

# UNIVERSE

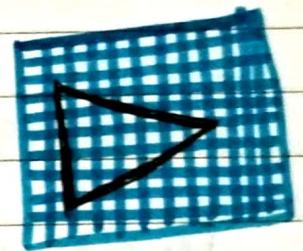
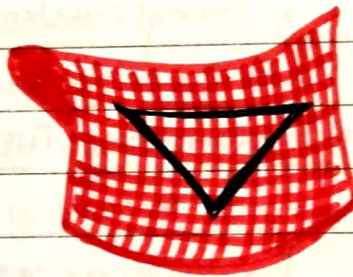
## Definition

- Entirety of space, time, matter and energy that exists.
- Planets, stars, galaxies, & everything in between.
- All of space, all of matter, energy that space contains.

## Types of universe

- Flat Universe
- Spherical (closed) universe (positive curvature)
- Hyperbolic (open) universe (negative curvature)

} Based on angular motion  
↓  
[Geometry]



[Positive curvature]  
(Spherical)  
(closed)

[Negative curvature]  
(Hyperbolic)  
(open)

[Flat curvature]  
(Zero curvature)

All the three geometries are classes of what is called Riemannian geometry, based on three possible states for parallel lines.

- Flat curvature - lines - never meeting
- Spherical - lines - must cross
- Always divergent - Hyperbolic

## Contents of Universe

Matter + Dark matter + Dark energy

[makes up visible structure]

[Stars, Galaxies, Planets]

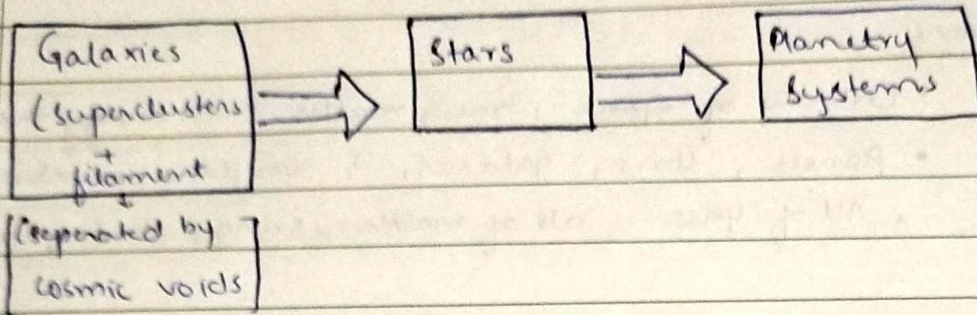
[Doesn't interact with light]

↓

[Exerts gravitational effects]



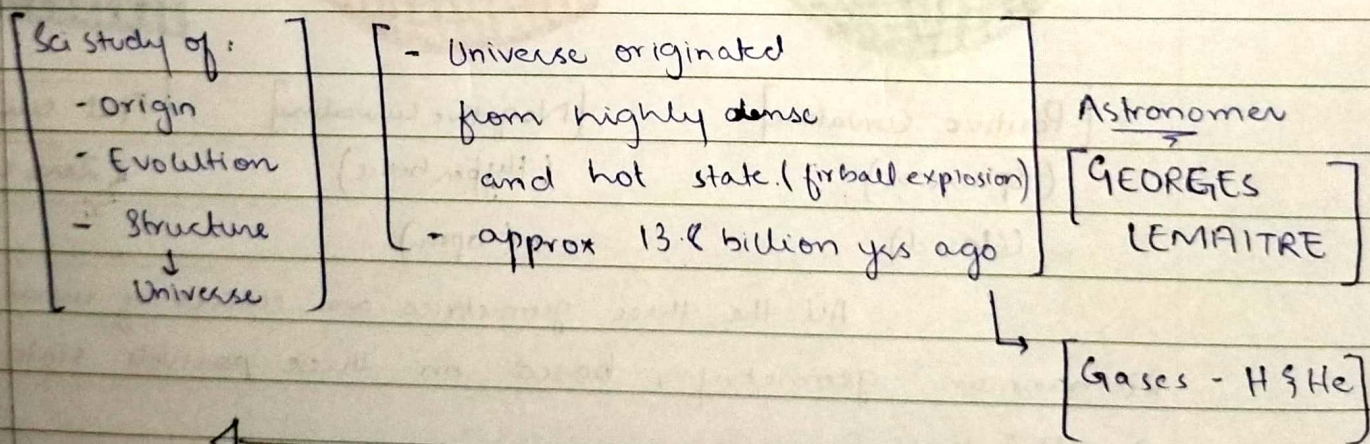
### STRUCTURE OF UNIVERSE



### FORCES IN UNIVERSE

- (4) →
- Gravity
  - Electromagnetism
  - Weak nuclear force
  - Strong Nuclear force
- } → Interactions b/w Particles  
→ Behavior of matter & energy

### COSMOLOGY AND BIG BANG THEORY

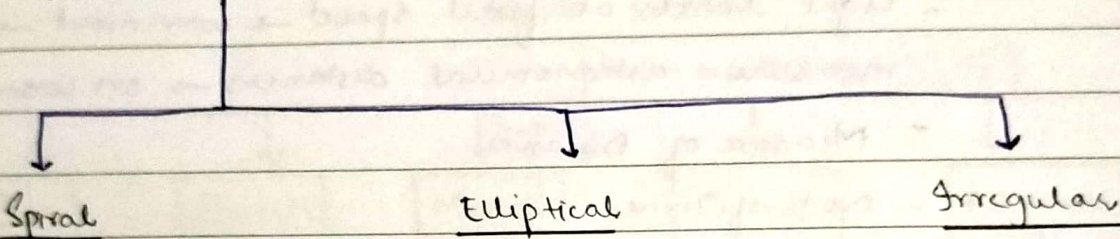


# GALAXY - estimated 100 million stars (FUNDAMENTAL BUILDING BLOCK OF UNIVERSE)

## Definition

- A vast system consisting of stars + interstellar gas + dust + dark matter → All bound together by gravity + Supermassive Black Hole
- Most of matter in galaxy is Dark Matter.

## Types of Galaxies



### Spiral

- Distinct spiral arm
- Central buldge
- Rotating disk

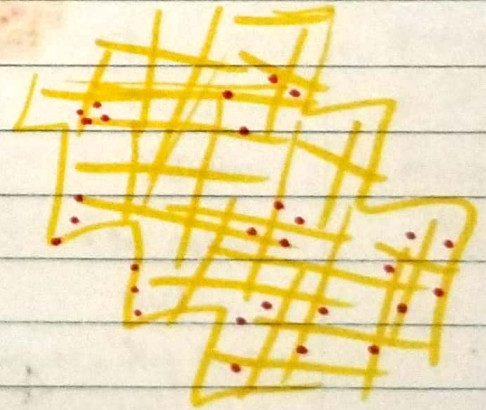
[e.g Milkyway]  
↓  
billions of stars  
↓  
\* Sun

### Elliptical

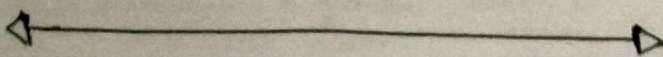
- Rounded / Elongated
- having older stars
- less active star formation compared to spirals,

### Irregular

- No shape / No features
- Smaller
- less massive
- Result of merging galaxies.



Formation and Evolution - Evolve by star formation, merges of other + envire  
They are thought to have formed - Gravitational forces collapse of matter in early Universe



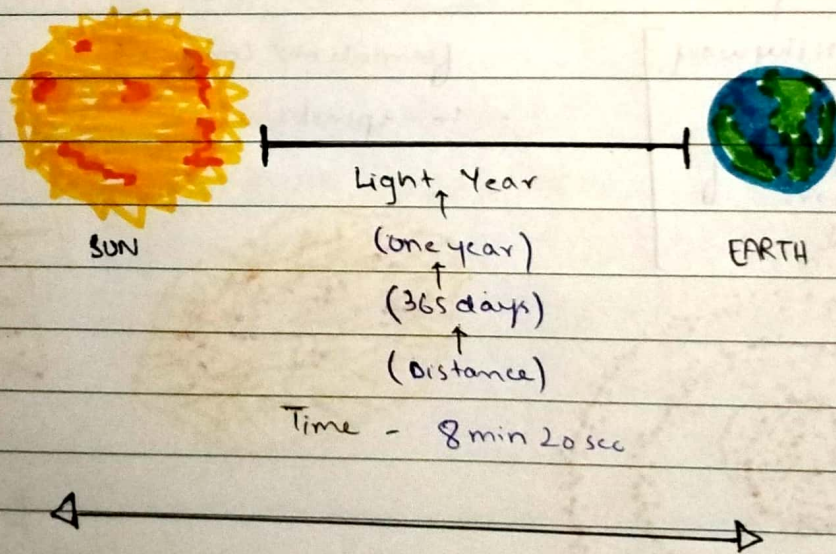
# LIGHT YEAR

[IAU] → [INTERNATIONAL ASTRONOMICAL UNION]

[6 Trn Miles - 9 Trn Km]

## DEFINITION

- Unit of distance - Used in astronomy to measure vast distances in Universe
- Distance light travels in one year in vacuum
- 186,282 miles per second.
- Light travels at fixed speed → convenient → to measure astronomical distances → on cosmic scale.
- Measure of Distance
- Not of Time
- Time - 8 mins 20 seconds (light → sun → earth)  
8 min  
20 sec
- 365.25 days



day/date

# SOLAR SYSTEM

- Orbits the center of Milky way galaxy at about 515,000 mph (828,000 kph) - In four spiral arms

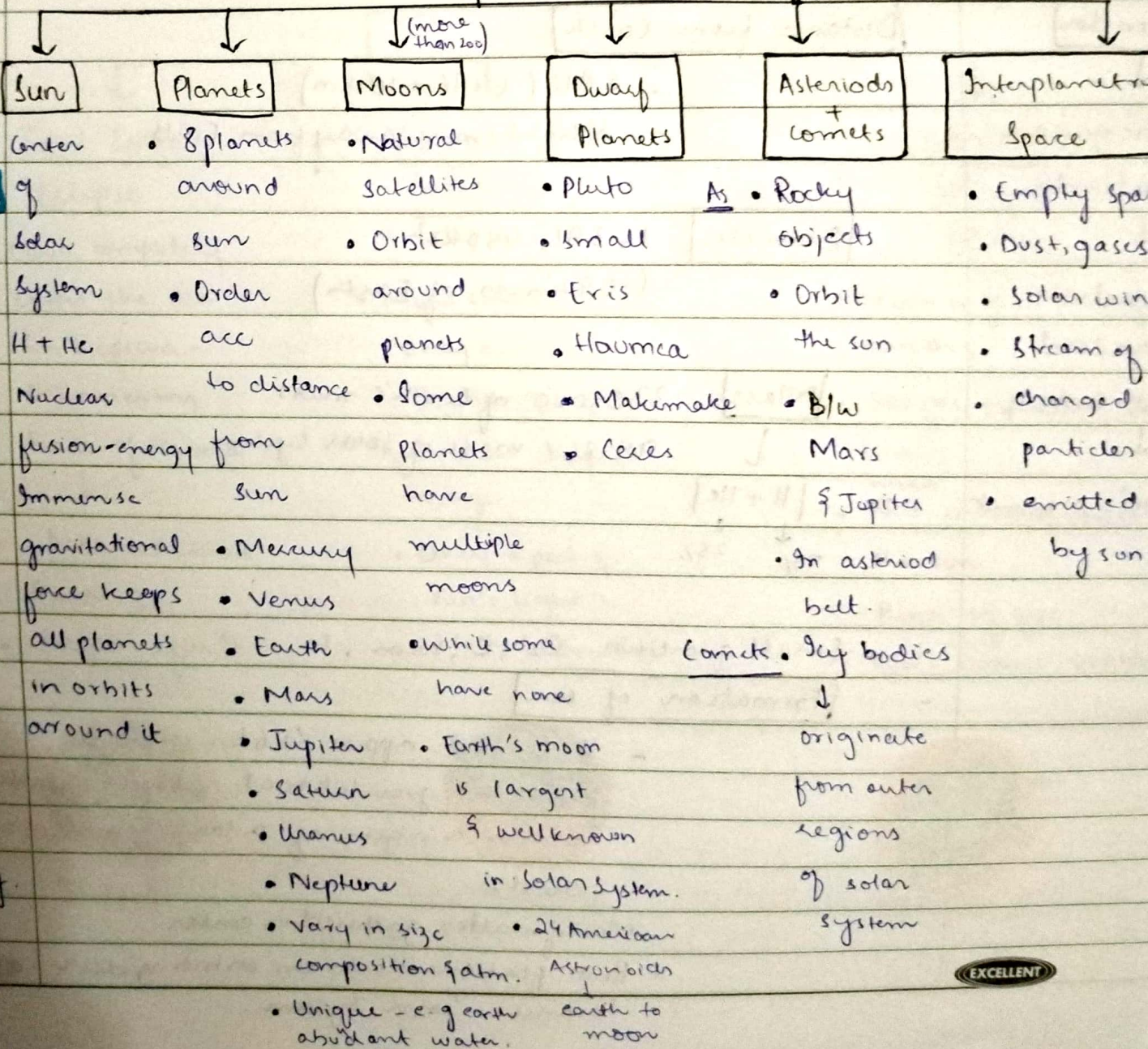
## DEFINITION

- Collection of celestial bodies that orbit around the Sun.
- Sun + Eight Planets + moons + dwarf planets + asteroids + comets + small objects

- It takes our SS about 230 million yrs to complete one orbit around galactic center.

## SOLAR SYSTEM

(only one to support LIFE)



EXCELLENT

# SUN ☉ - symbol of sun

- DEFINITION**
- sun is the star at the center of the solar system
  - It is massive, hot ball of plasma, inflated and heated by nuclear fusions at its core
  - Part of this energy is emitted from its surface as light, UV & Infrared Radiation.
  - Providing most of energy for life on Earth.

Calendar  
↓  
Gregorian  
Calendar  
↓

## Distance from Earth

- 1 AU ( $1.496 \times 10^8$  km)
- 8 light mins away from Earth.

based on  
Standard  
16th century  
↓

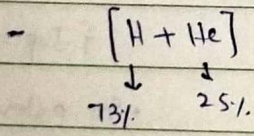
## Diameter

1,391,400 km  
(109 times of Earth)

Sun's movement

## Mass

330,000 of Earth's mass  
99.86% mass of solar system



- Small quantities, O<sub>2</sub>, C, Neon, Fe

## Formation of sun

- It formed approx 4.6 bn yrs ago from the gravitational collapse of matter within a region of a large molecular cloud.
- Most of matter gathered in center
- Rest flattened into an orbiting disk became Solar System.



# SOLAR ECLIPSE

## DEFINITION

- Captivating celestial event
- Moon passes b/w Earth & Sun
- Blocking the sun light partially or entirely from reaching earth's surface

## TYPES OF SOLAR ECLIPSE

### Total Solar Eclipse

- Moon completely covers the sun
- Sun's corona - shimmering halo of plasma  
↓
- becomes visible
- Rarest SE
- Sought-after SE



Total SE

### Partial Solar Eclipse

- Moon covers only a portion of sun
- Crescent shaped image
- Only a part of sun's light is blocked (shadow)



Partial SE

### Annular Solar Eclipse

- Moon is farthest from earth,
- Seems smaller than sun
- Not covering entire the sun
- Ring of fire
- Sun's edges - visible



Annular SE

- 5<sup>th</sup> largest Planet
- Diameter - 12,742 km

# EARTH

 $\oplus, \otimes$  (symbol)

- Densest Planet of SS'
- Rounded - ellipsoid. (circumference 40,000 km)

formed -  
4.5 yrs ago  
from gas

## DEFINITION

- Earth is the third planet from sun
- Only Planet with life
- water world
- liquid surface water
- global ocean - 70% water
- 29.2% land

Life - origin  
on Earth  
↓  
Great Oxidation  
Event

## EARTH CRUST

- Earth's land part - Earth's crust
  - ↳ consisting of several slowly moving Tectonic Plates
  - T. Plates interact to produce mountain Ranges, volcanoes & Earthquakes
- liquid outer core - magnetosphere - capable of deflecting most of the destructive solar winds and cosmic radiation.

Human - emerged  
300,000 yrs ago in

Africa  
↓  
very continent  
except

## Earth Surface

- 101.325 kPa (at sea level)

## Pressure +

Antarctica

## Composition

- 78% N<sub>2</sub>: dry air, 20.95% O<sub>2</sub>, ≤ 1% water vapour  
0.9340% argon, 0.0415% CO<sub>2</sub>, 0.00182% neon  
0.00052% helium, 0.00017% methane  
0.00011% krypton, 0.00006% hydrogen

man  
pend on  
with Biosphere

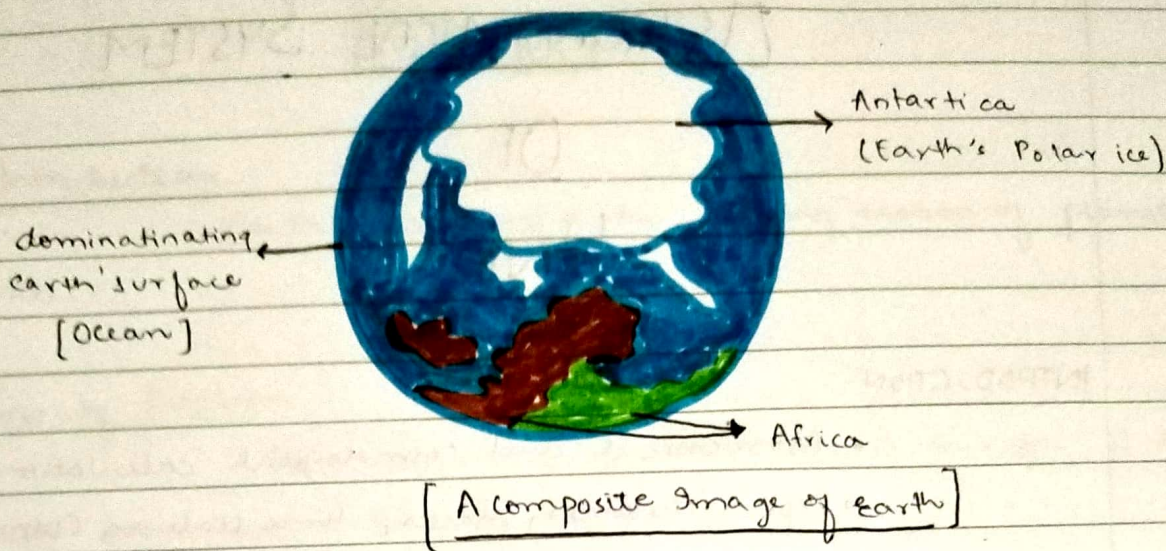
## Surface temp of Earth

= 14.76°C (at which water is liquid under atm pressure)

Natural  
sources to  
wine

- Dominating is Ocean
- lush green to dry - Africa
- Earth Polar ice - Antarctica



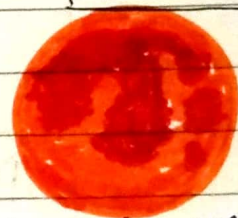
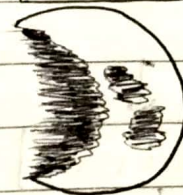


# LUNAR ECLIPSE

Penumbral LE

Partial LE

Total LE (Blood Moon)



## DEFINITION

- It is a celestial event, when Earth passes between Sun & Moon
- causing the moon to fall into earth's shadow.
- Moon temporarily darkens or turns reddish Brown

## Blood Moon

- During a lunar Eclipse, earth blocks sunlight to reach moon
- Some of sunlight is refracted & scattered by earth's atmosphere
- The refraction causes longer wavelengths, such as Red to Orange → moon - Reddish color - 'Blood' Moon.

## Types of Lunar Eclipse

### 1) Total LE

- Moon is entirely engulfed in earth's shadow

### 2. Partial Lunar Eclipse

- Part of moon enters earth's shadow

### 3. Penumbral

- Earth's outer surface ↓
- Moon's surface Darkening

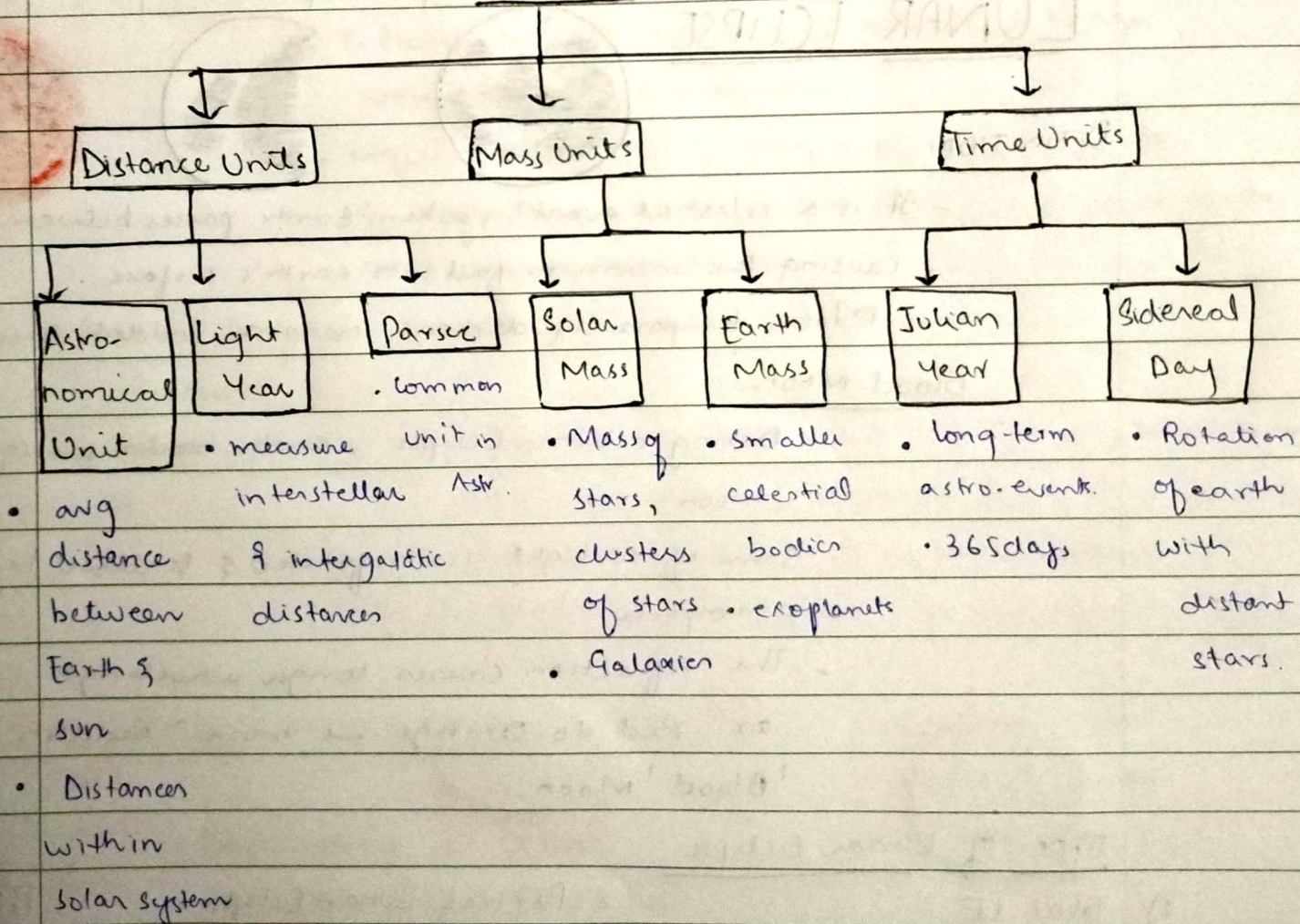


# ASTRONOMICAL SYSTEM OF UNIT

## INTRODUCTION

- Astronomical and cosmological calculation
- Express distances, masses, time scale on cosmic scale

## AU SYSTEM



# ROTATION

## Introduction

Earth's Rotation is the spinning motion of planet on its axis.

## Axis of Rotation

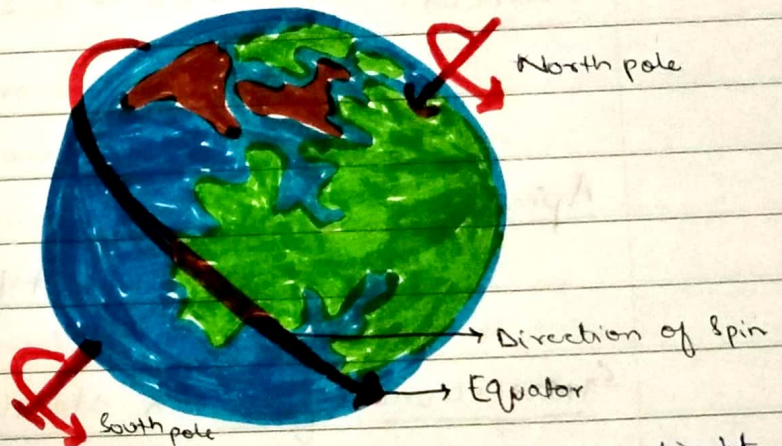
It is an imaginary line passing through center of earth from North Pole to South pole. It serves as Rotational axis.

## Direction and Speed of Rotation

- Earth rotates in an eastward direction
- From west to East
- Speed - 24 hrs

## Equator and Polar Region

↓ Fastest Rotation speed	↓ negligible speed
--------------------------------	--------------------------



## Effects of Rotation

- As earth rotates, different parts of planets exposed to sunlight,
- causing cycle of day & night
  - Movement of air
  - Ocean currents

## Stability & changes

- Stable -
- changes - due to seismic event / shift in mass distributions.

# REVOLUTION

## Introduction

- Orbital motion of our planet around the sun.
- Responsible for
  - Changing seasons
  - length of year
  - Patterns of day light & darkness

## Orbit

Earth follows an elliptical (oval shaped) path as it revolves around the sun.

## Duration

- 365 days - one full revolution
- calendar year
- 365 days, 6 hrs, 9 min

Perihelion Speed - 29.2 - 30.29 km/s

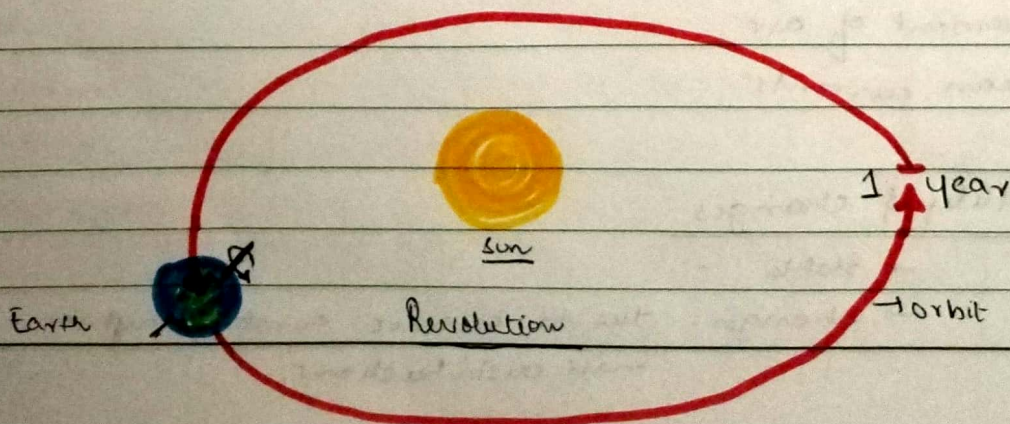
- Point in earth's orbit close to sun (Jan-3 each year)

## Aphelion

Point - Farthest from sun - (July 4 each year)

## Gravitational force & stability

- Gravitational force b/w sun & earth = Revolution
- Maintains stability of its orbit.



# WEATHER VARIABLES

## Weather

- short term atm conditions in specific location at particular time
- Elements like
  - Temperature - GST - avg of temp at surface of sea & air ab
  - humidity - Water vapors present in atmosphere  $g/w$
  - precipitation - The process of continuous condensation
  - Wind speed - Air moving from high to low pressure
  - Atmospheric pressure - Pressure within atm of Earth
- Weather conditions can change rapidly over hours or days

km/h, knots  
barometer

Units → m/s, km/h, miles/hr  
→ 760mm Hg, 101,325 Pa

- Circulation transports heat over the surface of Earth affecting water cycle.

## Factors Effecting Weather

- Short term - atm pressure such as air masses, fronts & low pressure systems
- Seasonal / Daily changes - local conditions & weather sys

## Climate - More stable than weather | Predictable | Expected condition ✓

- long term avg of weather patterns in a particular region over decades or centuries
- Repeating patterns
- Variation in weather over an extended period.

## factors effecting climate

- Distance from equator affects the amount of solar energy received, influencing temp & climate.
- Large bodies of water can moderate temp - coastal areas
- Wind patterns can distribute heat & moisture, influencing regional climates

# NATURAL HAZARDS AND DISASTERS

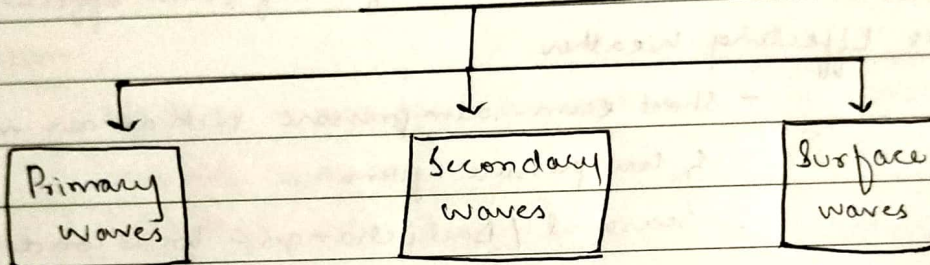
## EARTHQUAKE

- shaking of ground
  - crack & rupture of earth's surface
  - subsea EQ can generate tsunamis - large ocean waves
- } Effect of EQ

### Introduction

It is a natural geological event characterized by sudden release of energy in Earth's crust, resulting in seismic waves

### SEISMIC WAVES



- Fastest waves
- Travel through solid and liquid
- Cause back & forth movement

- Slower than Pri waves
- Travel - only solid
- up & down movement

- Slower and more destructive than Primary waves.
- Earth surface travel causing most of the damage during earthquake.

### Causes of Earthquake

(a) Tectonic Plate Movements - Plate boundaries - Earth's lithosphere - collisions, sliding past each other - plates interact - most occurrence of EQ - stress & strain in crust - earthquake

### (b) Subduction Zones

- when one tectonic plate is forced beneath other - powerful earthquake

(c) Faults - stress along faults - sudden release of stress along faults - earth's crust - features.



# VOLCANIC ERUPTION

## INTRODUCTION

- Geological event
- Molten rock, ash, gases - Expelled from volcano's vent.
- Earth surface, atmosphere
- Transfer of heat from Earth interior to surface

## Types of Volcanic Eruptions

### Effusive Eruptions

- Relatively gentle eruptions
- lava flow - steadily
- e.g Hawaiian volcanoes

### Explosive Eruptions

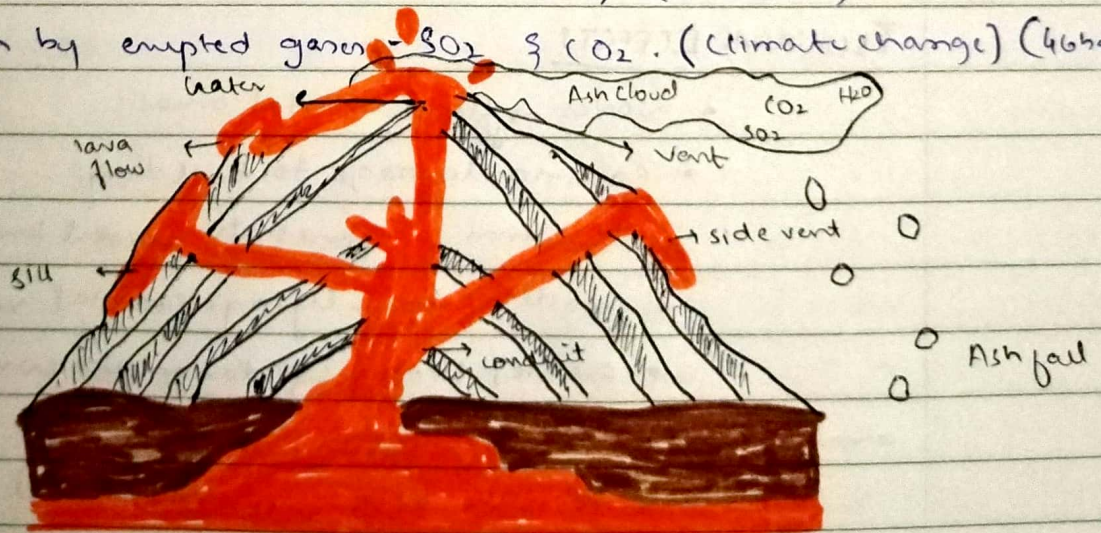
- Violent
- Sudden release of pressure
- Vesuvius (Pompeii)

### Phreatomagmatic Eruption

- magma interaction with ground water
- ↓
- explosive eruptions
- Magma = molten underground rock

## Effects of Volcanic Eruptions

- a) Destruction of vegetation and infrastructure
- b) Affecting agriculture and health (ash) (Acid rain)
- c) Air pollution by erupted gases - SO<sub>2</sub> } (CO<sub>2</sub> (climate change) (Global warming)



VOLCANIC ERUPTION



# TSUNAMI (TIDAL WAVE)

## INTRODUCTION

e.g  
2004 Indian  
Ocean

- Series of large ocean waves
- Cause — sudden displacement of large volume of water.

## CAUSES OF TSUNAMI

Tsunami

↓

- Underwater earthquake
- Explosive volcanic eruptions → tsunami
- Rapid underwater landslides can also displace water
- lead to tsunamis ↓
- Extremely rare, asteroids & meteor → massive waves

deadliest  
230,000  
People killed

+

missing  
in 14 countries

## CHARACTERISTICS OF TSUNAMI

bordering  
the Indian  
Ocean.

- Tsunami - long wavelength (100km) → entire ocean basin
- Tsunami - high speeds, low amplitude (low oscillation)
- Their wave height increase - devastating waves hitting coastline

## TSUNAMI EFFECTS

- Waves → flood coastal areas
- Causing damage to building
- Tsunami - penetrate several km
- flooding low-lying coastal regions
- create strong & dangerous currents,
- dragging ppl into ocean
- Health Risk - contaminated water - food supplies
- Infrastructure
- Natural habitat for birds & animals

EXCELLENT



# FLOODS

Case study =

Most 2022

WHO

## DEFINITION

Pakistan

Flood

during

Sept 2022

## CAUSES

33 million

affected

1,739-

killed

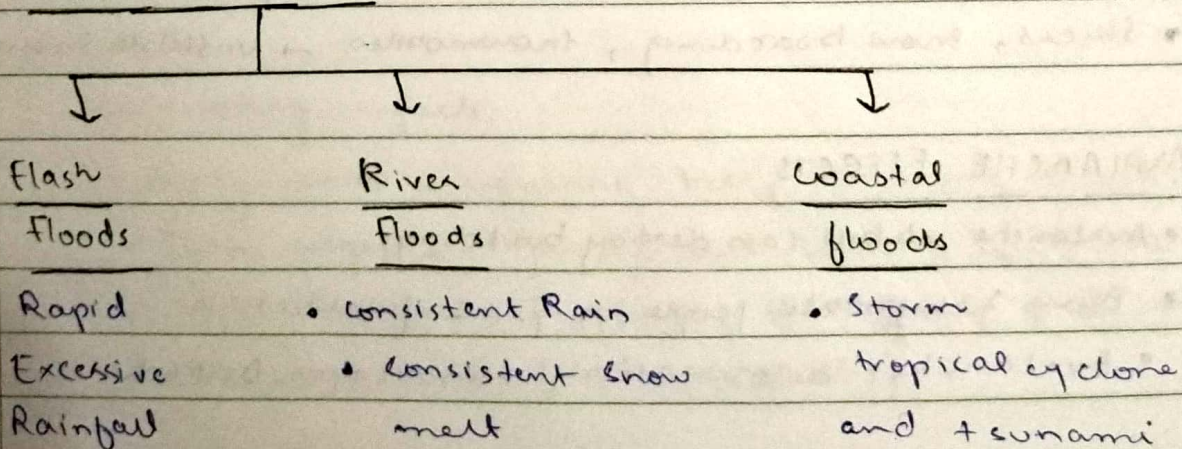
- Frequent type of Natural disaster
- Overflow of water submerges land.

- Heavy Rainfall
- Rapid snowmelt (glaciers)
- Storm -
- cyclone
- Tsunami in coastal area

## EFFECTS

- loss of life
  - loss of personal property
  - critical public health infrastructure
- e.g. • 1998-2017 → 2 billion people

## TYPES OF FLOODS



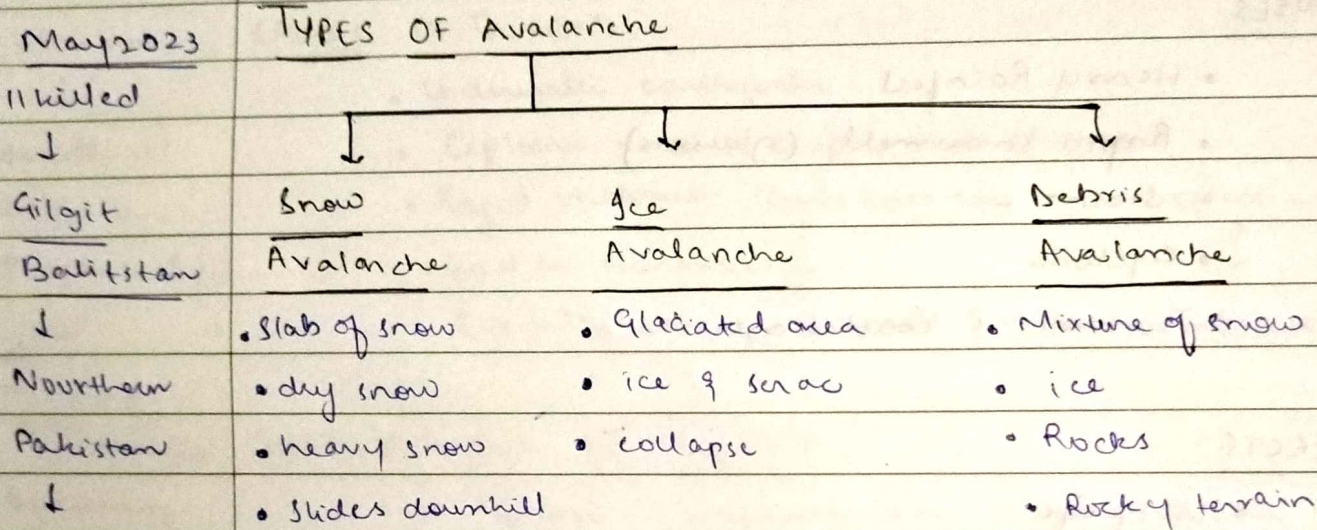
# AVALANCHE

## INTRODUCTION

Pakistan's  
Recent  
Avalanche

- Sudden & Rapid flow of snow
- ice down mountain side

## TYPES OF Avalanche



## AVALANCHE TRIGGERS

↓

Shounter  
pan

- Heavy, snow fall, Rain, Rapid temperature
- Steep slopes
- Weak layers within snowpack can collapse
- Skiers, snow boarding, snowmobiles → unstable snow layers

2012 May  
1 civilians  
29 soldiers

## AVALANCHE EFFECTS

↓

Most  
devastating

- Avalanche debris can destroy buildings
- Bury & suffocate people → path-fatalities
- Avalanche deforestation, landscapes. Destruction

# CYCLONE

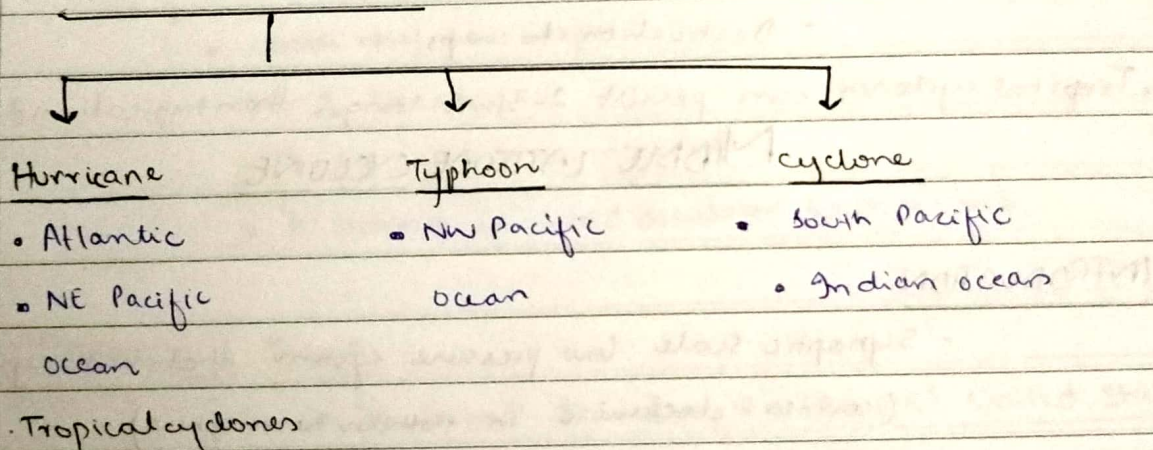
## INTRODUCTION

- Large scale weather system
- low atm pressure
- strong Rotating winds

## FORMATION OF CYCLONES

- involves several stages
- Heating up of air above warm ocean
- low pressure
- Earth's rotation + winds rotation = cyclone

## TYPES OF CYCLONE



## IMPACTS

- devastating impacts
- Strong winds - uprooting trees, damaging building
- Storm surges - High sea level leading to coastal flooding
- Heavy Rainfall - Triggering flash floods and land slides
- Tornadoes - Rotating air (violently)

## STRUCTURE

- A cyclone has well defined eye at its center
- most intense rainfall occur
- Surrounding the eye is eye wall
- Outer rainbands extended further out from center

EXCELLENT

# TROPICAL CYCLONE

## INTRODUCTION

- Tropical cyclone - non-frontal
- Synoptic-scale

## STRUCTURE - cyclone developing over tropical

- subtropical water
- organized circulation.

e.g. - hurricane, typhoons or simply tropical cyclones depending on the region.

- They develop at latitudes  $\pm 5^\circ$  from the equator.

## Example - Philippines is prone to tropical cyclones

(Heavy Rains + flooding)

## Effects

- Heavy casualties
- Destruction to crops

• Tropical cyclones can persist 2-3 times longer than typical midlatitude cyclones.

# MIDDLE LATITUDE CYCLONE

## INTRODUCTION

- Synoptic scale low pressure system that has cyclonic (counter-clockwise in northern hemisphere)

- flow in middle latitudes (i.e.  $30^\circ N - 55^\circ N$ )

## Location

- location difference (Tropical vs mid latitudes) (Tropical have warm core while MLC has cold core)

## Size

Size diff in (Tropical) hurricane and mid latitudes cyclone  
200 - 1000 km      1500 - 5000 km in diameter

## Characteristics of MLC

- a) low pressure at the surface
- b) Rotate cyclonically
- c) from east of upper-level trough
- d) Propagate from west to east and Poleward



# TORNADOES (TWISTER)

## Definition

- A violently rotating column of air touching the ground, usually attached to base of thunderstorm
- Most violent storm
- Winds of tornado may reach 300 miles/hr.
- Some tornadoes are clearly visible
- While rain & low hanging clouds obscure others
- Rapid & Quick
- On ground - less than 15 mins
- travels 10-20 miles/hr

Deadliest  
F5 Tornado  
 longest  
 219 miles  
 across  
 Missouri  
 Illinois  
 Indiana

## Causes

- Instability - warm moist air near the ground
- cooler dry air aloft
- wind shear
- A change in wind speed
- A change in wind direction with height

## COMMONLY FOUND

- In Great Plains of the Central United States
- Ideal Environment - Tornadoes
- Tornado Alley - (Area) - when dry cold air moving south from Canada - meets warm moist air travelling from North from the Gulf of Mexico.

## EFFECTS

- Rip homes to shreds
- broken glass & debris → lethal missiles
- Automobiles → airborne



# DROUGHT

## Overview

- Period drier than normal conditions
- Can last for days, months & years
- Unusually persistent dry weather that persists long enough to cause serious problems such as crop damage & water supply shortage.
- The severity depends on

## Factors

- Degree of moisture deficiency
- The duration
- The size of affected area

## Causes

- lack of Rainfall
- water shortages
- High temperatures
- Extreme Heat
- water reservoir - dried
- Extreme variation in monsoon rainfalls
- Arid / Hyper Arid environment

## Impacts

- visibly dry vegetation
- lower water levels
- lower water reservoirs
- land subsidence
- seawater intrusion
- damage to Ecosystem

# WILDFIRE

## Overview

- A wildfire, forest fire, bushfire, wildland fire, rural fire is an unplanned, uncontrolled and unpredictable fire in an area of combustible vegetation

## Classification

- Cause of Ignition
- Physical Properties
- Combustible material
- Effect of weather

## Effects

- Health Impact
  - smoke & fire
- Destruction of Property
- Economic and Ecosystem services losses
- Contamination of water & soil

## COMMON AREAS

- Siberia
- California
- British Columbia
- Australia
  - Areas with Mediterranean climates
- taiga biome
- US

# URBAN FIRE

## DEFINITION

- Urban fires - involving buildings or structures in cities or towns with potential to spread to adjoining structures.

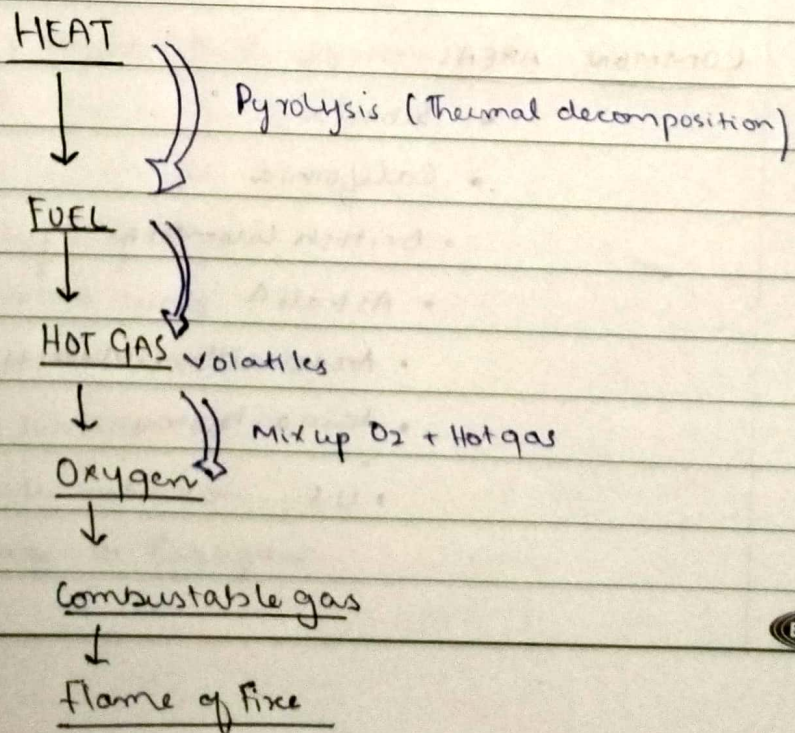
## TRIGGERS

- Human Actions  
e.g. knocking over a candle
- Technological triggers  
e.g. Power surge overloading appliances
- Natural triggers
  - Wildland fires interaction with cities, Volcanic eruptions

## ELEMENTS OF TRIGGER

- Fuel
- Oxygen
- Heat

## PROCESS



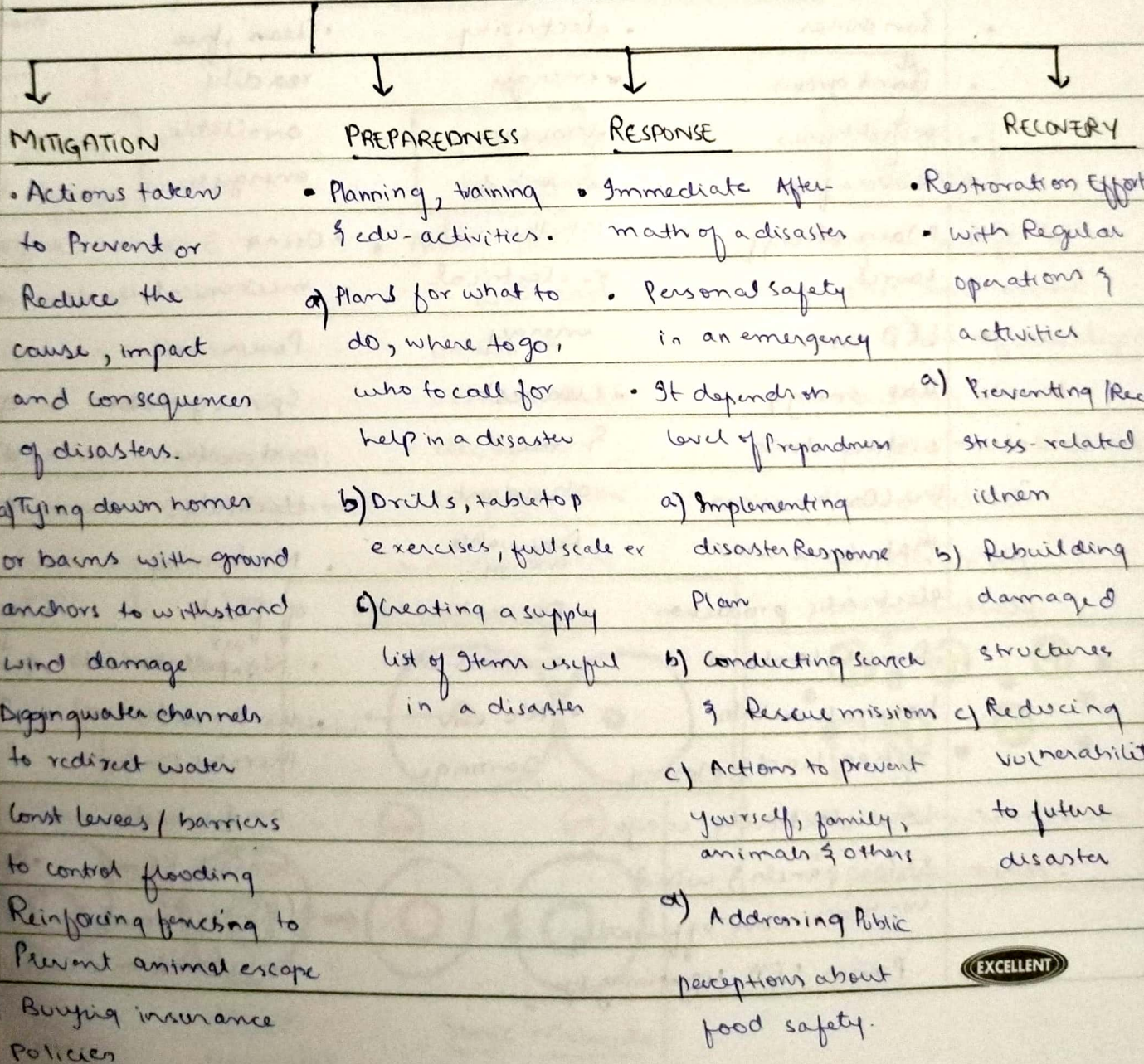


# DISASTER RISK MANAGEMENT

## Introduction

- Application of disaster risk reduction policies
- Strategies to prevent new disaster Risk
- Reduce existing disaster Risk
- Manage residual Risk
- Contribution → Strengthen Resilience & Reduction of disaster

## FOUR TYPES OF DISASTER RISK MANAGEMENT



# ENERGY RESOURCES

Primary energy Resources (heat) → secondary → Electricity → Hydrogen

RENEWABLE ENERGY ← Sources of energy → NON-RENEWABLE ENERGY

**Renewable LED Energy**

- Naturally replenished
- Sun shines
- Plant grows
- Wind blows
- Rivers flow
- Main energy source
- LED uses less energy
- cutting down the CO<sub>2</sub> emissions that come with electricity production
- Do not contain harmful metals such as lead & Mercury
- less electricity usage
- Solar panels & wind turbines can efficiently power LED lighting sys.

**Renewable Solar Energy**

- From Sun
- heating
- electricity
- energy from sun converted into thermal or electrical energy.
- Cleanest & most abundant Renewable energy
- No carbon emissions
- No env Damage

**Renewable Wind Energy**

- From wind blow
- Electricity
- Clean, free readily available energy source
- Using mechanical Power to spin a generator and create electricity.
- No burning of fuel
- No air pollution
- Wind rotates the rotor blades and which convert KE (Kinetic energy) into Rotational energy

**Non-Renewable Energy**

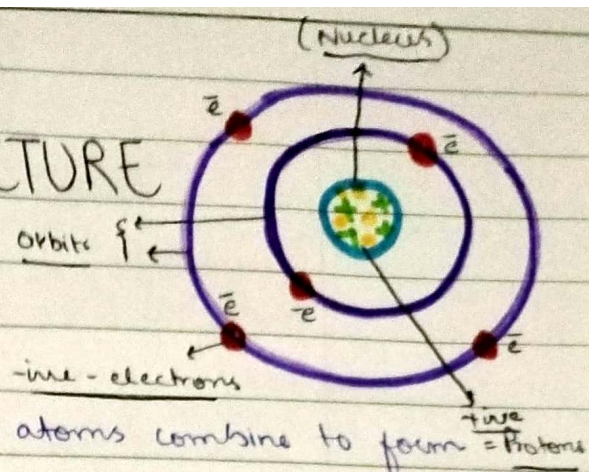
- NRE supplies are limited to the amounts that can be mined or extracted from Earth.
- e.g a) Petroleum
- b) Hydrocarbon gas liquids
- c) Natural gas
- d) Coal
- e) Nuclear energy
- Fossil fuels (ancient - long dead animal & plants buried in soil)
- Million yrs ago



# ATOMIC STRUCTURE

## CHEMICAL BONDING

### INTRODUCTION



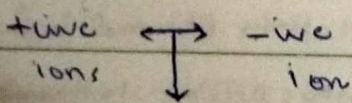
- It is a process by which atoms combine to form molecules or compounds.

- It involves the interaction of electrons between atoms to form stable chemical entities.

### TYPES OF CHEMICAL BONDING

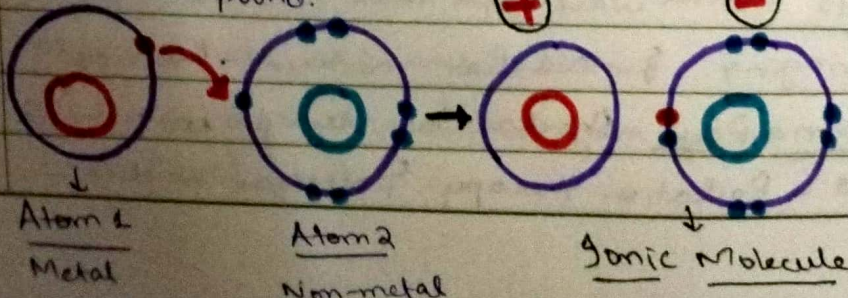
#### IONIC BONDS

- Atoms transfer  $e^-$  to each other
- forming cations and anions
- Cations - +ive charged ions
- Anions - -ive charged ions



electrostatic forces

ionic compound.

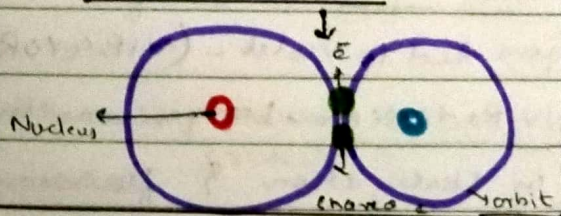


#### COVALENT BONDS

- Atoms share  $e^-$  with each other to achieve stable electronic configuration.

e.g non-metals

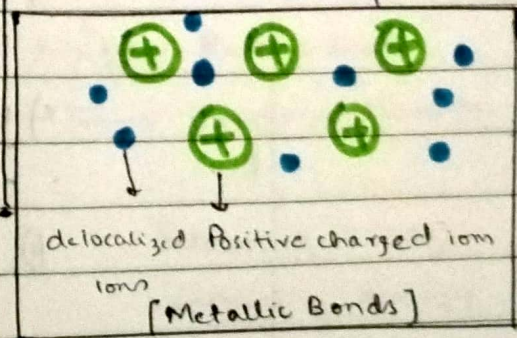
covalent molecules



#### METALLIC BONDS

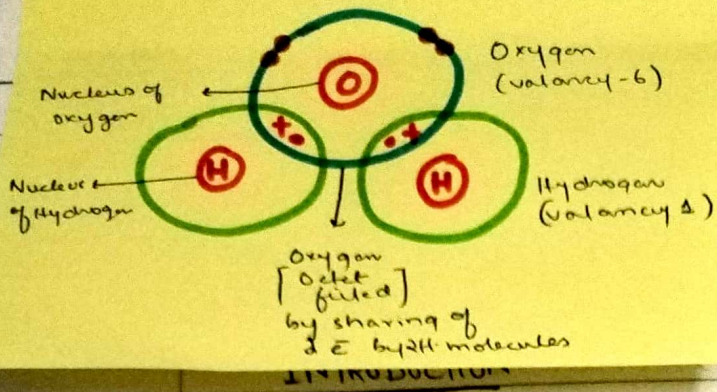
- They are specific to metals and involve a 'sea' of delocalized electrons shared among metals' atoms

- Shared  $e^-$  cloud
- malleability
- conductivity

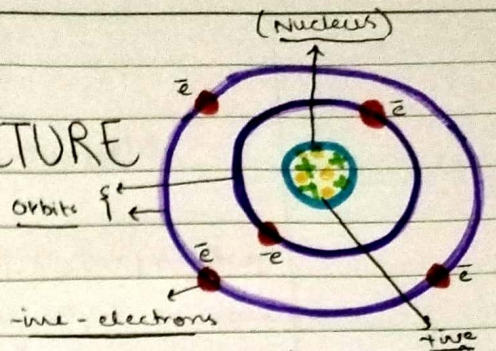


EXCELLENT

# H<sub>2</sub>O - Covalent Bond



## STRUCTURE



- It is a process by which atoms combine to form molecules or compounds.
- It involves the interaction of electrons between atoms to form stable chemical entities.

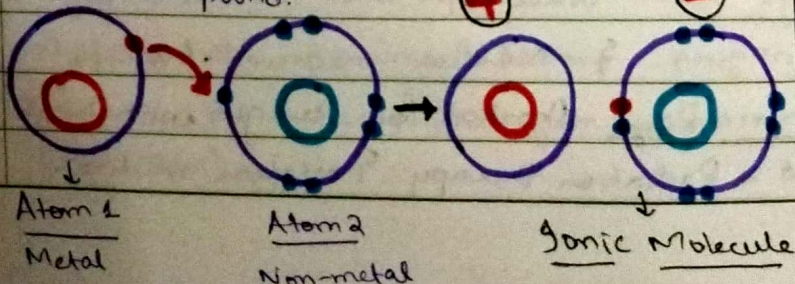
## TYPES OF CHEMICAL BONDING

### IONIC BONDS

- Atoms transfer  $e^-$  to each other
- Forming cations and anions
- Cations - +ive charged ions
- Anions - -ive charged ions
- +ive ions ↔ -ive ion

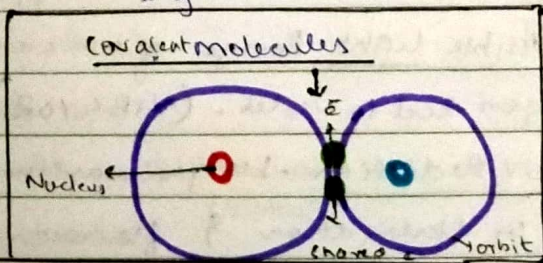
electrostatic forces

Ionic compound.



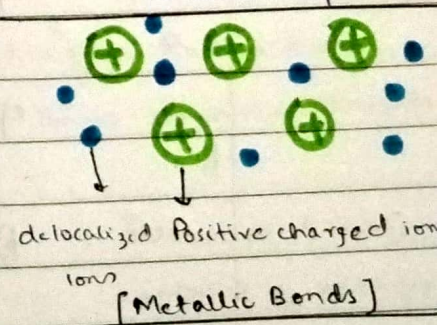
### COVALENT BONDS

- Atoms share  $e^-$  with each other to achieve stable electronic configuration.
- e.g non-metals



### METALLIC BONDS

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- Shared  $e^-$  cloud
- malleability
- conductivity



# ELECTROMAGNETIC RADIATIONS

## DEFINITIONS

- They are form of energy that travels through space in the form of oscillating Electric and magnetic fields.
- These waves donot require medium for propagation and can travel through vacuum.

## ELECTROMAGNETIC SPECTRUM

- It composes a wide range of electromagnetic radiations
  - Classified based on - wavelengths & frequencies
  - From longest to shortest wavelength - it includes
- Radio waves long wavelength - used in communication
    - Broadcasting - Radar systems
  - Microwaves - shorter wavelengths than Radiowaves.
    - Used in Microwave ovens & Satellite communication
  - Infrared Radiations - They have longer wavelengths than visible light - Used in heat sensitive applications (thermal imaging - Remote control)
  - Visible light Range of wavelengths visible to human eye - from Red to violet - (VIBGYOR)
  - UV Radiation - Longer wavelengths than Xrays and used
    - in sterilization & fluorescent lighting.
  - Xrays shorter wavelength than UV. Used for Medical Imaging & Nuclear medicine - therapy
  - Gamma Rays Shortest wavelengths with high energy used in Radiation therapy & nuclear medicine

EXCELLENT

### PROPERTIES OF ELECTROMAGNETIC WAVES

- Oscillating electric and magnetic fields
- Perpendicular to each other
- Perpendicular to direction of wave propagation
- EM waves travel at speed of light in vacuum
- Wave like + Particle like behavior of EM
- Wave - Particle duality - EM waves

### PRODUCTION AND INTERACTION

- Produced by accelerating charged particles, such as antennas & synchrotrons
- Interaction with matter - absorption
  - transmission
  - Reflection

### NATURAL RADIOACTIVITY

vs

### ARTIFICIAL RADIOACTIVITY

- Natural Radioactivity is the form of radioactivity takes place on its own in nature
- Discovery by Henry Becquerel in 1896
- Explained by Marie Curie - 1898 (Noble Prize)
- Release of Particles and energy from unstable nuclei. to become (stable)
- Decomposition of nuclei
- e.g Uranium (A.no. 92)
- alpha, beta, gamma Radiations
  - alpha → 2p, 2n (+2ve charge)
  - beta → e<sup>-</sup> (1ve)
  - gamma → Photons from nucleus

- Artificial Radioactivity is induced by man in laboratories.
- Bombarding → slow moving neutrons
- Radioactive isotopes of Thorium & Uranium
  - ↓ Artificial Radioactivity
  - ↓ Trans Uranium elements
  - ↓
  - Releasing a huge amount of energy
  - to turn water into steam
  - Steam to turbines
  - electricity.



# MODERN MATERIALS / CHEMICALS

## CERAMICS

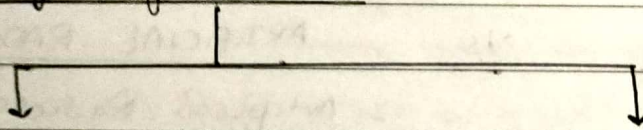
### Introduction

- Broad category of inorganic, non metallic material
- Typically made of clay, minerals, natural sources

### Composition and Structure

- Oxygen, silicon, metal atoms
- Arranged in crystalline structure
- Hard & brittle by this structure

### Types of Ceramics



#### 1) Traditional Ceramics

- Pottery
  - Bricks
  - Tiles
  - Porcelain
  - Natural clay
  - Molding
  - Drying
  - Firing
- } Shaped

#### 2) Advanced Ceramics

- Engineered ceramics
- Modern technology
- Alumina
- Zirconia
- Silicon
- Carbide
- Boron nitride

### Characteristics

- Ceramics are extremely hard, brittle
- Can resist wear, abrasion & deformation
- High  $M_p$  - Suitable for high temp
- Excellent electrical & thermal insulators

## Applications

- a) Building materials - Bricks, tiles, cement
- b) Electronic devices (capacitors)
- c) Gas turbine engines, ballistic protection
- d) Bioceramics are used in dental implants
- e) Bone grafts, medical tools
- f) Cutting tools, bearings & furnace linings

## NANOCERAMICS

- Nanoparticles
- Early 1980's discovery
- Ultrafine particles
- Less than 100nm in diameter

Formed - Sol-gel process

- Chemical solution deposition
- Mix nano particles within solution & Gel → nanoceramics

## HOW NANOCERAMICS BETTER THAN CERAMICS

• Unique & Improved properties

- \* • Dielectricity
- Ferroelectricity
- Piezoelectricity
- Pyroelectricity
- Ferromagnetism
- Magneto resistance
- Super conductivity
- Super plasticity
- Machineability
- Bioactivity
- Strength & toughness
- Resistance against compression & bending
- Steel like strength



# PLASTICS

## INTRODUCTION

They are a group of synthetic and semi synthetic polymers derived from petrochemicals.

## TYPES OF PLASTICS

### ① Thermoplastics

- can be softened
- can be reshaped

Multiple times

↓  
Heating

e.g. Polyethylene  
Polypropylene

### ② Thermosetting Plastics

- Irreversible chemical change
- when heated.
- cannot be reshaped

e.g. epoxy

- phenolic resins

## PROCESS

- Through Polymerization process
- Small molecules (monomers) → long chains (Polymers)

## PROPERTIES

- light weight
- Durability
- Strength
- flexibility
- Transparency
- Electric Insulation

# SEMICONDUCTORS

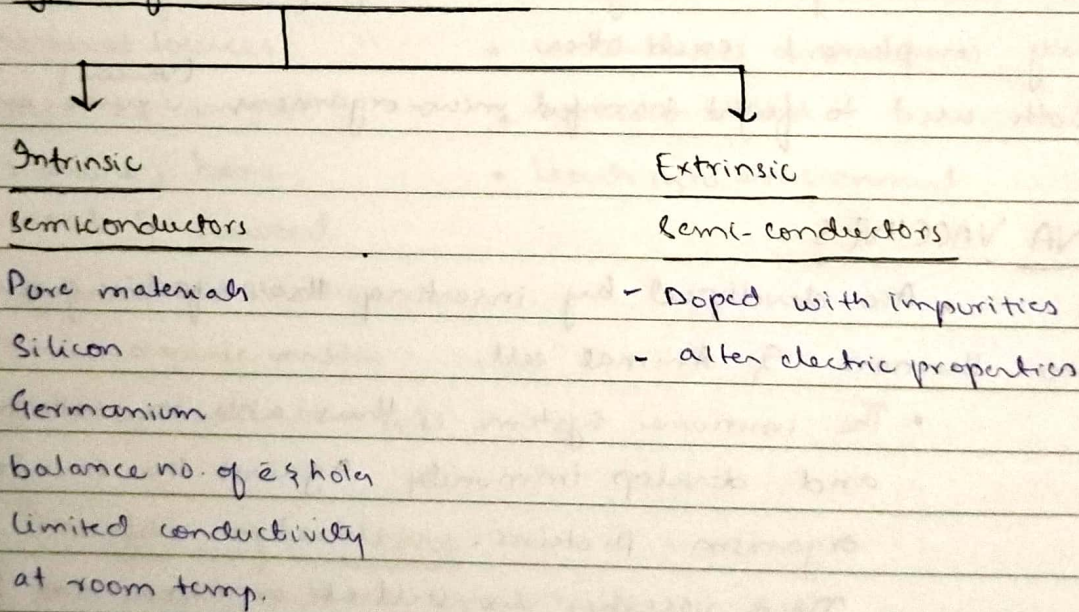
## Introduction

- class of materials with unique electrical properties
- lies b/w conductors & insulators

## Band theory

- Explain distribution of electrons in energy levels & bands
- a) • valance band -  $\bar{e}$  - bound to atoms
- b) • conduction band - holds  $\bar{e}$  - free to move - conduct electricity
- Energy gap b/w these bands determine conductivity

## Types of Semi-conductors



## Transistors ← Semiconductors - The Brain of Modern electronics

Instant on/off ability • Critical component of millions of electronic devices used in education, Research Communication, healthcare, transportation, energy.

eg • Laptop's semiconductor-based central processing unit (CPU) and Graphics Processing Unit (GPU) implement computing functions that instantly turn questions into answers.

• Integrated circuits (ICs) made of silicon (semiconductor) are essential parts of modern electronic devices.



# ANTIBIOTICS AND VACCINES

## Antibiotics vs Vaccines

- Antibiotics are used to treat already established infection when millions of pathogens are already in the body
- Vaccines are used as prevention of infection. Vaccination trains the body before infection. (live attenuated)
- Immunity booster
- Inactivated microbes / toxins / antigens
- Viral disease
- Antibiotics do not work on viruses

How do both contribute to health.

- Both have important roles in managing infectious diseases
- They complement each other
- Both used to fight harmful micro-organisms, (vaccine) viruses and (antibiotics) bacteria

## DNA VACCINES

- Are developed by inserting the infective agent's DNA into Human & Animal cell.
- The immune system is thus able to recognize and develop immunity against the invader organism proteins.
- DNA vaccines are still at experimental stage
- But Promising effects of it
- last longer
- Stored easily

## Side Effects of Antibiotics

Antibiotics while taken for too long can effect / kill the good Bacteria - whose presence in the gut - is important for health.

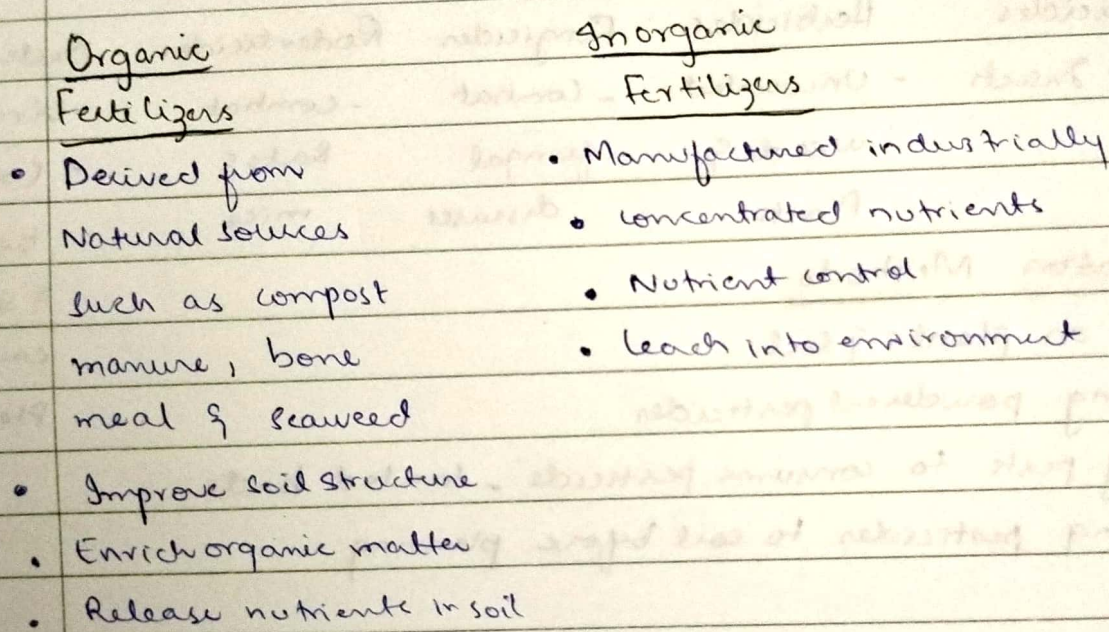


# FERTILIZERS

## Introduction

- Substances and Mixtures applied to soil or plants to provide essential nutrients.
- Enhance Plant Growth & improve crop yield.

## Types of Fertilizers



## Benefits of Fertilizers

- Increased nutrient availability
- Better growth & productivity
- Address specific deficiencies in soil
- Strengthen Plant's ability to resist disease & pests

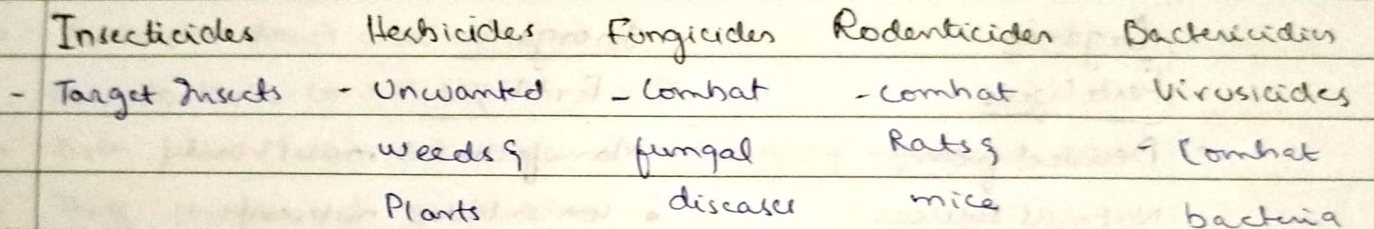
Q Why excessive use of carbon fertilizers be avoided?  
 Carbon ensures clear water but unfortunately also binds metals and important nutrients from soil that are essential for plant growth.

# PESTICIDES

## Introduction

- Chemical substances / Biological agents used to control and manage pests that can harm crops, live stock & human health.

## Types of Pesticides



## Application Methods

- Spray on plants & soil
- Dusting powdered pesticides
- Luring pests to consume pesticide - treated baits
- Applying pesticides to soil before planting

## Benefits of Pesticides

- Increased crop yield - higher productivity
- Control plant diseases by pathogens
- Reduce economic losses - (crops decline)

Q- Why Persistent pesticides more lethal for mankind?

- Acute large doses exposures to the organochlorides in pesticides typically effect the nervous system, causing problems, such as tremors, numbness & seizures.

- Pesticide Poisoning - Birth defects, fetal death, cancer, neurological diseases

