rains do fall, they can cause flash floods. Very strong winds can create desert sand or dust storms.

Mediterranean Climate

A Mediterranean climate produces hot, dry summers and cooler, wetter winters, making these areas popular with tourists in search of abundant sunshine. The hot and dry summers and normally frost-free winters make this climate ideal for growing citrus fruit. Many plants and a few animals cope with this climate by doing most of their growing in spring and autumn and going to sleep during the hot dry summer.

This type of climate obviously occurs in regions around the Mediterranean Sea, such as Italy, Spain and Greece, but you can also get a Mediterranean-style climate in coastal parts of California, South Africa and southern parts of Australia. In winter, temperatures rarely drop below 5°C (41°F) and are more likely to be in the region of 12°C to 13°C(53°F to 55°F) while in summer averages can be up to 27°C (80°F).

Tropical Climate

The zone known as the Tropics lies between the Tropic of Cancer at 23.5° N latitude and the Tropic of Capricorn at 23.5° S latitude. Tropical climates are often associated with the rich variety of plants, insects and animals found in jungles and rain forests.

Much of the equatorial belt within the tropical climate zone experiences hot and humid weather. There is abundant sunshine but heavy rainfall, and thunderstorms can occur almost every day. Areas with tropical climates include the Amazon Basin in Brazil, the Congo Basin in West Africa, Malaysia, southern Vietnam and Indonesia.

a. Temperatures

Temperatures in the tropics rarely exceed 35°C because a large proportion of the sun's heat is used up in evaporation and rain formation. A daytime maximum of 32°C is common, with night-time temperatures falling to about 22°C. Temperatures in the tropics remain constantly high throughout the year, with as little as 2°C separating the highest noon temperature from the lowest throughout the year.

b. The Seasons

The seasons, as far as they exist, are distinguished by changes in rainfall and cloud cover rather than by periods of hot or cooler weather. On the equator there tend to be two wet and two dry seasons but as you move away from the equator the two rainy seasons merge into one, and the climate becomes more monsoonal, with one wet season and one dry season.

Mountain Climate

Mountains have a significant effect on weather and climate at both a local and a global level. Mountains create their own climate no matter where they are located and tend to be much wetter than their surrounding areas. In the western highlands of Scotland, for example, the average annual rainfall is 4577mm, while on the east coast of Scotland, rainfall can be as low as 550mm. This is because the Grampian and Cairngorm mountain ranges force moist air to rise and condense and fall as precipitation.

a. Sub-Climates

The climates on mountains can vary greatly depending on altitude and aspect. For every 1000 metres you climb it is usually 6°C colder and high mountain ranges may be split into several sub-climate zones.

For instance, mountains in tropical climates may have foothills covered in rainforests but their upper slopes may be covered in pine forests. Above the tree line you may find alpine plants which can withstand the harsh conditions.

The highest slopes and peaks may be bare rock and covered in snow and ice. Examples of these types of mountain climates can be found in the Himalayas, the Rocky Mountains and the Andes. In Africa, only Mount Kenya, Kilimanjaro and the Rwenzori range are high enough to carry permanent snow.

b. Global Impact

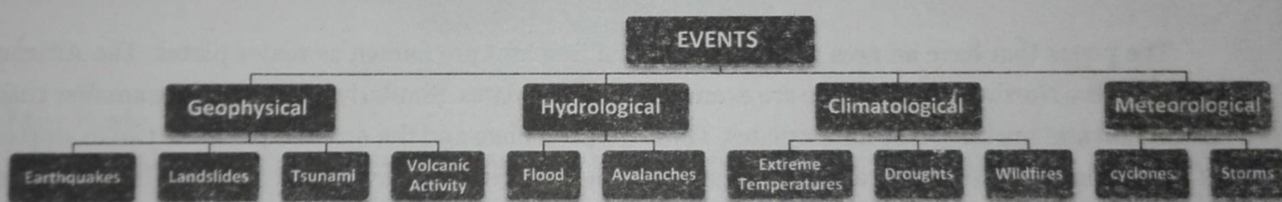
Mountain ranges on the Earth can dramatically influence global climate too. The Rocky Mountains that stretch along the western side of North America, for example, deflect air to the north, which cools in the polar latitudes before returning south. The colder north-westerly wind influences the climates of the Canadian and United States interiors, and winter temperatures can be very low.

CHAPTER 3
NATURAL HAZARDS AND DISASTERS

Natural hazards are naturally occurring physical phenomena. These are a result of natural processes of the Earth. In severe cases, they result in unprecedented loss of life and property. For example, the 1931 floods in China resulted in the deaths of approximately 4 million people. Similarly, the World Bank estimated that the 2011 Earthquake and Tsunami in Japan resulted in economic losses of over $235 billion.

A **disaster** is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. Though often caused by nature, disasters can have human origins. The equation (VULNERABILITY+ HAZARD) / CAPACITY = DISASTER summarizes the occurrence of a disaster. It shows that disaster occurs when a hazard impacts on vulnerable people. The combination of hazards, vulnerability and inability to reduce the potential negative consequences of risk results in disaster.

Natural disasters can be of different types, and their major categories are discussed below. The events are categorized into:



Others are Technological or man-made hazards (complex emergencies/conflicts, famine, displaced populations, industrial accidents and transport accidents) are events that are caused by humans and occur in or close to human settlements. This can include environmental degradation, pollution and accidents. Now there will be the discussion on the **natural disasters** and their types.

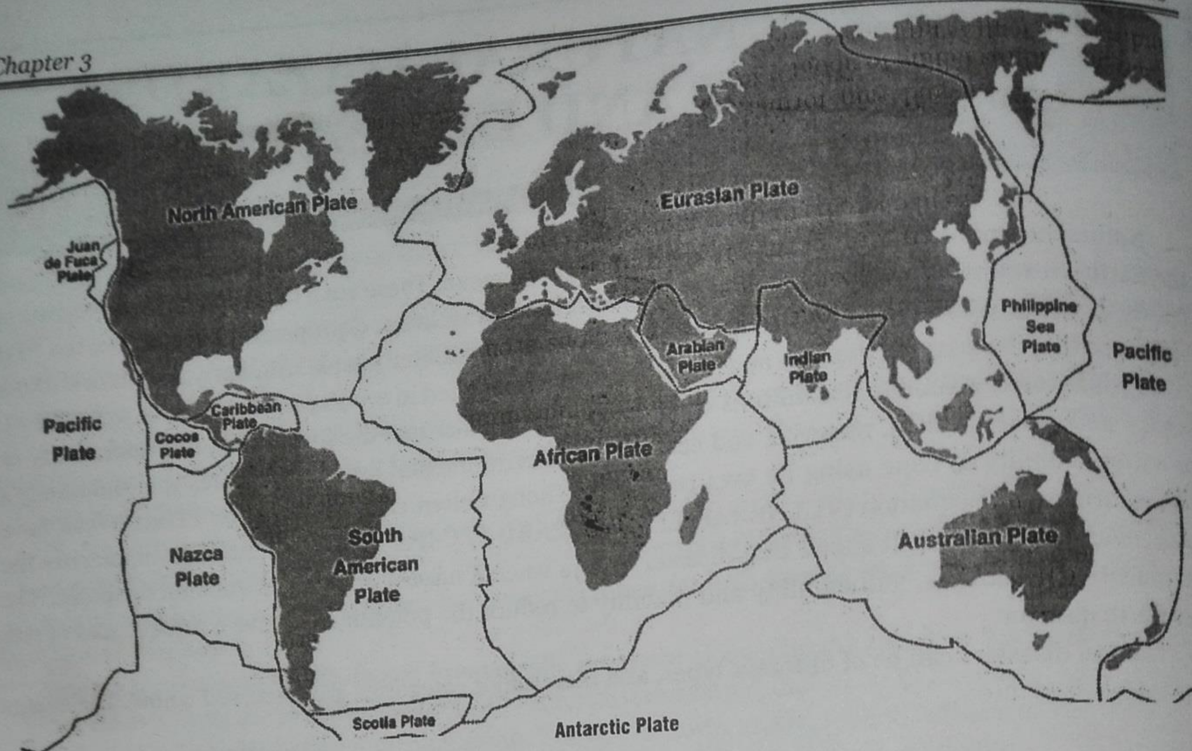
EARTHQUAKES

These are by far the most unpredictable and highly destructive. They occur due to sudden release of energy during tectonic activities within the Earth's crust; the release of energy that has slowly built up during the stress of increasing deformation of rocks. An Earthquake is a sudden lateral or vertical disturbance of rock along a rupture surface. It is shaking of the earth's surface caused by rapid movement of the earth's rocky outer layer. The released energy is transmitted to the surface of the earth by earthquake waves. The energy released radiates in all directions from the place of movement. These pulses of energy are known as seismic waves, and they can pass through the entire earth, or part of it. Thus a strong earthquake in northern hemisphere can be recorded by a seismograph in southern hemisphere.

Causes of Earthquake

1. **Tectonic Plates Movement**

   The major cause of the earthquakes is tectonic movement of the earth crust. These earthquakes occur due to structural adjustments inside the earth. The earth's lithosphere is divided into tectonic plates of various sizes.

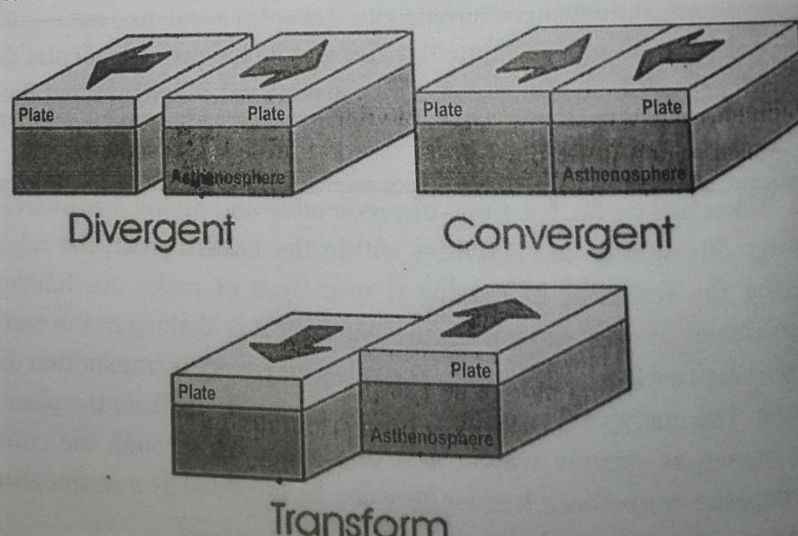


The plates that have an area greater than 20 million km² are known as major plates. The African plate and the North American plate are examples of major plates. Similarly, plates that are smaller than 20 million km² are known as minor plates. The Caribbean plate and the Arabian plate are two examples of minor plates. Lastly, there are micro plates, which are those that have an area of less than 1 million km². All these plates are floating on *Asthenosphere* which is the upper part of the Mantle. The movements of the tectonic plates can be classified into three main categories:

a. **Transform / Lateral movements** are those in which plates rub against each other (san Andreas fault in California)

b. **Convergent movements** are those in which plates sink beneath each other (Peru-Chile Trench along with western border of South America)

c. **Divergent movements** are those in which plates spread apart from each other (Mid-Atlantic Ridge).



2. Volcanic Activity

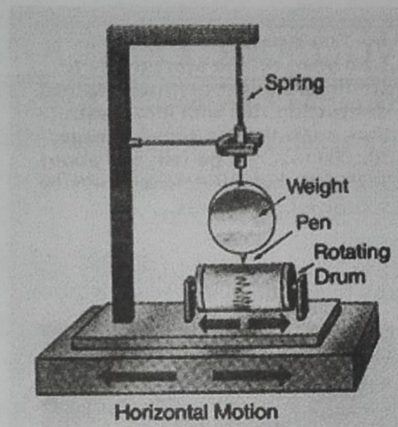
Earthquakes are sometimes caused by volcanic activity but they are usually local and seldom cause any extensive damage.

3. Miscellaneous Causes

Many other factors like light intensity, land sliding, mining and underground atomic explosion etc. can also cause earthquakes.

Seismograph

The intensity of the earthquake's wave can be measured by seismograph. It consists of a pendulum, at the end of which is fixed a pen. The point of the pen touches a card or paper, rolled over a cylinder. When there is an earthquake, zigzag lines are marked, and from these the intensity of the waves and the distance from the place of origin can be understood.



Richter Scale

Richter scale is a logarithmic scale used to measure the intensity of earthquakes. Intensity of earthquake is given in the following table:

Richter Magnitude	Earthquake effects
0-2	Not felt by people
2-3	Felt little by people
3-4	Ceiling lights swing
4-5	Walls crack
5-6	Furniture moves
6-7	Some buildings collapse
7-8	Many buildings destroyed
8-Up	Total destruction of buildings, bridges and roads

Deadliest Earthquakes

There have been several deadly earthquakes in over the past century. The tables below give the lists of most destructive earthquakes in Pakistan, and the world.

PAKISTAN (Since 1947)			
Year	Location	Magnitude	Deaths
2005	Kashmir	7.8	86,000
1974	Hunza	6.2	5300
2013	Balochistan	7.7	1225
2015	Hindu Kush	7.5	363
2008	Ziarat	6.4	215

GLOBAL (Since 1900)			
Year	Location	Magnitude	Deaths
1920	China	7.8	273,400
1976	China	7.8	242,769
2004	Indian Ocean	9.1-9.3	230,210
1908	Italy	7.1	123,000
1948	USSR	7.3	110,000
2010	Haiti	7.0	100,000
2005	Pakistan	7.6	86,000

VOLCANIC ERUPTION

Magma forms when a part of the earth's upper mantle or lower crust melts. A volcano is essentially an opening or a vent through which this magma and the dissolved gases it contains are discharged. So volcanos are vents in the Earth's surface that make volcanic eruptions possible. Volcanic eruption refers to the discharge of magma, solid rock and gasses from volcanos.

Causes of Volcanic Eruption

Although there are several factors triggering a volcanic eruption, three predominate: the buoyancy of the magma, the pressure from the gases in the magma and the injection of a new batch of magma into an already filled magma chamber.

Volcanic eruptions are largely thought to occur when there is a huge pressure difference between the broiling magma within the chamber and the outside world. When this pressure difference becomes too large for the encasing rock to keep it in, it fractures, allowing the magma to violently decompress onto the surface. Pressure is largely controlled by gas content of magma. This is often due to different types of magma mixing in the chambers. Lighter, less-dense magma naturally rises, but if a bubble of lighter magma builds beneath a denser, viscous reservoir of magma, the pressure can build up inside the chamber. Eventually, it becomes enough to force the heavier magma through the volcano's vent, causing an explosive eruption.

As rock inside the earth melts, its mass remains the same while its volume increases, producing a melt that is less dense than the surrounding rock. This lighter magma then rises toward the surface by virtue of its buoyancy. If the density of the magma between the zone of its generation and the surface is less than that of the surrounding and overlying rocks, the magma reaches the surface and erupts.

Another cause of volcanic eruptions is an injection of new magma into a chamber that is already filled with magma of similar or different composition. This injection forces some of the magma in the chamber to move up in the conduit and erupt at the surface.

Types of Eruptions

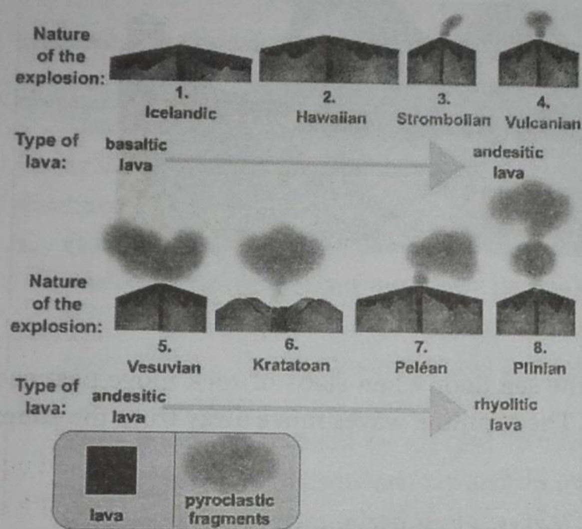
Volcanic activity and volcanic areas are commonly divided into major categories based on the intensity of the explosion, as well as the kind of lava that is given out. The categories of explosion are listed in ascending order in the diagram below. While studying the diagram below, it is important to understand the following terms:

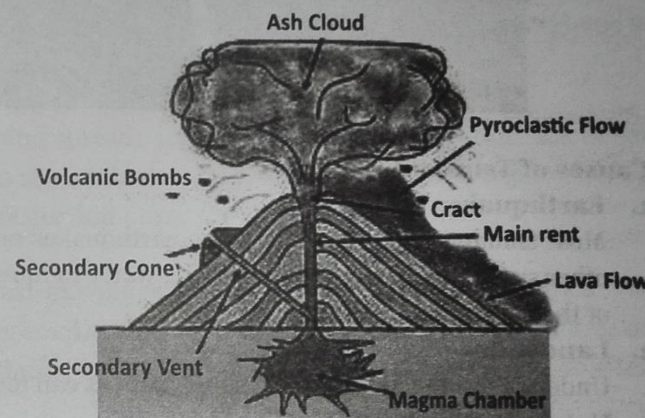
a. **Pyroclastic fragments** are instant fragments that are produced by volcanic processes. These include rocks, gases and magma.

b. Basaltic lava is characterized by its low gas content and low viscosity. The low viscosity is due to the low silica (silicon dioxide) content.

c. Andesitic lava has high gas content and viscosity. This high viscosity is due to high levels of silicon dioxide present in it. This also allows it to trap gas, which results in explosive eruptions.

d. Rhyolitic lava has complex silicon compounds, which give it an extremely high viscosity and allow it to trap a lot of gas. This causes the build up of a lot of pressure, and these eruptions are the most catastrophic in nature.





Deadliest Volcanic Eruptions

There have been several deadly volcanic eruptions in recorded history. Some of the major ones are listed in the table below.

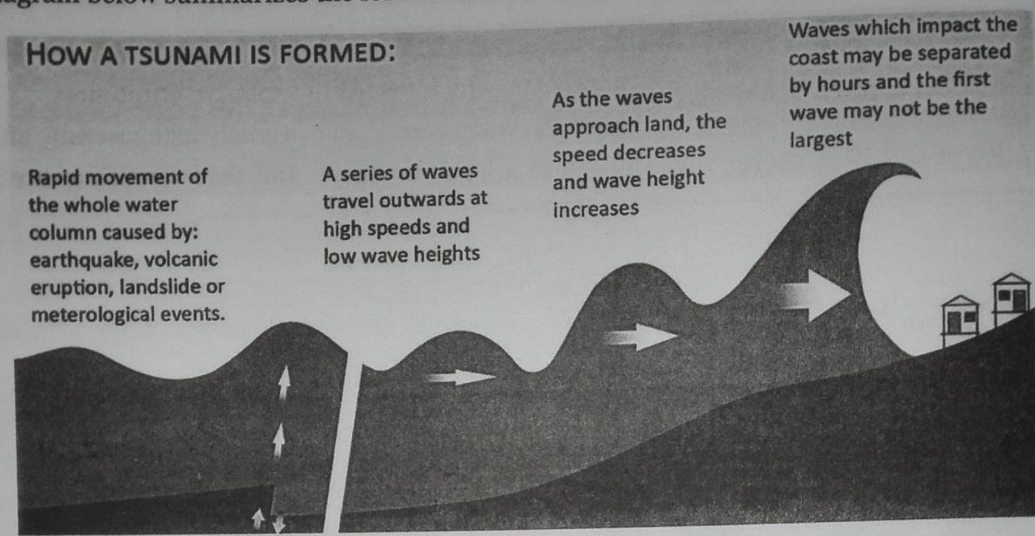
GLOBAL (since 1500)			
Year	Location	Name of Volcano	Deaths
1815	Indonesia	Mount Tambora	92,000
1883	Indonesia	Mount Krakatoa	36,000
1902	Caribbean Sea	Mount Pelée	29,000
1985	Columbia	Mount Nevado	23,000
1792	Japan	Mount Unzen	15,000

TSUNAMI

Tsunami are the waves caused by sudden movement of the ocean due to earthquakes, landslides on the seafloor, land slumping into the ocean, large volcanic eruptions or meteorite impact in the ocean. The events like Earthquakes and volcanic eruptions cause the sea floor to move resulting in sudden displacement of ocean water in form of high vertical waves. Seismologists say only earthquakes measuring greater than 7.0 on the Richter scale can produce a major tsunami. These are generated in subduction zone. A *subduction zone* is a region of the Earth's crust where tectonic plates meet. They are sometime impossible to perceive in Deep Ocean but when they reach shallow coastal waters they build up to several feet in height and may crash on the coastal line with devastating effect.

Tsunami Formation

The diagram below summarizes the formation of a tsunami.

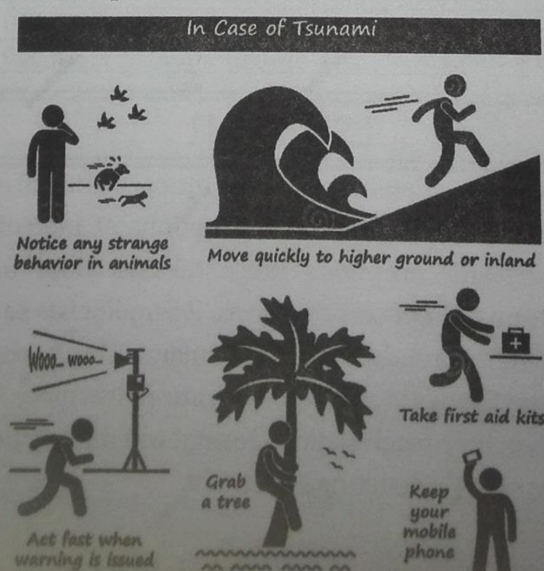


Causes of Tsunami

1. **Earthquakes**
   Most tsunamis are caused by large earthquakes on the sea floor when slabs of rock move past each other suddenly, causing the overlying water to move. The resulting waves move away from the source of the earthquake event.
2. **Landslides**
   Underwater landslides can cause tsunami as can terrestrial land which slumps into the ocean.
3. **Volcanic Eruptions**
   Less common are tsunami initiated by volcanic eruptions. These occur in several ways:
   a. Destructive collapse of coastal, island and underwater volcanoes which result in massive landslides
   b. Pyroclastic flows, which are dense mixtures of hot blocks, pumice, ash and gas, plunging down volcanic slopes into the ocean and pushing water outwards
   c. A caldera volcano collapsing after an eruption causing overlying water to drop suddenly

Preventive Measures after Occurrence of Tsunami

The figure below summarizes the steps with visual demonstration about what to do in case of a tsunami:



Deadliest Tsunamis

There have been several deadly tsunamis in recorded history. Some of the major ones are listed in the table below.

GLOBAL (since 1500)		
Year	Location	Deaths
2004	Indian Ocean	280,000
1908	Italy	123,000
1883	Indonesia	120,000
1755	Portugal	50,000
1707	Japan	30,000

FLOOD

Flood is a natural event or occurrence where a piece of land that is usually dry, suddenly gets submerged under water. Some floods occur suddenly and recede quickly. Others take days or even months to build and discharge. There are several types of flooding, which are listed below

1. **Overbank Flooding**
   The water within a river overflows its banks and spreads across the land around it. Overbank flooding takes days to dissipate in plain areas while in mountainous areas, where water flows together through steep valleys, the flood water tends to move faster and linger for a shorter duration.
2. **Flash Floods**
   They are characterized by a rapid rise of fast-moving water, which is extremely dangerous. Water moving at 9 feet per second (2.7 meters per second), a common speed for flash floods, can move rocks weighing almost a hundred pounds. Flash floods carry debris that elevate their potential to damage structures and injure people.
3. **Ice Jam Flooding**
   In cold temperatures, bodies of water are often frozen. Heavy precipitation can cause chunks of ice to push together and create a dam in what is known as ice jam flooding. Behind the dam, water begins to pile up, spilling over to the plains nearby. Eventually, the wall of ice breaks, and fast-moving water rushes downstream much like a conventional flash flood, destroying objects in its path. The water carries huge chunks of ice, which can increase damage to surrounding structures.
4. **Coastal Flooding**
   It occurs along the edges of oceans, and is driven predominantly by storm surges and wave damage. This is usually connected to hurricanes, tsunamis or tropical storms.

Causes of Flooding

Here are a few events that can cause flooding

1. **Rain**
   Each time there are more rains than the drainage system can take, there can be floods. Sometimes, there is heavy rain for a very short period that results in floods. In other times, there may be light rain for many days and weeks and can also result in flood.
2. **Rivers Overflow**
   Rivers can overflow their banks to cause flooding. This happens when there is more water upstream than usual and as it flows downstream to the adjacent low-lying areas (also called a floodplain).
3. **Strong Winds in Coastal Areas**
   Sea water can be carried by massive winds and hurricanes onto dry coastal lands and cause flooding. Sometimes water from the sea resulting from a tsunami can flow inland to cause damage

4. Dam Breaking

Dams are man-made blocks mounted to hold water flowing down from a highland. The power in the water is used to turn propellers to generate electricity. Sometimes, too much water held up in the dam can cause it to break and overflow the area. Excess water can also be intentionally released from the dam to prevent it from breaking and that can also cause floods.

5. Ice and Snow Melts

In many cold regions, heavy snow over the winter usually stays un-melted for some time. There are also mountains that have ice on top of them. Sometimes the ice suddenly melts when the temperature rises, resulting in massive movement of water into places that are usually dry. This is usually called *a* snowmelt flood.

6. A Lack of Vegetation or Woodland

Trees and plants intercept precipitation (i.e. they catch or drink water). If there is little vegetation in the drainage basin, then surface run-off will be high.

Effects of Flooding

Floods can have devastating consequences and can have effects on the economy, environment and people.

1. Economic

During floods (especially flash floods), roads, bridges, farms, houses and automobiles are destroyed. People become homeless. Additionally, the government deploys firemen, police and other emergency apparatuses to help the affected. All these come at a heavy cost to people and the government. It usually takes years for affected communities to be re-built and business to come back to normalcy. For example, the 2010 floods were one of the most devastating in Pakistan's history. According to the Economic Survey of Pakistan, the estimated damage from these floods was worth over $10 billion.

2. Environment

The environment also suffers when floods happen. Chemicals and other hazardous substances end up in the water and eventually contaminate the water bodies that floods end up in. In 2011, a huge tsunami hit Japan, and sea water flooded a part of the coastline. The flooding caused massive leakage in nuclear plants and has since caused high radiation in that area. Authorities in Japan fear that Fukushima radiation levels are 18 times higher than even thought. Additionally, flooding causes kills animals, and others insects are introduced to affected areas, distorting the natural balance of the ecosystem.

3. People and Animals

Many people and animals die in flash floods. Many more are injured and others made homeless. Water supply and electricity are disrupted and people struggle and suffer as a result. In addition to this, flooding brings a lot of diseases and infections including military fever, pneumonic plague, and dysentery. Sometimes insects and snakes make their ways to the area and cause a lot of havoc.

Flood Management Techniques

Flood management strategies generally involve multiple engineering projects that can fall under one of two categories. Hard engineering projects are ones that involve the construction of artificial structures that, through a combination of science, technology and a bit of brute force, prevent a river from flooding. Soft engineering projects are the opposite. These projects use natural resources and local people's knowledge of the river to reduce the risk posed by a flood. Each type of project has its advantages and disadvantages.

1. **Hard-Engineering Options** are generally very successful and have a large impact on the river. However, they have a greater impact on the natural landscape and the environment. There's also the high cost, technological requirements & maintenance of hard engineering projects that makes them unfeasible in countries without significant economic resources. Examples of hard engineering options include the following:

a. Dam Construction

Dams are often built along the course of a river in order to control the amount of discharge. Water is held back by the dam and released in a controlled way. This controls flooding. Water is usually stored in a reservoir behind the dam. This water can then be used to generate hydroelectric power or for recreation purposes. It should be noted that building a dam can be very expensive. Moreover, sediment is often trapped behind the wall of the dam, leading to erosion further downstream. Settlements and agricultural land may be lost when the river valley is flooded to form a reservoir.

b. River Engineering

The river channel may be widened or deepened allowing it to carry more water. A river channel may be straightened so that water can travel faster along the course. The channel course of the river can also be altered, diverting floodwaters away from settlements. Altering the river channel may lead to a greater risk of flooding downstream, as the water is carried there faster.

2. **Soft-Engineering Options** are usually less expensive and long term. They are sustainable and have a lower impact on the environment. Soft engineering projects focus more on reducing the impacts of a flood rather than preventing one. The biggest advantage of soft engineering is cost. Soft engineering projects are significantly cheaper than hard engineering projects making them more suitable for less developed countries. They also have lower education and technology requirements so they can be implemented by local people in remote parts of poor countries. Soft engineering projects are more sustainable than their hard engineering counterparts. Soft engineering projects are low maintenance and low cost unlike hard engineering projects. In addition, they don't disturb the natural processes and ecological systems in a river basin instead choosing to integrate with them and in some cases improve them. Examples of soft engineering options include the following:

a. Afforestation

Trees are planted near to the river. This means greater interception of rainwater and lower river discharge. This is a relatively low cost option, which enhances the environmental quality of the drainage basin.

b. Managed Flooding

This method is also known as ecological flooding. The river is allowed to flood naturally in places, to prevent flooding in other areas for example, near settlements.

c. Long term Planning

Local authorities and the national government introduce policies to control urban development close to or on the floodplain. This reduces the chance of flooding and the risk of damage to property. There can be resistance to development restrictions in areas where there is a shortage of housing. Enforcing planning regulations and controls may be harder in LEDCs.

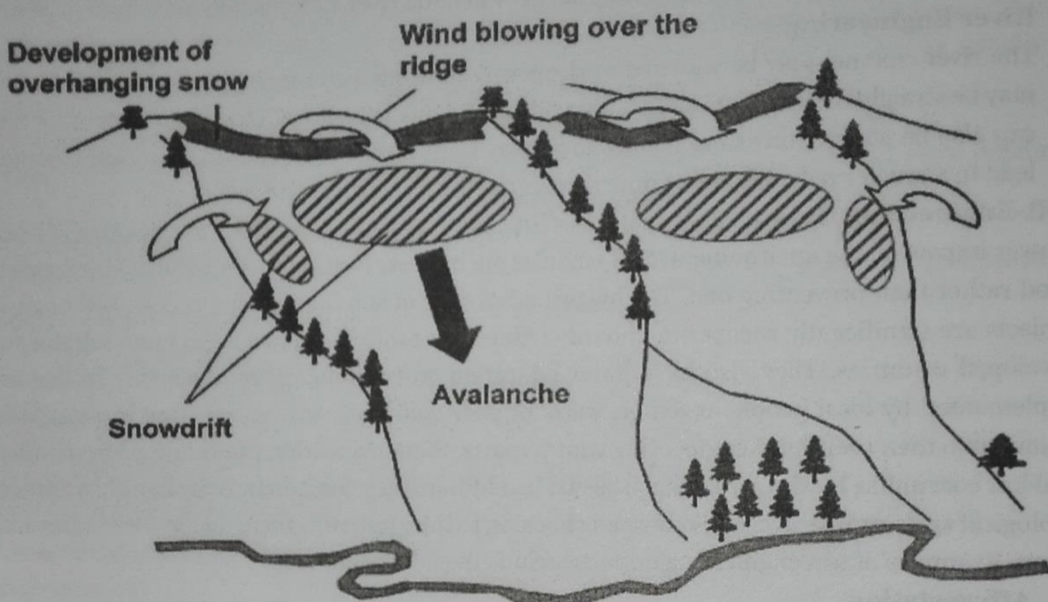
Deadliest Floods

There have been several deadly floods in recorded history. Some of the major ones are listed in the table below.

GLOBAL (since 1500)			
Year	Location	Name of River	Deaths
1931	China	Yangtze and Huai	4,000,000
1887	China	Huang He	2,000,000
1975	China	Banqiao Dam failure	229,000
1935	China	Yangtze	145,000
1971	Vietnam	Hanoi	100,000

AVALANCHE

An avalanche is any amount of snow sliding down a mountainside. It can be compared to a landslide, only with snow instead of earth. Another common term for avalanche is "snow slide". As an avalanche becomes nearer to the bottom of the slope, it gains speed and power, which can cause even the smallest of snow slides to be a major disaster.



Types of Avalanches

Avalanches can be divided into four main categories:

1. **Loose Snow Avalanches**
   These avalanches are common on steep slopes and are usually seen after fresh snowfall. Since the snow does not have time to settle down fully or has been made loose by sunlight, the snowpack is not very solid. Such avalanches have a single point of origin from where they widened as they travel down the slope.
2. **Slab Avalanches**
   Loose snow avalanches in turn could cause a Slab Avalanche, which are characterized by the fall of a large block of ice down the slope. Thin slabs fairly cause small amount of damage, while the thick ones are responsible for many fatalities.
3. **Powder Snow Avalanches**
   These are a mix of other form of avalanches, loose snow and Slab. The bottom half of this avalanche consists of slab or dense concentration of snow, ice and air while above this is a cloud of powdered snow. The speed attained by this avalanche can cross 190 miles per hour and they can cross large distances.
4. **Wet Snow Avalanches**
   These avalanches are quite dangerous as they travel slowly due to friction which collects debris from path fairly easily. The avalanche comprises of water and snow at the beginning and it can pick up speed with ease.

Deadliest Avalanches

The sudden nature of avalanches means that it very difficult to take precautionary measures. An example of such an incident was the 2012 Siachen Glacier avalanche in Pakistan, where 140 people lost their lives. The table below lists the deadliest avalanches

GLOBAL (since 1500)		
Year	**Location**	**Deaths**
1970	Peru	20,000
1916	Italy	10,000
1962	Peru	4,000
2015	Afghanistan	310
1951	Austria – Switzerland	1951

CYCLONES

Cyclones are extremely large, powerful and destructive storms that are built up around an area of low pressure. They rotate in a counterclockwise direction in the northern hemisphere, and a clockwise direction in the southern hemisphere. Cyclones are of different kinds: tropical cyclone, mid-latitude cyclone and tornados.

1. Tropical Cyclone

These are intense low-pressure areas confined to area lying between 30 N and 30 S latitudes. A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation. These are also called **typhoon** or **hurricane.** Tropical cyclones rotate counterclockwise in the Northern Hemisphere.

Formation of Tropical Cyclones

Favorable environmental conditions that must be in place before a tropical cyclone can form are:

a. Warm Ocean waters of at least 80°F / 27°C.

b. Potentially unstable atmosphere which cools fast with height.

c. Moist air near the mid-level of the troposphere (16,000 ft / 4,900 m).

d. Generally, a minimum distance of at least 300 miles (480 km) from the equator.

e. Little vertical wind shears between the surface and the upper troposphere. (Vertical wind shear is the change in wind speed with height.)

Stages of Development of Tropical Cyclones

a. Tropical Depression

A tropical cyclone with maximum sustained winds of 38 mph (33 knots) or less.

b. Tropical Storm

A tropical cyclone with maximum sustained winds of 39 to 73 mph (34 to 63 knots).

c. Hurricane

A tropical cyclone with maximum sustained winds of 74 mph (64 knots) or higher.

d. Major Hurricane

A tropical cyclone with maximum sustained winds of 111 mph (96 knots) or higher, corresponding to a Category 3, 4 or 5 on the Saffir-Simpson Hurricane Wind Scale.

Intensity of Tropical Cyclones

Cyclones can be of varying intensities, depending on the atmospheric conditions that produce them. They are assigned categories based on the potential of the winds to cause damage. This is done by looking at the speed of the winds that make up the cyclone, as well as the speed of the cyclone as it moves from one point to another. The diagram below lists the various intensities cyclones.

Category 1 (Minimal) No real damage to building Structures. Low lying coastal areas flooded, minor damage to piers.

Category 2 (Moderate) Minor damage to structures, poorly constructed buildings major damage. Coastal and low lying escape routes flooded over, considerable pier damage

Category 3 (Extensive) Major damage to structures, poorly constructed building destroyed.

Category 4 (Extreme) Extensive roofing and window damage, complete destruction of mobile homes

Category 5 (Catastrophic) Complete failure of roof structures and very severe window and door damage, some complete buildings fail.

Names of Tropical Cyclones in Different Regions

Tropical cyclones are known by various names in different parts of the world.

a. In the North Atlantic Ocean and the eastern North Pacific they are called *hurricanes.*

b. In the western North Pacific around the Philippines, Japan, and China the storms are referred to as *typhoons*.

c. In the western South Pacific and Indian Ocean, they are variously referred to as *severe tropical cyclones, tropical cyclones, or simply cyclones.*

Deadliest Cyclones

Cyclones have the potential to cause great damage. The table below lists the deadliest cyclones in recorded history.

GLOBAL (since 1500)			
Year	**Location**	**Name of Cyclone**	**Deaths**
1970	East Pakistan	Bhola Cyclone	375,000
1839	India	India Cyclone	300,000
1737	India	Calcutta Cyclone	300,000
1975	China	Typhoon Nina	229,000
1876	India	Backerganj Cyclone	200,000

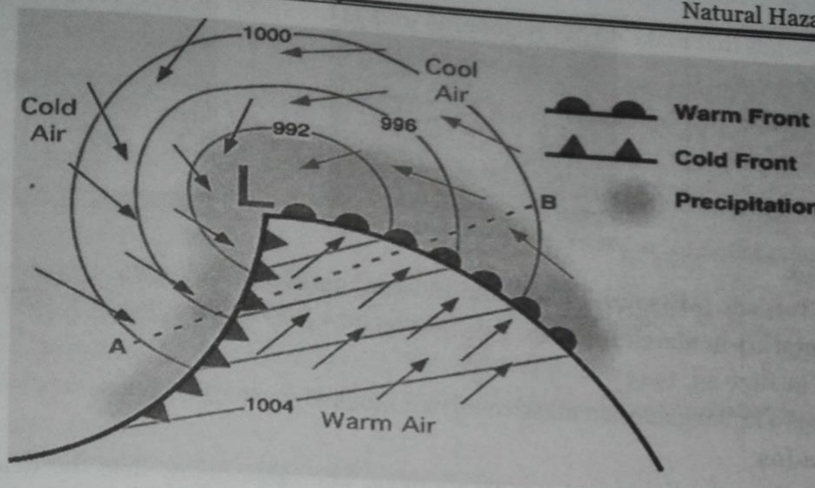
2. Mid-Latitude Cyclones

Mid-Latitude cyclones are also known as *extra-tropical* or *frontal cyclones* occurring in the *middle latitudes* of earth. They are classified as large, traveling, cyclonic storms up to 2000 kilometers in diameter with centers of low atmospheric pressure. An intense mid-latitude cyclone may have a surface pressure as low as 970 millibars, compared to an average sea-level pressure of 1013 millibars. Normally, individual frontal cyclones exist for about 3 to 10 days moving in a generally west to east direction. Mid latitude cyclones cause far less damage than tropical cyclones or hurricanes. Although rare, mid-latitude cyclones can have winds as strong as what is associated with a weak hurricane.

Development of Mid Latitude Cyclones

Mid-latitude cyclones are the result of the dynamic interaction of warm tropical and cold polar air masses at the polar front. This interaction causes the warm air to be cyclonically lifted vertically into the atmosphere where it combines with colder upper atmosphere air. This process also helps to transport excess energy from the lower latitudes to the higher latitudes.

The mid-latitude cyclone is rarely motionless and commonly travels about 1200 kilometers in one day.



Direction of Mid Latitude Cyclones

Its direction of movement is generally eastward. An estimate of future movement of the mid-latitude cyclone can be determined by the winds directly behind the cold front. If the winds are 70 kilometers per hour, the cyclone can be projected to continue its movement along the ground surface at this velocity. Mid-Latitude has a very low pressure and wind will travel around a low pressure area (in the Northern Hemisphere) counterclockwise and inward.

Examples of Mid Latitude Cyclones

a. March 1993: East coast had reported winds of up to 90 knots had over 50 billion tons of snow.

b. Ice Storm in Oregon, 1998 and 2004

3. Tornado

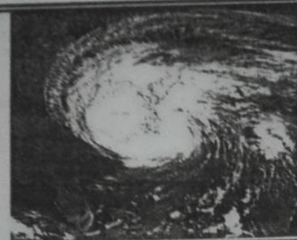
A tornado is a rapidly rotating column of air in contact with the ground. A visible cloud is not needed for a tornado to be in progress. Some tornadoes may not appear to extend to the ground but are causing considerable damage. Tornadoes take on various shapes and sizes, and most produce winds less than 120 mph. However, a few are capable of producing winds over 200 mph. Some tornadoes are very small and last for only a minute or so, while others can be a mile wide or larger and stay on the ground for over an hour.

Formation of Tornado

There are some things that are necessary in order for a tornado to form: A change in wind direction and a high degree of wind speed is necessary in order to have a tornado. Tornadoes need increasing height. They do not just stay at a base level. Lastly, when you have a thunderstorm, air begins to rise which helps form a tornado.

Difference between Hurricanes and Tornadoes

	Hurricanes	Tornadoes
Where they form	Form over warm water in tropical oceans and develop best when far from jet stream	Form over land and form within storms that are often very close to jet stream
Size	Can be up to several hundred miles wide	Usually less than 1 mile wide
How long they last	Can last up to 3 weeks	Usually less than an hours
How strong the winds are	Usually less than 180 mph	The severe ones can be more than 300 mph
Advance warning time	Several days	Usually around 15 minutes



Major Tornadoes

a. The Tri-State Tornado (Missouri, Illinois and Indiana) on March 18th,1925

b. Tornado in Ontario's in March 16, 2016

c. West Virginia in June 23, 1944

d. On April 26, 1989 in Bangladesh a massive tornado took at least 1,300 lives

Deadliest Tornados

Tornados have the potential to cause great damage. The table below lists the deadliest tornados in recorded history.

GLOBAL (since 1500)		
Year	**Location**	**Deaths**
1989	Bangladesh	1300
1969	East Pakistan	923
1925	United States of America	695
1973	Bangladesh	681
1551	Malta	600

DROUGHT

Drought is an extended period of shortage of water due to lack of rainfall. It is a condition of no rains when the standing crops, mostly rain-fed, gets dried up and is destroyed. Drought is defined as the time period when a region gets much less than normal rainfall and is characterized by immense water deficient and this may last for months and sometimes even years. A drought can be announced after a period of only 15 days and is something that brings a lot of suffering for both mankind and other living organisms. The primary drought cause is receipt of less than average precipitation for a prolonged period of time. And this can have a great impact on the ecosystem and agriculture of the affected region. A drought can last for several years and even it does not, a drought that lasts for few days or weeks can have significant effect on the local economy and cause damage. An example of the devastation caused by droughts can be observed in Tharparker, Pakistan. Drought conditions may be worsening in the country with every coming year and lesser rain, particularly in the southern regions, spell trouble for cotton farmers and vulnerable populations in Balochistan and Tharparkar. This is a danger signal for an agrarian economy. Successive droughts were a direct result of climate change which was evident form extreme weather events in 2010, 2011 and 2012. Some parts of the country witnessed heavy rains and even super floods while others like Thar and Lasbela faced drought. In 2015, drought-stricken Thar people faced the fourth drought in a row. There has been only marginal rainfall and that too in isolated areas in the desert region, which is enough neither for producing fodder nor for seasonal crops of cluster beans, millet and sesame. Livestock face more stress.

Causes

The situation of drought arises when there is long spell of severe water shortages. These include the following:

1. Scarcity of rain-fall.

2. Lack of irrigation facilities to supplement the need for water during the period of inadequate monsoon.
3. Lack of properly developed Rain-water harvesting methods
4. Lack of proper planning to deal with the situation.
5. Widespread deforestation and cutting of trees has reduced the ability of soil to hold water. Lack of underground water is a major cause for droughts.

Effects of Drought

Here are some of the effects that drought has:

1. Reduces crop production.
2. Diminishes carrying capacity of livestock.
3. Dust storms and dust bowls thereby making the soil more prone to erosion.
4. Causes famine as less water is available for irrigation.
5. Creates damages in ecosystem that affect both plant and animal life.
6. Causes hunger as agricultural production falls and less food remains for consumption
7. Causes dehydration and malnutrition.
8. Mass migration of masses to a place with sufficient water.
9. The impact of drought is even in the social field. Faced by hunger and frustrated by uncertain future, many of our people indulge into illegal practices creating law and order problem for the government.
10. Wild fires.
11. Economic instability because Industry suffers a setback due to the scarcity of raw materials produced by agriculture.

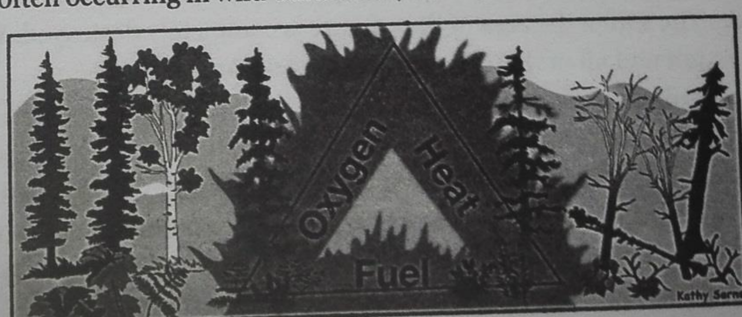
Fighting Drought

To tackle the problem of drought in our country, the following solutions are suggested:

1. All our efforts should be made to preserve rain waters in various ways and tap ground water sources to meet unexpected drought situations.
2. Improved rain-water harvesting methods should be deployed.
3. The people should be educated regarding the importance of water, so that they do-not misuse the stored water
4. New improved methods of irrigation should be introduced.
5. Deforestation should be discouraged to increase the ability of the soil to hold water

WILDFIRE

A wildfire, also known as a wild-land fire, forest fire, vegetation fire, grass fire, peat fire, bushfire (in Australia), or hill fire is an uncontrolled fire often occurring in wild-land areas, but which can also consume houses or agricultural resources. Wildfires often begin unnoticed, but they spread quickly igniting brush, trees and homes. They can wipe out an entire forest and destroy almost every organic matter in it



Wildfire Causes

Wildfires can be caused by nature—like lava or lightning—but most are caused by humans.

1. **Humans and Wildfire**

As many as 90 percent of wild land fires are caused by humans. Below are few of the man-made causes of wildfires.

a. Burning Debris

It is pretty common to burn yard waste in many places. While it is legal to do so, it may cause fires at many places when things go out of hand. Winds play a major role in wildfires. They can cause flames of burning debris to spread into forests or farms or fields.

b. Unattended Campfires

Camping can be of great fun for both young and old age people. Unattended campfires can put things out of control and can cause wildfires. It is therefore recommended to choose safe location for a campfire that is away from ignitable objects and is stocked with a bucket of water and a shovel.

c. Equipment Failure or Engine Sparks

A running engine can spew hot sparks when things go wrong. Car crashes have been known to start fires quickly. Small engine sparks can give way to high flames if that vehicle is operating in a field or a forests.

d. Cigarettes

Cigarettes are another common cause of wildfires. It is common for people to throw the cigarette bud on the ground knowing that it is still burning. Smokers must understand that a small negligence on their part can cause huge impact on the environment and surrounding areas.

e. Fireworks

Fireworks are fun to shoot off, but special care needs to be taken when they are in the hands of amateurs. Fireworks must be avoided even when there is small chance that they could start a wildfire. If not handled properly that may end up as flames in unwanted territory

f. Arson

Arson is the act of setting fire to property, vehicles or any other thing with the intention to cause damage. A person who commits this crime is called an arsonist. Arson is sometime done by people to their own property in order to receive compensation. Arson may account for 30% of all wildfire cases.

2. Nature and Wildfire

Mother Nature is responsible for other 10% of wildfires.

a. Lightening

Lightening can cause wildfires, especially the type of lightning called "hot lightning", which can last for a relatively long time. When it strikes, it can produce a spark which can set off a forest or a field.

b. Volcanic Eruption

Hot burning lava, from volcanic eruptions, also causes wildfires.

Effects of Wildfires

1. Wildfires take away homes, wildlife, as well as vegetation.
2. The soil in the area of the wildfire is completely destroyed. When a wildfire hits this soil it becomes too hot and all of those nutrients are gone for good.
3. Animals lose their lives.
4. Trees and plants are gone, which increase environmental pollution.
5. Too much water in the soil can cause erosion. Firefighters use a great deal of water to put out these vicious wildfires. Too much water in the soil causes it to erode and make it useless.
6. Large amount of smoke is released into the air which makes it difficult to breathe and also causes air pollution.
7. Unfortunately, some human lives are also lost in wildfires. Typically people who are fighting the fire who lose their lives trying to save others.
8. Ash and smoke can cause serious health problems to humans who suffer from allergies and other medical problems. This same smoke and ash has the ability to permanently damage the lungs and the throat.

9. Incomes and jobs are lost for workers in the agricultural field whose field crops and animals were destroyed by the wildfire.
10. The loss of animals has the ability to also create extinction for certain animals and other creatures of the forest.

How to Prevent Wildfires

1. Follow all of the local regulations and laws regarding burning fires during various times of day, year, and what materials and substances are permitted to be burned.
2. Keep up to date with the weather forecast so you are sure not to burn any substances while there are high winds or other treacherous conditions.
3. Only light fires in areas that are easily controlled locations.
4. Do not burn any materials that are combustible or unusual in nature.
5. Put your cigarette out completely before disposing of it.
6. Teach your children the rules and safety precautions of camping and being outdoors

Deadliest Wildfires

Wildfires have the potential to cause great damage. The table below lists the deadliest wildfires in recorded history.

GLOBAL (since 1500)		
Year	**Location**	**Deaths**
1871	United States	2500
1936	USSR	1200
1918	United States	453
1894	United States	418
1881	United States	282

URBAN FIRE

An urban fire describes an uncontrolled burning fire, which can cause damage to forestry, agriculture, infrastructure and buildings.

Causes of Urban Fires

Urban fires can be caused by:

1. Accidents
2. Unforeseen ignition i.e. electrical, mechanical and chemical process.
3. Earthquakes
4. Lightening
5. Carelessness in kitchen
6. Rubbish fires when left unattended

Strategies and precautions to deal with urban fires

1. Install home sprinklers, 24 hours a day, for protection from the danger of fire.
2. If you discover a fire, call Rescue centers.
3. Check any fire restrictions that may be in place in your district.
4. Keep flammable material away from the access of children
5. Properly check stove and heaters before going to bed.

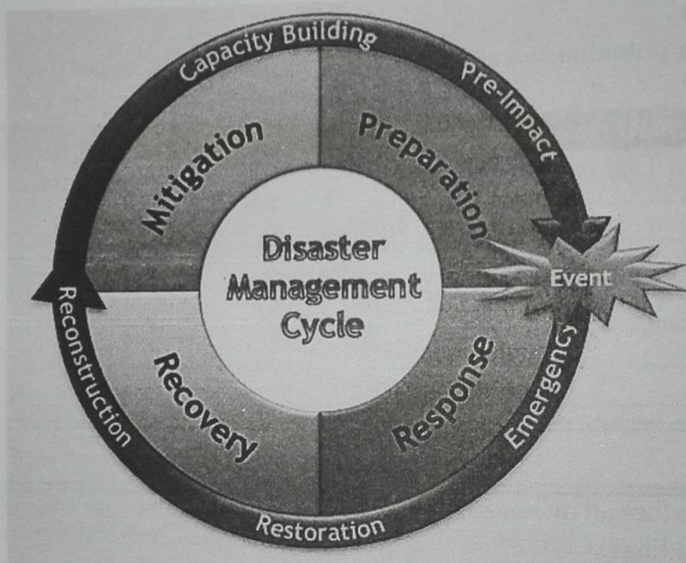
DISASTER RISK MANAGEMENT

The World Health Organization (WHO), defines *disaster as an occurrence disrupting the normal conditions of existence and causing a level of suffering that exceeds the capacity of adjustment of the* *affected community*. This disruption and suffering can affect human beings, ecology, health and health services, and the habitats of flora and fauna. The scale of the disaster means that there is often the need for immediate and extraordinary response from outside the affected community and area.

Disaster Risk Management

Disaster Risk Management is a systematic process of using administrative directives, organizations, operational skills and capacities to implement strategies and policies which help to improve coping capacities in order to avoid or lessen the adverse impacts of hazards and the possibility of disaster through activities and measures for prevention, mitigation and preparedness.

Cycle of disaster management consists of four phases: mitigation, preparedness, response and recovery. The mitigation and preparedness are pre-disaster phases while response and recovery are post-disaster phases. Former two are made on the basis of anticipation while latter two are made after realization of disaster. Often phases of the cycle overlap and the length of each phase greatly depends on the severity of the disaster.



The different phases of disaster management are as follows:

1. **Mitigation**

   Mitigation refers to the minimization of the effects of disaster. Mitigation efforts attempt to prevent hazards from developing into disasters altogether, or to reduce the effects of disasters when they occur. The mitigation phase differs from the other phases because it focuses on long-term measures for reducing or eliminating risk. Mitigation measures can be structural or non-structural.

   a. **Structural measures** use technological solutions, like flood levees.

   b. **Non-structural measures** include legislation, land-use planning and insurance.

   Mitigation is the most cost-efficient method for reducing the impact of hazards; however, it is not always suitable. Mitigation does include providing regulations regarding evacuation, sanctions against those who refuse to obey the regulations (such as mandatory evacuations), and communication of potential risks to the public.

2. **Preparedness**

   Planning refers to the development of response mechanisms. Preparedness is a continuous cycle of planning, organizing, training, equipping, exercising, evaluation and improvement activities to ensure effective coordination and the enhancement of capabilities to prevent, protect against, respond to, recover from, and mitigate the effects of natural disasters, acts of terrorism, and other man-made disasters. In the preparedness phase, emergency managers develop plans of action to manage and counter their risks and take action to build the necessary capabilities needed to implement such plans. Common preparedness measures include:

a. Communication plans with easily understandable terminology and methods.

b. Proper maintenance and training of emergency services, including mass human resources such as community emergency response teams.

c. Development and exercise of emergency population warning methods combined with emergency shelters and evacuation plans.

d. stockpiling, inventory, and maintain disaster supplies and equipment

e. Develop organizations of trained volunteers among civilian populations. Professional emergency workers are rapidly overwhelmed in mass emergencies so trained; organized, responsible volunteers are extremely valuable.

For example, Community Emergency Response Teams, Red Cross, Federal Emergency Management Agency (FEMA). Another aspect of preparedness is *casualty prediction*, the study of how many deaths or injuries to expect for a given kind of event. This gives planners an idea of what resources need to be in place to respond to a particular kind of event.

3. Response

Response includes efforts to minimize the hazards created by a disaster. The response phase includes the mobilization of the necessary emergency services and first responders in the disaster area. This is likely to introduce:

a. firefighters

b. Police

c. Ambulance

d. disaster relief operation (military)

e. Non-combatant evacuation operation

f. Special rescue teams at the site of the disaster prone areas.

4. Recovery

Returning the community to normal. The aim of the recovery phase is to restore the affected area to its previous state. It differs from the response phase in its focus; recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed. Recovery efforts are primarily concerned with actions that involve rebuilding destroyed property, re-employment, and the repair of other essential infrastructure. Efforts should be made to "build back better", aiming to reduce the pre-disaster risks inherent in the community and infrastructure.

Framework in Pakistan

Pakistan has always been susceptible to disaster risks from a range of hazards. In recent years, it has witnessed increased frequency and intensity of these events. Some of them which have a high scale of impact include: earthquakes, droughts, floods, storms and landslides. These have caused widespread damages and losses in the past.

The leading way of dealing with disasters in Pakistan has been the **emergency response approach**, that is, a reactive and not a pro-active approach. After considering at the extent of the loss of life and property and the challenges that were faced in the wake of October 2005 earthquake, the need for establishing appropriate policy and institutional arrangements to reduce losses from disasters in future, was desperately felt at federal and provincial level. This need for strong institutional and policy arrangements has been fulfilled with the promulgation of National Disaster Management Ordinance, 2006. Under the Ordinance the National Disaster Management Commission (NDMC) had been established under the Chairmanship of the Prime Minister as the highest policy making body in the field of disaster management. As an executive arm of the NDMC, the National Disaster Management Authority (NDMA) was made operational to coordinate and monitor implementation of National Policies and Strategies on disaster management. Further, a de-centralized system for disaster management was envisioned. The mechanism for the disaster management had to be devolved to the provinces as well as districts. Resultantly, that Provincial Disaster Management Commissions (PDMCs), Provincial Disaster Management Authorities (PDMAs) and District Disaster Management Authorities (DDMAs) had been established with similar arrangements in areas like Azad Jamu & Kashmir and Northern Areas, which were more prone to disasters. These DDMAs are the cornerstone of the entire process and are to play the role of the first line of defense in any unfortunate event.

The National Disaster risk Management Framework has been formulated to guide the work of entire system in the area of disaster risk management. It has been developed through wide consultation with stakeholders from local, provincial and national levels. The Framework identifies National Strategies and Policies for disaster management. Nine priority areas were identified within this framework to establish and strengthen policies, institutions and capacities. These include:

1. Institutional and legal arrangements for DRM
2. Hazard and vulnerability assessment.
3. Training, education and awareness.
4. Disaster risk management planning.
5. Community and local level programming.
6. Multi-hazard early warning system.
7. Mainstreaming disaster risk reduction into development.
8. Emergency response system, and
9. Capacity development for post disaster recovery.

At the federal level, both the National Disaster Management Authority **(NDMA)** and the **Earthquake Reconstruction and Rehabilitation Authority (Erra)** are attached with PM Secretariat; however, they have different governing bodies. NDMA is governed by the 16-member National Disaster Management Commission (NDMC) headed by the PM, while Erra is governed by a seven-member council also headed by the PM. There is another federal body, the **Emergency Relief Cell**, attached with the Cabinet Division, which was sidestepped after the 2005 earthquake and a temporary **Federal Relief Commission** was established and later merged with Erra.

Initially, Erra was established as a project covering nine districts of Khyber Pakhtunkhwa and Azad Kashmir, but through an act in 2011 it has become a permanent body extending its scope to the whole of Pakistan. During the 2010 floods, NDMC became irrelevant as the **Council of Common Interests** took key decisions on compensation and reconstruction strategy. Additionally, another body, the **National Oversight Disaster Management Council**, was established in August 2010 in a bid to ensure transparency in aid distribution. Damage assessment of the 2010 floods was steered by the provincial governments, while NDMA was sidestepped by the Planning Commission in flood reconstruction and rehabilitation planning and execution.

After the 2008 earthquake in Balochistan the provincial **Social Welfare Department** took the lead in relief coordination. **Awaran** was taken over by security forces after the 2013 earthquake. During the IDP crisis in KP in 2010, the role of the PDMA was replaced with the temporary Provincial Emergency Response Unit and the NDMA was bypassed by the federal-level Special Support Group, led by the law-enforcement agencies.

The institutional conflicts between the NDMA and PDMAs have increased in view of contested interpretation of the 18th Amendment. There exists a long list of disaster-response agencies (in the public and private sectors) which tend to work in silos, sometimes reducing disaster response to a public-relations enterprise. The absence of a coordinated responsibility mechanism of these agencies and organisations adds to the problem of crisis management. Existing arrangements lead to a culture of institutional overlaps, accountability deficit, lack of enforcement and administrative inconsistencies in disaster management systems and structures in the country. Unless reformed and corrected, this accumulated institutional crisis of risk governance will continue unleashing multiple disasters in the country.

CHAPTER 4

ENERGY RESOURCES

ENERGY

Energy is an essential component of our lives. In scientific terms, it is defined as the ability or capacity to do work, or attempt to do work. Human beings, animals, plants, and machinery, all need energy to be able to perform their routine tasks. Energy exists in many different forms, and it can be converted from one form to another. An important concept to remember is the **law of conservation of energy.** This law states that it is not possible to create or destroy energy. It is only possible to convert it from one form to another. This is the law that controls the methods of generation of electricity, which are discussed later.

FORMS OF ENERGY

Energy exists in a number of different forms, each of which has the capacity to do work. Energy has a number of different forms, all of which measure the ability of an object or system to do work on another object or system. In other words, there are different ways that an object or a system can possess energy. Moreover, all forms of energy can be converted into other forms, which allow us to use them for a variety of purposes. Some of the most common forms of energy are discussed below.

Kinetic Energy

Kinetic energy is the energy possessed by a body due to its motion. This means that any object that is moving possesses some kinetic energy. Consider a baseball flying through the air. The ball is said to have "kinetic energy" by virtue of the fact that it is in motion relative to the ground. You can see that it is has energy because it can do "work" on an object on the ground if it collides with it (either by pushing on it or damaging it during the collision). The kinetic energy of an object depends on two things:

a. Its velocity (how fast the body is moving)

b. Its mass (how heavy the object is)

It is given by the following formula: *Kinetic Energy* = (1/2) × *mass* × *velocity*². This means, a bullet has a lot of kinetic energy because even though it has a small mass, its velocity is very high. Similarly, a truck that is moving very slowly will also have a lot of kinetic energy because it has a lot of mass.

Potential Energy

Potential energy is the energy possessed by a body due to its position, in the presence of certain conditions. This energy is sometimes defined as the ability of an object to return to its original position. Potential energy can be divided into different categories:

1. **Gravitational Potential Energy**

   This is the energy possessed by an object due to its position above the surface of any body that exerts a gravitational force on it. The gravitational potential energy of an object depends on the following:

   a. Its mass (how heavy the object is)

   b. Its height above the surface

   c. The gravitational force acting on the body.

   The gravitational potential energy of a body is given by the following formula:

   Gravitational Potential Energy = (mass) x (gravitational force) x (height above ground)

As an example, consider that you lift a rock from the ground. As soon as you leave it, it will fall down and return to its original position. This is due to gravitational potential energy it acquired when raised above the ground.

2. **Elastic Potential Energy**
   This is the energy that is stored in a body that is stretched, compressed or twisted by application of a force. Once the force is removed, the body returns to its original position due to the elastic potential energy. Consider a rubber-band as an example. If you stretch a rubber band and then leave it, it comes back to its original shape.

Chemical Energy

Chemical energy is the energy stored in the bonds between atoms and molecules. This energy is released when chemical reactions take place. As a result of these reactions, energy is released in the form of heat, light, and sound. Chemical energy is extremely important because it is being used around us all the time. The food we eat has stored chemical energy. When the body breaks down the chemical bonds in the food molecules, energy is released. This energy is then used by our bodies to help us walk, run and perform all our activities.

Heat Energy

Heat energy is due to movement of the molecules of the body. The faster the movement of molecules, the greater is the heat energy. Consider a hot cup of coffee. The coffee is said to possess "thermal energy", or "heat energy. The Sun is the largest source of energy.

Light Energy

Light energy is a form of kinetic energy. This is due to the fact that light is made up of small moving packets of energy called photons. Light is the only kind of energy that we can see with our eyes. Light is usually produced by radiation of particles (the Sun), through chemical reactions, and through electricity (bulbs)

Electrical Energy

Electrical energy is the energy that is derived from the kinetic energy of moving charges. It is one of the most commonly used forms of energy, and can be easily moved from one place to another.

Nuclear Energy

Nuclear energy is the energy produced from nuclear reactions. The term nuclear reaction refers to the reactions between nuclei of different atoms. There are two main kinds of nuclear reactions: nuclear fission, when the nucleus of an atom splits into smaller parts; and nuclear fusion, when two or more nuclei come together to form a larger nucleus. In both cases, large amount of heat energy is produced.

SOURCES OF ENERGY

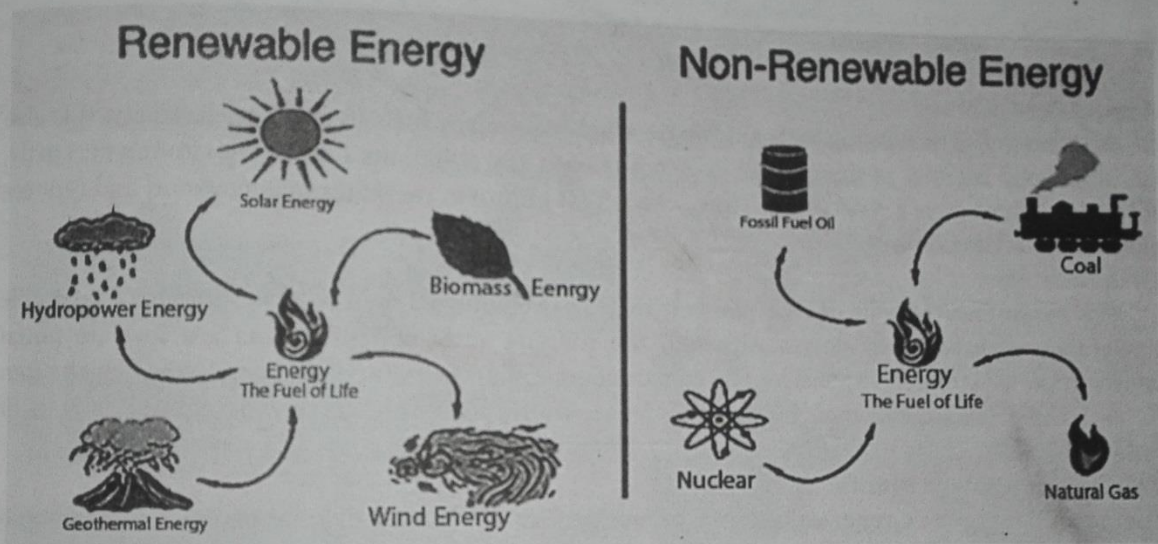
We live in a world where energy is important for all aspects of life. From the fuel that is used in vehicles and industries, to the electricity that is used for running machinery, energy is extremely important for us. As we learned earlier, according to the law of conservation of energy, energy cannot be created or destroyed. As a result, human beings have to get energy from different sources. There sources can be broadly categorized into two different groups: *renewable* and *non-renewable resources* of energy. Both of these resources are found in nature. Similarly, both have certain advantages and disadvantages, which make one of them more preferable than the other. The differences between the two are explained below.

Non-Renewable Sources of Energy

Non-renewable sources of energy are those that cannot be reused again and again. While these resources can be restored, the process takes an extremely long time, making them unsustainable to meet the energy requirements. In most cases, non-renewable resources are not very environmental friendly, and produce pollutants such as carbon dioxide. The most commonly used sources in this category are fossil fuels (coal, natural gas, and oil) and nuclear energy.

Renewable Sources of Energy

Renewable resources of energy are those that can be easily recycled by using biological and chemical processes, and sustainable practices. Renewable Energy is a clean source of energy, which is inexhaustible and can replenish itself for years to come. The use of renewable sources is very environmental friendly since it does not increase the amount of pollutants in the environment. The use of renewable sources is also important because it lowers the carbon footprint and reduces the strain on fossil fuels. Some of the most commonly used forms of renewable sources are wind energy, tidal energy, solar energy, geothermal energy, biomass, and hydroelectric power.



Alternative Energy

That form of energy which does not create as much pollution, which is created when fossil fuels—Coal, Oil, and Natural Gas—are burned to meet energy needs. It is alternate to the one which produces harmful leftover material, that is, it is environment friendly.

PRODUCING ELECTRICITY FROM ENERGY RESOURCES

Earlier, we studied about the law of conservation of energy, which states that energy cannot be created or destroyed; it can only be converted from one form to another. Since electricity is a form of energy, we should understand that it cannot be created magically. It has to be produced by converting one of the many sources of energy, into electrical energy.

Another important thing to remember while discussing the production of electricity is the use of a turbine (present inside generators). The turbine moves inside a magnetic field to create electricity. This process is known as electromagnetic induction.

Renewable Energy

1. **Hydroelectric Power (HEP)**
   The term hydropower refers to the energy derived from falling or fast-flowing water. Hence, hydroelectric power means electricity that is produced using hydropower. HEP is a renewable form of energy, which makes it very sustainable.

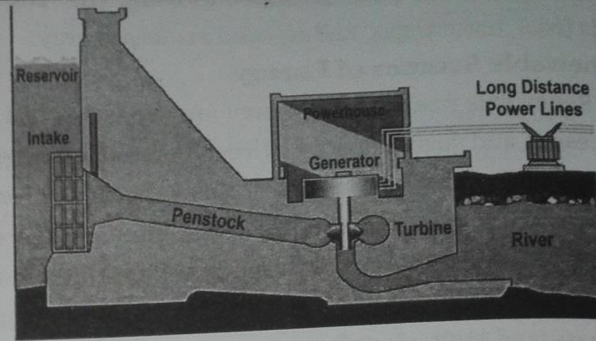
Gravitational Potential Energy
(Water at a height)

↓

Kinetic Energy
(Water falling down a slope and rotating turbines)

↓

Electrical Energy



Energy Transformation Flowchart for HEP Plants

Advantages

HEP has very low running costs since it does not require any fuels to produce electricity. It is also environmental friendly as the process does not release any pollutants into the environment. Lastly, most HEP plants have a reservoir to store water. This improves the water management, and reduces chances of flooding downstream.

Disadvantages

One major disadvantage of HEP plants is that they can only be built in places that have favorable topography such as steep slopes. Although the running costs of HEP plants are low, its initial construction is extremely expensive. The construction of the reservoir needs a large area, which often forces many people to lose their homes. This is also causes the destruction of the natural habitats of flora and fauna.

2. Geothermal Power Plants

Geothermal energy is a renewable source of energy that utilizes the thermal energy generated and stored in earth. Geothermal energy uses naturally occurring high temperatures inside the ground, to generate electric power and for direct uses such as heating and cooking. Geothermal electric power involves the drilling of well in search of high temperature rocks. Water is pumped down this well and heated by hot rocks. It rises up a second well as steam, which can be used to run a turbine and generate electricity or it can be used for heating or other purposes. Geothermal areas are generally located near tectonic plate boundaries, where there are earthquakes and volcanoes. According to international geothermal association (IGA) the global potential of geothermal sources is about 70 Gigawatts .

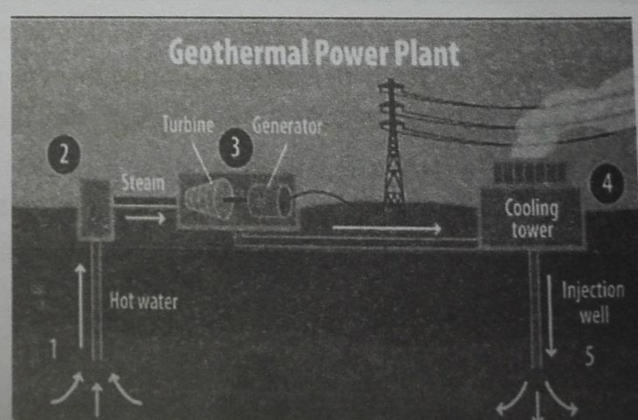
Heat Energy
(From the earth's surface, used to boil water)

↓

Kinetic Energy
(Steam moves and rotates the turbines)

↓

Eletrical Energy



Energy Transformation Flowchart for Geothermal Power Plants

Advantages

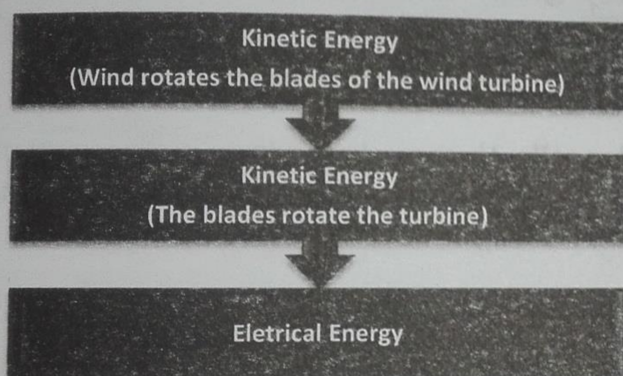
Geothermal energy is a renewable resource that does not need any fuels. As a result, geothermal plants have a very low carbon footprint. Geothermal energy is a stable resource, and unlike wind and solar energy, its supply does not fluctuate a great deal.

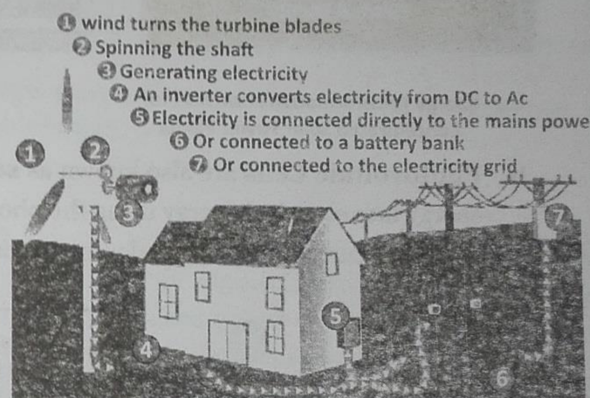
Disadvantages

The biggest problem with geothermal energy is that it is location specific. This means that geothermal plants can only be constructed in specific locations. Another disadvantage is that the locations where these plants are constructed, are prone to earthquakes and volcano eruptions. Lastly, since the power plants are usually located far away from cities, the distribution costs are high.

3. Wind Power

Wind power is a renewable form of energy that captures the energy generated by the movement of air in the earth's atmosphere to drive electricity-generating turbines. Wind turbines consist of huge blades that are connected to a housing that contains gears linked to a generator. When the wind blows, it transfers some of its kinetic energy to the fan blades, which in turn drive the generator. For utilizing wind energy, several wind turbines are located together to form a wind farm. Globally, it has the potential to generate 5 times as much energy as it is being used today.





Energy Transformation Flowchart for Wind Turbines

Advantages

Wind energy is a renewable resource that does not need any fuels. As a result, wind turbines have a very low carbon footprint. Wind turbines are often constructed in remote areas, which can result in development of these locations.

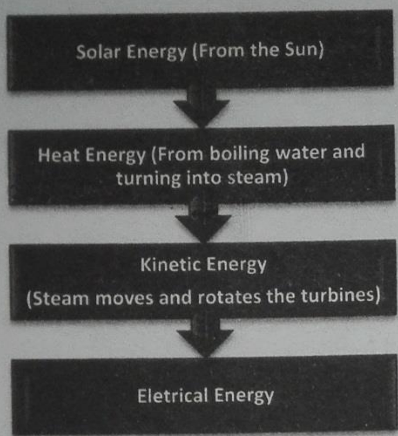
Disadvantages

The biggest drawback of wind energy is that the strength of wind is not constant at all times. This results in an inconsistent supply of energy. In addition, wind turbines are extremely expensive to set up. Lastly, wind turbines are noisy, and can be harmful for bird populations.

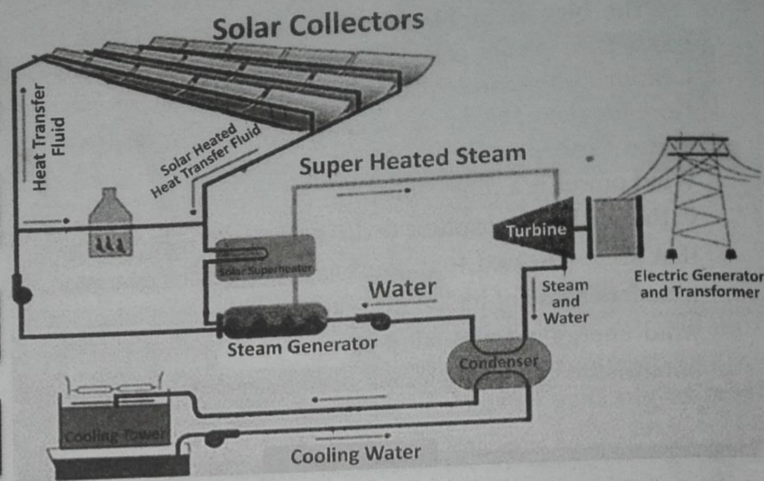
4. Solar Power

Solar power refers to the utilization of the heat energy received from the Sun in order to produce electricity, or to run heating systems. The amount of solar radiation, also known as *insolation*, reaching the earth's surface every hour is more than all the energy currently consumed by all human activities each year. However we merely use less than 0.1%. This energy is determined by a number of factors, such as geographic location, time of day, and weather conditions. There are two commonly used methods of producing energy from solar power: Concentrated Solar Power and Photovoltaic Cells. In Pakistan a 1000 MW Quaid-e-Azam solar park is located in Bahawalpur.

a. **Concentrated Solar Power** uses mirrors and lenses to converge the sunlight into a single, narrow beam. This beam is then concentrated on a small area, which lies over a water patch. The concentrated beam of sunlight heats up the water and turns it into steam. This steam is then used to drive turbines that produce electricity.

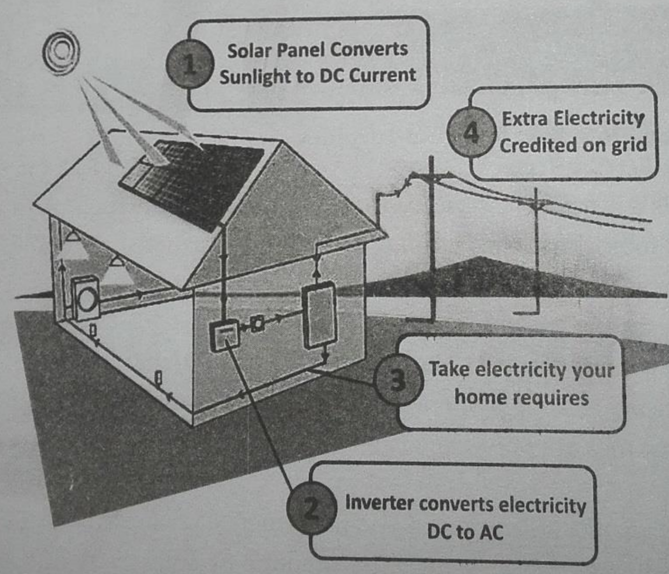


Energy Transformation Flowchart for Concentrated Solar Power Plants



Concentrated Solar Power

b. **Photovoltaic Cells** are also known as **solar cells**. These are devices that directly convert solar energy into electrical energy using the photovoltaic effect. Photovoltaic effect refers to the creation of electric current in a material upon exposure to sunlight.



Photovoltaic Power

Advantages

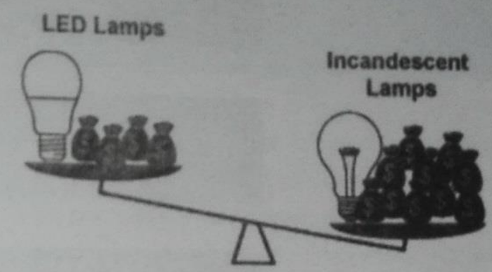
Solar energy is a renewable form of energy, which means it does not pollute the environment. It has low operational and maintenance costs, which makes the electricity produced from solar power very cheap. Lastly, solar power has a lot of potential; scientists say that solar power is enough to meet the energy needs of the entire world.

Disadvantages

The initial cost of installing solar systems is extremely high, which discourages people from installing solar systems. The energy produced is weather dependent, and needs to have sufficient backup in order to compensate for cloudy and rainy days. Another problem with solar energy is that its storage is very expensive. Lastly, solar power projects need a lot of space which prevents land from being used for other purposes.

5. **LED**

LEDs stand for light emitting diode. LEDs have many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Light-emitting diodes are now used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, camera flashes and lighted wallpaper. As of 2015, LEDs powerful enough for room lighting remain somewhat more expensive, and require more precise current and heat management, than compact fluorescent lamp sources of comparable output.

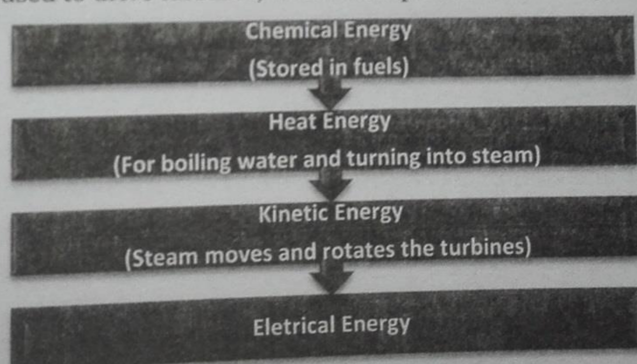


Total lighting cost =
Initial cost + Operation costs + Replacement costs

Non Renewable

1. **Thermal Power Plants**

Thermal power plants are those that use fossil fuels such as coal, oil and natural gas to produce electricity. They are the most commonly used method of producing electricity. In thermal power plants, fossil fuels are burned to produce heat. This heat is then used to boil water, and turn it into steam. Finally, the steam is used to drive turbines, which then produce electricity.



Energy Transformation Flowchart for Thermal Power Plants

Advantages

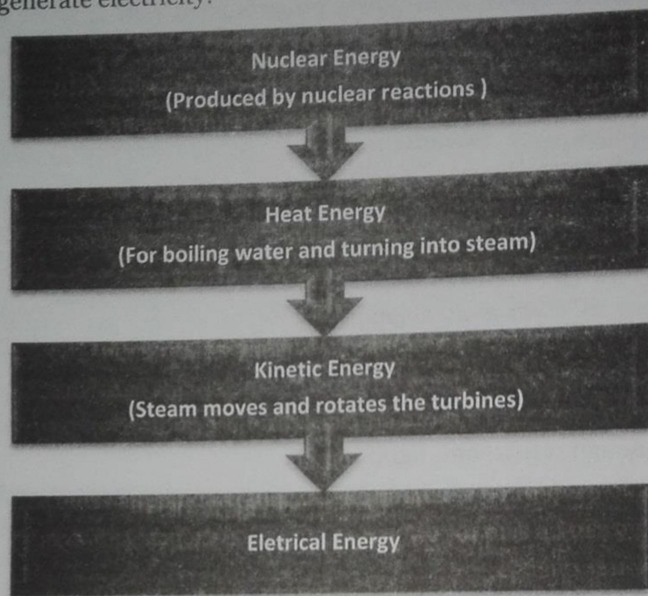
Thermal power plants do not need a very large area for construction, and can be built anywhere. Compared to other method of producing electricity, the functioning of thermal plants is relatively simpler. This makes them easy to maintain.

Disadvantages

Since thermal power stations rely on the use fossil fuels, they are a source of CO_2, which adds to the problem of greenhouse gasses and global warming. Thermal power stations are not very efficient, and only convert 33%-48% of the heat energy into electricity.

2. Nuclear Power Plants

Nuclear Power Plants use nuclear energy to generate electricity. In these plants, nuclear reactions are used to generate heat. This heat is used to boil water and turn it into steam. This steam is then used to drive turbines and generate electricity.



Energy Transformation Flowchart for Nuclear Power Plants

Advantages

The biggest advantage of nuclear power is that a small amount of radioactive material can produce large amounts of energy. Nuclear energy does not release pollutants such as carbon dioxide into the atmosphere.

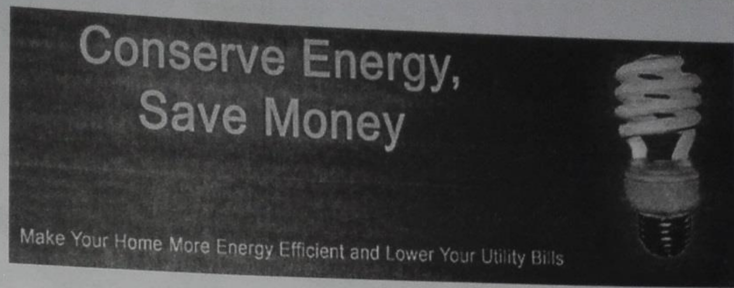
Disadvantages

Nuclear plants are very expensive to construct. They need a large and steady supply of water for cooling the reactors and controlling the nuclear reactions. The biggest drawbacks of nuclear power plants are health and safety risks. A small accident at a nuclear facility can have catastrophic results. Moreover, the handling of nuclear waste is also a problem because it takes many years for the waste material to lose its radioactivity.

ENERGY CONSERVATION

Conserving energy helps the planet and saves money. Energy conservation refers to reducing energy consumption through using less of an energy service. It is the act of saving energy by reducing a service. In other words, to conserve energy, you need to cut back on your usage. Examples include driving your car fewer miles per week, turning your thermostat down a degree or two in the wintertime and unplugging your computer or home appliances when they are not in use. In all of these examples, you are reducing the amount of energy you use by doing without or making due with less fuel or electricity. While energy conservation might cut down on your comfort level and make things a bit less convenient, it can help reduce monthly heating and electricity bills and save money at the gas pump.

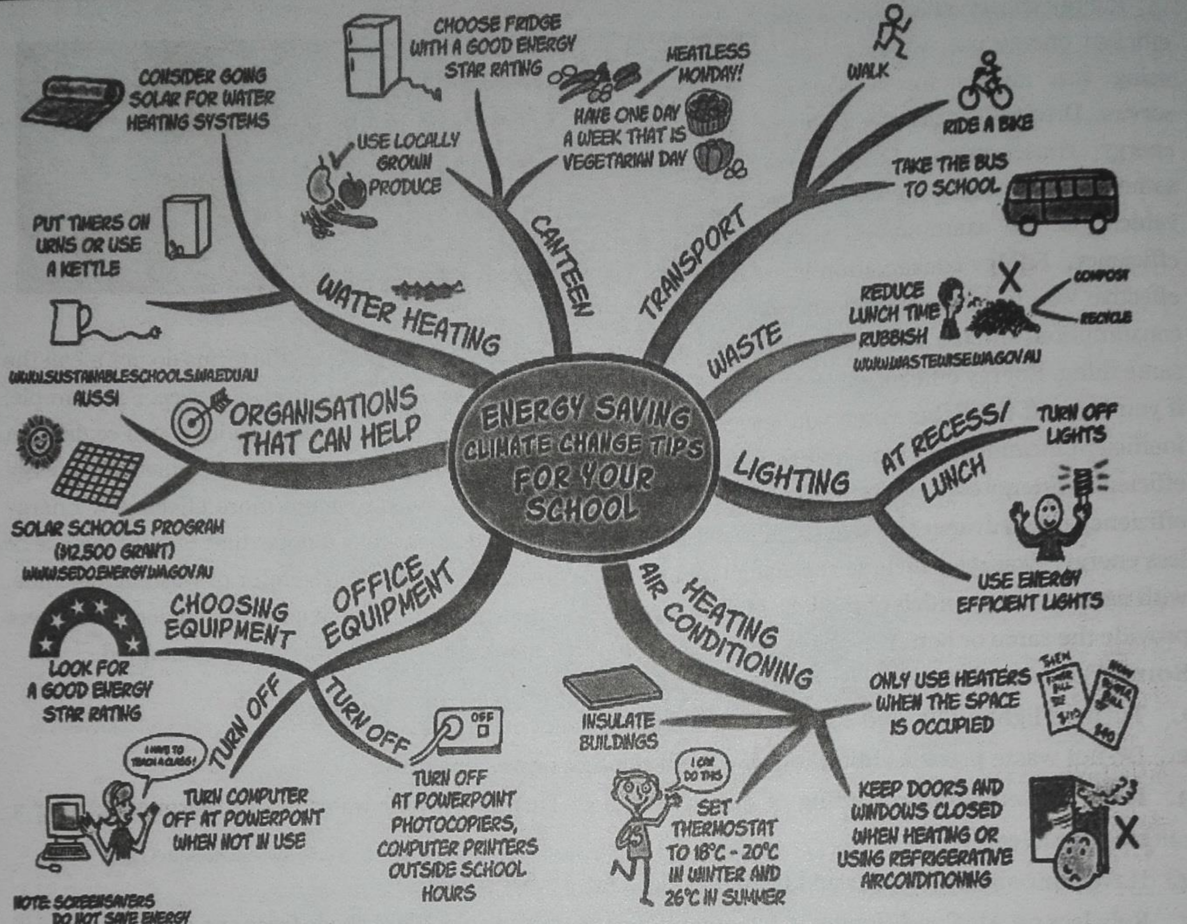
Energy Conservation and Energy Efficiency



Energy conservation differs from efficient energy use, which refers to using less energy for a constant service. Driving less is an example of energy conservation. Driving the same amount with a higher mileage vehicle is an example of energy efficiency. Energy conservation is an effective way to lower overall energy consumption, and the same can be said for improved energy efficiency. However, the terms do not mean the same thing. Energy efficiency is defined as saving energy, but keeping the same level of service. For example, if you turn off the lights when you leave a room, you are practicing energy conservation. If you replace an inefficient incandescent light bulb with a more efficient compact fluorescent bulb, you are practicing energy efficiency. Energy conservation is 'cutting back' and energy efficiency is using energy more 'effectively.' Energy efficiency uses advances in science and technology to provide services and products that require the use of less energy. Examples include replacing older model appliances, such as a refrigerator or washing machine, with newer, energy-efficient models. Modern appliances use significantly less energy than older models, yet provide the same or better service. We must keep in mind that the energy saved is energy generated.

Some Ways to Conserve Energy

1. Turn off lights, TVs, and computers when they are not being used.
2. Do not waste precious hot water in washing clothes or washing dishes.
3. Keep the temperature-setting of ACs above 26 C; Turn down your water heater thermostat; wear a sweater in cold.
4. Have your air conditioner and heater serviced once every season.
5. Rely less on Air Conditioners in hot and electric heaters in cold; Plant shade trees and paint your house a light color if you live in a warm climate, or a dark color if you live in a cold climate, that is, the designs of the building must be made according to prevalent weather conditions.
6. Whenever possible, walk, bike, or use mass transit; In multi-national companies, the employees use bicycles for moving inside plants. This strategy must be adopted all across the Globe.
7. Use natural ventilation more effectively; Keep the air flow by keeping air vents open.
8. Use less hot water by installing low-flow showerheads in washrooms; Take shorter showers; Fix any faucets that drip; Turn off the faucet run while performing activities such as brushing your teeth or shaving.
9. Rely on natural light; design the house as to use sunlight to illuminate your home.
10. Replace light bulbs with compact fluorescent lights. Efficient fluorescent light bulbs use less than half the energy than traditional incandescent bulbs do to produce the same amount of light, and they last a lot longer.
11. When purchasing an appliance such as a dishwasher or television, look for a model that's highly efficient.
12. Insulate your walls and ceilings. This can save 20 to 30% on home heating bills and reduce CO_2 emissions. Some of the energy conservation techniques are summarized in the figure below



A recent report from consulting firm McKinsey found that the United States could save $1.2 trillion through 2020, by investing in improvements like sealing leaky building ducts and replacing inefficient household appliances with new, energy-saving models. That investment would cut the country's projected energy use in 2020 by about 23 percent.

SUSTAINABLE USE OF ENERGY

Sustainable use is such that it serves the needs of the present generation without compromising on the ability of future generations to meet their needs. In other words, it must be sustained. This form is accomplished by using non-exhaustible resources, which can cater for the present energy demands, and also fulfill the demands of future generations. Advancements using sustainable energy include using renewable energy resources—solar, wind, tidal, hydro, and geothermal. Employing Energy saving or conserving technologies also constitute sustainable use. Moreover, the progress in increasing energy efficiency is also sustainable use. By energy conservation, energy efficiency, using renewable energy, we are able to meet our needs without compromising on the ability of future generations to meet their needs.