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Important Questions:

1:) What are the different branches of geology?
2:) Write the importance of geology.
3:) Differentiate between geology and engineering geology.
4:) Explain the importance of geology in civil engineering with reference to road.

Answers:

1→ Geology (भू - विज्ञान) is the scientific study of the Earth, focusing on its composition, structure, history, etc. There are some branches of Geology which are listed below:-

- Physical Geology: Investigates Earth's materials, including minerals and rocks, and studies processes like erosion and sedimentation.
- Historical Geology: Examines the Earth's past through the analysis of rocks, fossils, and geological events to understand its evolutionary history.
- Structural Geology: Focuses on the deformation and arrangement of rocks to comprehend the forces shaping the Earth's crust.
- Mineralogy: Studies minerals, including their composition, structure, and properties.
- Paleontology: Analyzes fossils to understand the history of life on Earth and the relationships between different organisms.
- Stratigraphy: Investigates the chronological sequence of rock layers to establish the geological history of an area.
- Geo Chemistry: Studies the chemical composition of rocks, minerals, and fluids to gain insights into Earth's processes.

⇒

- **Geophysics**: Applies principles of physics to explore Earth's interior and subsurface structures, often using methods like seismic surveys.
- **Environmental Geology**: Focuses on the interactions between human activities and the Earth, assessing environmental impact and sustainability.

These branches collectively contribute to understanding of the Earth's dynamic nature and provide insights for various applications.

2→ Geology is the scientific study of the Earth, focusing on its composition, structure, history, etc.
Geology is important for several ~~regions~~ reasons:

- **Resource Exploration**: It helps to identify and locate valuable Earth resources such as minerals, fossil fuels, and water, contributing to sustainable resource management.
- **Environmental Management**: Geologists assess and manage environmental impact, addressing issues like pollution, land degradation and natural hazards.
- **Understanding Natural Hazards**: Geology contains studying of earthquakes, volcanic eruptions, landslides and other natural hazards, aiding in risk assessment and mitigation.
- **Infrastructure Development**: Geological studies inform construction projects by providing insights into the stability of the ground, preventing issues like foundation failures
- **Water Management**: Geology helps in understanding groundwater flow, aquifer properties, and the ~~avi~~ availability of water resources vital for sustainable water management.

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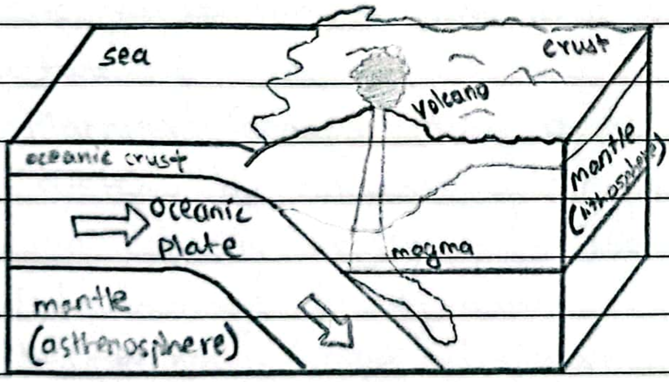
- <u>Climate Change Studies</u>: Geological records provide valuable information on past climate changes, aiding in the understanding and prediction of current and ~~fu~~ future climate patterns.
- <u>Energy Exploration</u>: Geologists contribute to the exploration and extraction of energy resources, including oil, gas and geothermal energy.
- <u>Earth's History</u>: Geology allows us to unravel the Earth's geological history, providing insights into the evolution of life and the planet itself.
- <u>Natural Resource Conservation</u>: By studying geological processes, we can develop strategies for conserving and managing natural resources for ~~fu~~ future generations.
- <u>Scientific Exploration</u>: Geology contributes to our fundamental understanding of Earth's processes, fostering scientific knowledge and discovery.



<u>Fig</u>: Geographic Structure of earth

Overall, geology plays a vital role in addressing societal challenges, promoting sustainable development, and enhancing our understanding of the Earth and its dynamic systems.

3→

Gedogy	Engineering Geology
It focuses on study of Earth's composition, structure, processes and history.	It focuses on application of geological principles to engineering and construction projects.
Its objective is to understand natural Earth processes and features over geological time scale.	Its objective is to access geological factors that impact construction & infrastructure stability.

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4) Geology in civil engineering with reference to road:

- Site Selection: It helps in selecting suitable sites for road construction by accessing the stability of the ground, soil conditions and potential geological hazards.
- Foundation Design: Geology provides insights into the composition and structure of the subsurface, enabling engineers to design appropriate foundations that can withstand the geological conditions.
- Slope Stability: Understanding the geological characteristics of slopes is crucial for designing roads on hilly terrain. Geology helps in accessing the stability of slopes to prevent landslides and ensure road safety.
- Material Selection: Geologists help identify suitable construction materials by analyzing the geological composition of rocks and soils. This is crucial for durable and long-lasting road infrastructure.
- Drainage Planning: Geology plays a role in designing effective drainage systems by considering the permeability and water holding capacity of the soil. Proper drainage prevents water-related damage to ~~a~~ roads.
- Cut and Fill Operations: Geological surveys guide engineers in cut and fill operations by accessing the stability of excavated slopes and the suitability of materials for filling.
- Geotechnical Investigations: Geotechnical studies, a branch of geology, provide crucial information about soil mechanics, bearing capacity and compaction properties, essential for road design & construction.
- Natural Hazard Assessment: Geology helps identify and ~~ass~~ assess natural hazards like ~~l~~ landslides, earthquakes and subsidence, allowing engineers to implement measures to mitigate these risks.

- Environmental Impact Assessment: Geology contributes to evaluating the environmental impact of road constructions, ensuring sustainable ~~pr~~ practices and minimizing ecological disruption.
- Maintenance Planning: A thorough understanding of the geological conditions aids in planning maintenance activities addressing issues such as soil erosion, weathering of road materials, and other geological factors affecting road longevity.

In summary, geology is integral to civil engineering, especially in road construction, as it provides essential information for site selection, foundation design, slope stability, material suitability, drainage, and overall infrastructure durability and safety.

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Chapter : 1 (NOTE) (Total : 2 page)

Introduction to ~~Geology~~ Engineering Geology.

✓ Engineering Geology

- It is defined as the branch of geology which deals with the application of geology for a safe, stable & economical design and construction of civil engineering projects.

Different Branches of Science

- Geophysics
- Geography
- Geodetic
- Oceanography
- Geochemistry
- Climatology
- Meteorology

✓ Branches of Geology

a> Physical Geology

- Mineralogy
- Petrology
- Geomorphology
- Geochemistry
- Geophysics
- Sedimentology
- Economic geology
- Engineering geology
- Structural geology (fold, fault, thrust, joints)

b> Historical Geology

✓ Interrelationship between different branches of geology.

- Mineralogical study
- Engineering properties of rocks
- Stress
- Chemical composition
- Structural
- Historical geology
- Petrology
- Geomorphology

Scope of Geology

- Civil Engineering
- Mining Engineering
- Water resource "
- Earthquake "
- Tunnel "
- Geomechanics
- geography
- Urban ... ing

Objective of Geology

- study various types of rocks, their origin, mineral composition, strength and their civil engineering significance
- study various geological process
- study about risk & geo-hazard
- study about type of geological structures (fold, fault, joint, thrust, etc

✓ Importance of Geology in Civil Engineering

- Knowledge about :- rocks, minerals, structures, road, tunnel, dam
- knowledge about geo-hazard
- Geological survey, geological map & cross-section
- Hydrological study

✓ Definition of Engineering Geology According to IAEG

IAEG (International Association for Engineering Geology)

1> IAEG statutes, Arnould, 1970.

→ The application of the earth sciences to engineering planning, construction, prospecting, testing & processing of related materials.

2> IAEG statutes, 1992

→ The science devoted to the investigation, study and solution of the engineering and environmental problems which may arise as the result of the interaction between geology and the works and development of measures for prevention or remediation of geological hazard.

IAEG defines engineering geology as the application of geological principles and techniques to the study and solution of engineering and environmental problems.

Chapter : 2 (NOTE) (Total: 8.5 page)

Structure of the Earth (Assignment: 8 page)

Origin of the Earth

A.) Nebular Hypothesis:

→ German philosopher Immanuel Kant in 1755
→ Modified in 1796 by Pierre Laplace
→ Explains formation of stars & planets.
→ Rotating Nebula – during rotation – cooled & contracted – making disc shape, increase in concentration of mass at center.
→ That Disc condensed into planets, moons, asteroids & comets, the great mass at center became Sun.

B.) Planetesimal Hypothesis:

→ Thomas Chrowder Chamberlin & Forest Ray Moulton in 1905
→ Sun existed before formation of planets – star came close to sun cuz of gravitational pull – small bodies were seperated from sun called planetesimals – that condensed with time to form planets – planets collided over time & formed moons.

C.) Gaseous Tidal Hypothesis:

→ Jeans & Jeffrey in 1925
→ Large star came near sun due to gravitational pull – gaseous tide was raised on surface of sun – gaseous tide detached when star moved away – shape of tide: spindle – broken in pieces forming 9 planets

D.) Binary Star Hypothesis:

→ Lyttleton in 1938
→ Before formation of planets, sun was twin star system – one star collide & twin star seperated – in the process, gaseous filament was torn and it remain close to sun – planets formed from gaseous filament.

Age of Earth

• 4.543 billion years

1.> Evolutionary change of Animals (fossils : 1000 million years)
2.> Rate of sedimentation (510 million years)
3.> Salinity of sea water (120 million years)
4.> Rate of cooling of Earth (20-40 million years)
5.> Radiometric dating (4600 million years)

Components of Earth

1.> Atmosphere : 78% Nitrogen, 21% Oxygen, 1% other gas
2.> Biosphere : life existing layer.
3.> Geosphere : minerals, rocks, landforms
4.> Hydrosphere : ocean, rivers, lakes, groundwater
5.> Cryosphere : frozen part of earth like snow, glaciers & sea ice

Structure of Earth

1.> External Structure: shape of earth is spherical. found rocky bodies. Rocks are less denser materials here than those of interior of earth.

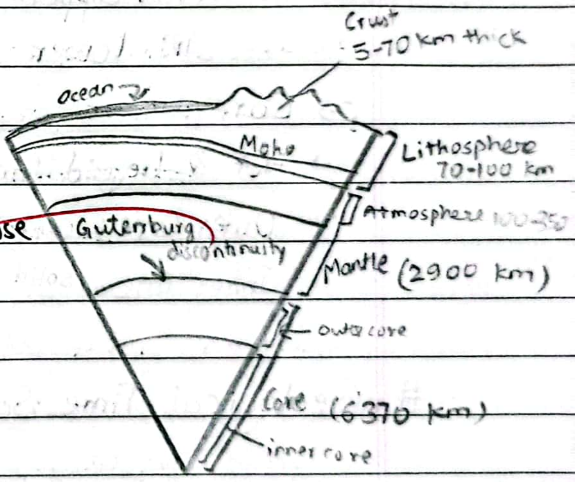

Fig:- Geographical Structure of Earth

2.> Internal Structure:
On the basis of relative pos^n, density, composition & seismic waves:-

a.> Crust
b.> Mantle
c.> Core

=>

Crust - Mantle : Mohorivicic Discontinuity
Mantle - Core : Gutenburg Discontinuity

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a.> Crust :

→ outermost layer, surface of Earth, composed of thin layer of rocks.
→ Thickness avg. 33 km (From Mt. Everest to Mariana Trench)
→ Continental Crust composed of crystalline & granitic rocks mainly of silica & aluminium (called SIAL)
· Oceanic Crust composed of basaltic igneous rocks, mainly of silica & magnesium (called SIMA)
→ Crust - Mantle boundary name: Mohorivicic Discontinuity. where seismic waves bounce & refract.

b.> Mantle :

→ Composed mainly of iron & magnesium silicates.
→ Thickness about 2900 km
- i.> Lithosphere (70 - 100 km) [Tectonic plates]
- ii.> Asthenosphere (100 - 350 km) [Rocks are near or at melting point.]
- iii.> Upper Mantle (350 - 670 km) [made up olivine & pyroxene calcium & aluminium.]
- iv) lower Mantle (670 - 2900 km) [mostly silicon, magnesium & oxygen with some iron, calcium & aluminium]

c.> Core :

→ Hot & liquid layer mainly of Nickel & liquid iron (called Nife layer)
→ Outer Core : contains Si, S, C [2900 km - 5150 km]
Inner Core : solid iron, nickel [5150 km - 6370 km]

Geological Time Scale & Evolution of Life:
~~(Ascending order)~~

Formation of Earth [First of All]

=)

Millions years ago	Era	Period	Events
0-1.6	Cenozoic (Age of Mammals)	Quaternary	Evolution of humans
1.6-65.5		Tertiary	Mammals Diversify
65.5-144	Mesozoic (Age of Reptiles)	Cretaceous	Extinction of Dinosaurs, first primates, first flowering plant.
144-208		Jurassic	First birds, Dinosaurs Diversify
208-245		Triassic	First Mammals, First Dinosaurs
245-286	Paleozoic	Permian	major extinctions, Reptiles Diversify
286-360		Carboniferous	first reptiles; scale trees, seed ferns
360-408		Devonian	first amphibians, jawed fishes diversify
408-438		Silurian	first vascular land plants
438-505		Ordovician	sudden diversification of metazoan families
505-570		Cambrian	first fishes, first chordates
570-2500	Precambrian	Proterozoic Eon	first soft-bodied animals
2500-3800		Achean Eon	first unicellular life appeared
3800-4600		Hadean Eon	Atmosphere & oceans form, oldest rocks form as Earth cools

Physical Features of Earth Surface

- Continental feature
  - Mountain
  - Plateau
- Oceanic feature
  - Abyssal fan
  - Abyssal plain
  - Archipelago
  - Peninsula
  - Island
  - Coral reef

* Mountain:

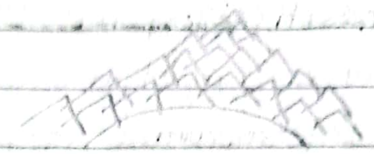
→ It is a large landform that stretches above the surrounding land in a limited area. They are formed through tectonic force or volcanism. They erode slowly through the action of rivers, weather conditions and glaciers.

Mountain building process (Orogeny)

- It takes place when two tectonic plates come together. Orogeny develop while a continental plate is crumpled and thickened to form mountain ranges.
- Himalaya range began to form between 40-50 million years ago when the Indian plate moving ~~noth~~ northwards collided with the Eurasian plate.
- Eurasian plate was partly crumpled & bucked up above the Indian plate but due to their low density / high buoyancy, neither continental plate could be subducted below the other.
- In this cause continental crust to thicken up due to folding and faulting by compressional forces.
- Around 20 million years ago, the Tethys sea disappeared and the sediment rising from its seabed led to the formation of Himalayas. The Himalayas are still rising by more than 1cm per year.

Types of Mountains:

1.) Dome or Upwarped

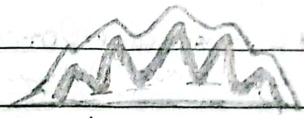


2.> Volcanic or Accumulated
(Fuji Yama in Japan, Mt. Popa)

3.) Fault - block

(Sierra Nevada in N. America, Black forest mountain in Germany)

4.) Folded (complex)



(Himalayas in Asia, The Alps in Europe)

* Plateau:

→ It is an area of highland, usually consisting of relatively flat terrain that is raised significantly above the surrounding area, often with one or more sides with steep slopes.

→ It has larger summit area than a mountain.

Formation of Plateau:

- Upwelling of volcanic magma, extrusion of lava & erosion by water and glaciers.
- When magma rises up from mantle towards the earth's crust but fails to break through the crust, then a section of the earth's crust is raised to give to a plateau.
- Plateau can be built up by lava spreading outward from cracks and weak area in the crust.
- Water can erode mountains and other landforms to form plateaus. Plateaus can be formed by the erosional process on mountain ranges.

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Classification of Plateau

1) Intermontane Plateau
- Plateau between mountains.
- Has horizontal rock layers (raised due to vertical movement of Earth
  Eg:- Plateau of Tibet

2) Dissected Plateau
- formed as a result of upward movement in Earth's crust.
- It is a plateau that has been eroded by rivers & stream resulting in a landscape of hills, valleys and cliffs.
  Eg:- Ozarak Plateau, Hornsby Plateau

3) Volcanic Plateau
- Produced by volcanic activity.
- 2 types
  - Lava Plateau
  - Pyroclastic Plateau

  Eg:- Deccan plateau

4) Piedmont Plateau
- Situated at foot of mountain & locked from other side by plai or sea.
- Also called plateau of denudation.
  Eg:- Malwa Plateau, Patagonian plateau in Argentina

5) Continental Plateau
- formed by crustal ~~mom~~ movement of tectonic plates.
- shows an abrupt elevation in contrast to nearby lowland or se
- Known as Plateau of Accumulation.
  Eg:- Plateau of Maharashtra

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* Plate Tectonic:

- The global distribution of geological phenomenon such as seismicity, volcanism, formation of mountain, movement & interaction of earth's lithospheric plate.
- Earth's outermost layer (lithosphere) is broken into 7 large plates:-
  - The African plate
  - North American plate
  - South American plate
  - Eurasian "
  - Australian "
  - Antarctic "
  - Pacific "
- Plate slide over a partially molten plastic layer called as asthenosphere; which occurs below the lithosphere in the upper mantle at depth between 100-200 km.
- Concept in the Theory of Plate Tectonic include:-

a.) The ocean floors are continuously moving, spreading from the centre, sinking at the edges and being regenerated.

b.) The main driving force of plate tectonics is gravity. However, convection currents beneath the plate are also responsible for plate movements.

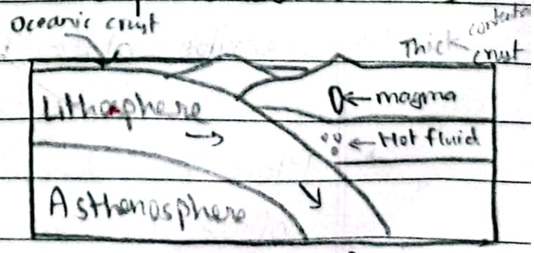
c.) The source of energy responsible for generating the heat and convection currents that move the plates is most likely the radioactivity, that takes place deep in the earth's mantle.

Types of Plate Boundaries:

1.) Convergent Plate Boundaries (Destructive plate boundaries)

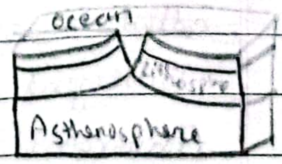
→ occurs when two plates moves towards each other & collide

→ denser plate is subducted underneath the less dense plates.



2.) Divergent Plate Boundaries (Constructive Plate Boundaries)

→ occurs when two plates moves away & magma rises up from the mantle to form new crust.



3.) Transform Plate Boundaries

→ occurs when two plate slide past each other. Crust is neither created nor destroyed.

Assignment:

1.) Define plate tectonics. Define features of the earth surface.

→ The global distribution of geological phenomenon such as seismicity, volcanism, continental drift and formation of mountain, destruction, movement and interaction of earth's lithospheric plates are called plate tectonics.

→ Features of Earth includes two features (i.e. continental features and oceanic features). Features related to a continent like mountains, plateau, shields are included in continental features and features related to particles of inside ocean ~~are~~ ~~has~~ like abyssal fan, abyssal plain, archipelago, etc are included in oceanic features.

2.) Describe plate boundary. How is mountain formed?

→ Plate boundary is a barrier or mid point where two plates collide or be separated. Generally, there are two types of plate boundaries i.e. Convergent plate boundary (also called Destructive plate boundaries) and other one is Divergent plate boundary (also called Constructive plate boundary) Convergent plate boundary occurs when two plates move towards each other and collide; whereas; divergent plate boundary occurs when two plate move away from each other.

Mountain is a large landform that stretches above the surrounding land in a limited area. They are formed through tectonic force or volcanism. It takes place when two tectonic plates come together if neither ~~of~~ the plate bend ~~go~~ downwards. In this case if there is no bending downwards either they will break into pieces or they will bend upward forming mountain. For example:- The Indian plate moved towards north collided with the Eurasian plate forming Mt. Everest situated in Nepal at present time.

3.) Mention any three evidence of plate tectonics.

→ Plate tectonics is a substantial model for understanding the Earth's structure & process.

→ The three evidences of plate tectonics are:-

- Seafloor Spreading: The discovery of mid-ocean ridges and the mapping of the ocean floor revealed that new oceanic crust is formed at these mid-ocean ridges through volcanic activity.
- Earthquake Distribution: Earthquakes often occur at convergent and transform boundaries, where tectonic plates interact which provides strong evidence for plate tectonics.
- Fossils and Rock Evidence: Similar Fossils and rock formations are found on continents that are now separated by oceans suggest that these landmasses were once connected which is ~~a~~ solid evidence of plate tectonics.

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4.) Explain the process of formation of fault block mountain.

→ Fault block mountain is also called as Horst and the rift valley formed as a result of faulting is called Graben. Fault block mountains are formed by the internal or endogenic earth movements which cause the force of tension and faulting. The down-lifting or uplifting of land in between two parallel faults results in the formation of Block Mountains.

Examples:- The Sierra Nevada in North America, Black Forest Mountains in Germany etc.

5.) Define plateau and its classification.

→ Plateau is an area of highland, usually consisting of relatively flat terrain that is raised significantly above the surrounding area, often with one or more sides with steep slopes.

→ Classification of plateau :-

a.) Intermontane Plateau: These type of plateaus lies between mountains. They have horizontal rock layers (raised due to vertical movement of Earth). For example: plateau of Tibet

b) Dissected Plateau: These type of plateaus are formed as a result of upward movement in Earth's crust. It is a plateau that has been eroded by rivers and streams resulting in a landscape of hills, valleys and cliffs. For example :- Ozarak plateau, Hornsby Plateau.

c) Volcanic Plateau: These type of plateaus are produced by volcanic activities. There are two types of volcanic plates i.e. Lava Plateau and Pyroclastic Plateau. Example of volcanic plateau include Deccan plateau.

d.) Piedmont Plateau: These type of plateaus are situated at foot of mountain and locked from other side by plain or sea. They are also known as plateau of denudation. For example:- Malwa Plateau, Patagonian plateau in Argentina.

e.) Continental Plateau: These type of plateaus are formed by crustal movement of tectonic plates. They shows an abrupt elevation in contrast to nearby lowland or sea. They are also known as Plateau of Accumulation. For example:- Plateau of Maharashtra

6.) Describe briefly the internal structure of Earth. Fig:- ?

→ Internal structure of Earth includes three major divisions called crust, mantle and core.

- Crust: This is the outermost layer of Earth composed of thin layer of rocks. It's thickness is about 0-70 km (avg. 33 km from Mt. Everest to Mariana Trench). Crust are divided into two groups; one is continental crust which is composed of crystalline & granitic rocks (silica & aluminium) and the other one is oceanic crust which is composed of basaltic igneous rocks (silica & magnesium).
- Mantle: This layer is mainly composed of iron & magnesium silicates. It's thickness is about 2900 km which is subdivided into following categories:-
  i.) Lithosphere (70-100 km) [contains tectonic plates]
  ii.) Asthenosphere (100-350 km) [Rocks are near or at melting point]
  iii.) Upper Mantle (350-670 km) [Made up olivine & pyroxene, calcium & aluminium]
  iv.) Lower Mantle (670-2900 km) [mostly silicon, magnesium & oxygen]
- Core: This layer is innermost layer and is hot & liquid layer mainly of Nickel & liquid iron. ~~The~~ It's thickness is about 3470 km & is divided in following categories:-
  i.) Outer Core (2900-5150 km) contains Si, S, C
  ii.) Inner Core (5150-6370 km) contains solid iron, nickel

7.) Write short note on :-

a.) Nebular hypothesis:-

German philosopher Immanuel Kant in 1755 gave this hypothesis & Pierre Laplace modified it in 1796. According to this hypothesis a rotating Nebula somewhere during rotation cooled and contracted making disc shape with increase in concentration of mass at centre. That disc condensed into planets, moons, asteroids & comets, the great mass at centre became Sun.

b.) Gaseous Tidal Hypothesis :-

Jeans and Jeffrey in 1925 gave this hypothesis. According to this hypothesis a large star came near sun due to gravitational pull. Then gaseous tide was raised on surface on sun. The gaseous tide detached when star moved away. The shape of tide was spindle which was then broken into pieces forming 9 planets.

c.) Radiometric dating:-

The process where a radioactive parent isotope decays into a stable daughter isotope at a constant rate is called radiometric dating. By measuring the accumulation of daughter isotopes into rocks, the age is determined.

Age of rock = $3.323\,T \log_{10}(1 + N_d/N_p)$

where, T = half life of radioactive substance

N_d = no. of atoms present in daughter isotope.

N_p = " " " of parent isotope present today.

[∵ The age of Earth was found to be 4600 million years by this method]

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d) <u>Shield</u>:
A large region exposed basement rocks commonly with a vary gentle convex surface, surrounded by sediments is called shield. Shields are mostly formed due to volcanic activities.

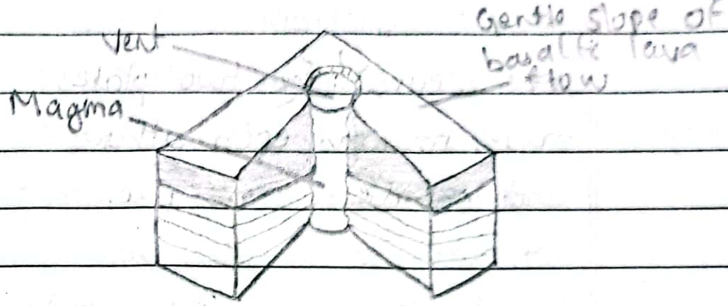


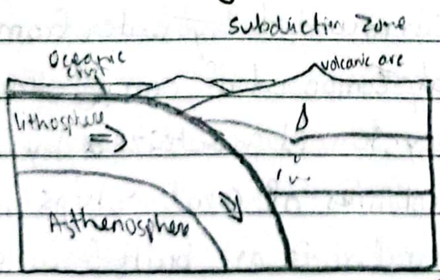
fig: Shield Volcano

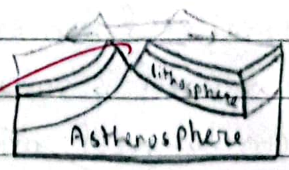
e) <u>Oceanic feature</u>:

- <u>Abyssal fan</u>: underwater geological structures associated with large scale sediment deposition. Formed by turbidity current.
- <u>Abyssal plain</u>: Vast, flat, sediment covered areas of deep ocean floor. Located between foot of continental rise and mid ocean ridge.
- <u>Archipelago</u>: A group of islands usually found in open sea. It is formed by erosion or result of volcanic activity.
- <u>Peninsula</u>: a strip of land surrounded by water on three sides but connected to maintain on the fourth side.
- <u>Island</u>: an area of land surrounded by water from all sides.
- <u>Coral reef</u>: an erosion resistant composed of compacted coral skeletons. Coral reef is an underwater ecosystem characterized by reef-building corals. Reefs are formed of colonies of coral polyps held together by calcium carbonate. Most coral reefs are built from stony corals, whose polyps cluster in groups.

8.) Difference between convergent plate boundary and divergent plate boundary.

Convergent plate Boundary	Divergent Plate Boundary
They occurs when two plates moves towards each other and collide.	They occurs when two plates moves away from each other
Subduction zones, deep ocean trenches, mountain ranges.	Mid-ocean ridges, rift valleys, volcanic activity.
Intense seismic activity and volcanic eruptions are common.	Moderate volcanic activity common along divergent boundaries.
They are also called Destructive plate boundaries.	They are also called constructive plane boundaries.
Eg: Himalayan mountain range, Pacific Ring of Fire.	Eg: Mid-Atlantic Ridge, East African Rift





9.> Mountain Building Process :

→ When two tectonic plates come together; Orogens develop while a continental plate is crumpled and thickened to form mountain ranges. When the two plates collide, there are three possibilities i.e. either break into pieces or bend downwards or bend upwards. If their density is low (ie. high buoyancy) then neither plate could be subducted below the other. In this case continental crust to thicken up due to folding and faulting by compressional forces. Around 40-50 million years ago, this same phenomenon occured with Indian plate moving northwards to collide with Eurasian plate forming Mount Everest which is highest peak in the world, currently situated in Solukhumbu, Nepal.

2080-10-23.

Chapter : 3 (NOTE)

Crystallography and Mineralogy

The study of crystals like their shape, structure, forms, arrangement and other properties of crystals are called Crystallography.

Crystals are solid geometric figures which are bounded by well defined faces (such as atom, molecules or ions arranged in a highly microscopic structure, forming a crystal lattice in all direction)

A unit cell is the smallest volume that contains all the structural and symmetry elements information of the crystal. i.e. smallest complete unit of pattern.

The symmetry of this unit determines the external symmetry of the crystal.

Elements of Crystals

a-> Interfacial angle
b-> Crystallographic axes
c-> Axial ratio
d-> Crystal faces

Crystal Systems:

Isometric : Fluorite
Tetragonal : Wulfenite
Orthorhombic : Tanzanite
Monoclinic : Azurite
Triclinic : Amazonite
Hexagonal : Emerald
Trigonal : Rhodochrosite

Crystal Morphology / structure

→ Crystals are solid geometric figures which are bounded by well defined faces (such as atom, molecules or ions arranged in a highly microscopic structure, forming a crystal lattice in all direction)

Interfacial Angle

→ In a crystal, the angle between normal of two adjacent faces is called interfacial angle.

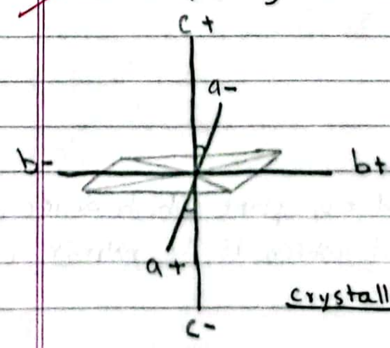
We define the interfacial angle between two crystal faces as the angle between lines that are perpendicular to the faces. Such lines are called the poles to the crystal face.

Note that this angle can be measured easily with a device called a contact goniometer.

Crystallographic axes

→ In order to describe the faces and symmetry of crystal, a set of three or four reference axes are established. These imaginary reference lines are called crystallographic axes.

→ While fixing a crystal in its study position with reference to the crystallographic axes, it is important to align it in such a way that one of the axes runs front to back, from the observer, another run right to left and one is passing from top to bottom of the crystal.



crystallographic Axes

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Axial ratio:

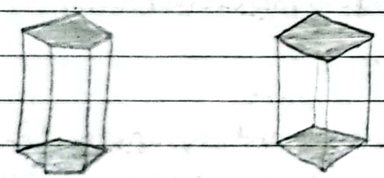
→ It is the ratio between the lengths of different crystallogr-aphic axes in a given crystal system and is always constant for that crystal.

- A=2, B=4, C=3
- A:B:C = ? 1:2:3

Crystal faces:

→ The crystals are rounded by flat surfaces which are known as faces.

→ A crystal may have only two faces of the same geometrical shape or it may have up to fourty-eight faces of a combination of geometrical shape



Symmetry elements of crystal

→ The faces, edges and solid angles in crystals occur with some regularity. This is known as symmetry.

→ Symmetry is property of fundamental importance for a crystal. It can be studied with reference to three different characters.

i.> Plane of symmetry
ii.> Axis of symmetry
iii.> Centre of symmetry

Plane of symmetry

→ A plane of symmetry is an imaginary plane which divide a crystal into two halves, each of which is the mirror image of the other.

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Axis of Symmetry

An imaginary line through the center of the crystal around which the crystal may be rotated so that after a definite angular revolution the crystal form appears the same as before is termed an axis of symmetry. Depending on the amount or degrees of rotation necessary, four types of axes of symmetry are possible when you are considering crystallography

- It is imaginary line throught crystal about which if the crystal is rotated, it gives the observer exactly the same view more than once in a single rotation.
- If the same view is repeated 2,3,4 or 6 times, the axis of Symmetry is referred to as two-fold, three-fold, four fold or six-fold respectively.
- Depending on the angle of rotation;

a.> Axis of binary (two fold) symmetry; angle 180°
b.) " " trigonal symmetry ; " 120°
c.) " " tetragonal " ; " 90°
d.) " " hexagonal " ; " 60°

Centre of Symmetry

- A crystal is said to posses a centre of symmetry if on passing an imaginary line from some definite face, edge or corner on one side of crystal through its centre, another exactly similar face, edge or corner is found on the other side at an equal distance from the centre.
- The cube and octahedron posses a centre of symmetry, whereas a tetrahedron does not. Many crystals have no planes or axis of symmetry but do posses centre of symmetry.

Crystal form:

→ Pedion (single face)
→ Pinacoid (two face opposite side)
→ Prism (3 or more face)
→ Pyramid (3 or more non parallel face)
→ Dipyramid (combination of two pyramids)
→ Scalenohedron (having facial geometry)
→ Rhombohedron (" " " of rhombus)

Crystal habit:

- It is the description of the general shape and crystallographic form of any crystals plus how well developed crystals are. It help to identify the minerals. In some cases factors influencing the habit are heat, pressure at the formation and growth conditions.
- List of crystal habits;
  - Crystal habit is the ideal shape of crystal faces.
  - Ideal faces require ideal growth conditions.
  - Many descriptive terms are used to characterize habit.

Habit	Description	Examples
icular	Needle-like, slender and or tapered	Natrolite, Rutile
ygdaloidal	Almond - shape	Heulandite
ded	Blade-like, slender and flattened	Actinolite, Kyanite
bular	Grape-like, hemispherical masses	Hematite, Adamite
rous	Extremely thin prisms (strands)	Asbestos, Gypsum
ic	Cube shape	Galena
iated	Layered structure, parting into thin sheets	Mica (biotite, Muscovite)
ular	Aggregates of anhedral crystals in matrix	Bornite
atic	Elongated, prism-like crystal face parallel to c-axis	Tourmaline
Massive	Shapeless	Limonite
Octahedral	Octahedron	Diamond
Reticulated	Crystals forming net-like intergrowths	Cerussite
Platy	Flat, tablet-shaped	Wulfenite

* Crystal systems / family / lattice system

- Crystals having same set of crystallographic axis belongs to the same crystal system. Crystallographic axes are the imaginary lines passing through the centre of crystal. There are six crystal system / family i.e. Triclinic, Monoclinic, Orthorhombic, Tetragonal, Hexagonal, Cubic (isometric).

1.) Isometric System:-

Isometric system includes all the crystals which are referred to three equal and mutually perpendicular axes.

$a_1 = a_2 = a_3$ $\quad \alpha = \beta = \gamma = 90°$

2.) Tetragonal System:-

It includes all the crystals which are referred to three mutually perpendicular axes. Two horizontal planes are equal and interchange-able. They are called a_1 & a_2. The third is vertical or c-axis.

3.) Orthorhombic System:-

All three axes are unequal in length and all are perpendicular to one another. It has three variants i.e. Body-centred, Base-centred & Face-centred.

4.) Monoclinic Crystal System:-

All three axes are unequal in length, and two axes are perpendicular to each other. It has one variant i.e. Base-centred monoclinic

5.) Triclinic crystal system:

Three axial lengths of the unit cell are not equal and all the threee axes are inclined obliquely to each other.

$a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma \neq 90^\circ$.

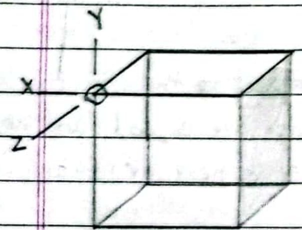
Eg:- $CuSO_4$, $K_2Cr_2O_7$

6.) Hexagonal Crystal System

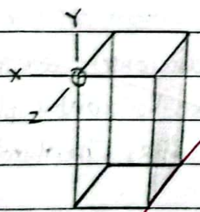
Three equal coplanar axes intersect at an angle of 60°, and another axis is perpendicular to the others and of a different length. $a = b \neq c$, $\alpha = \beta = 90^\circ$ & $\gamma = 120^\circ$

7.) Rhombohedral (or trigonal) System

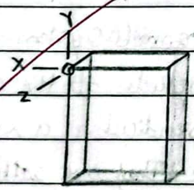
All three axes are of equal length and none of the axes is perpendicular to another, but the crystal faces all have the same size and shape.



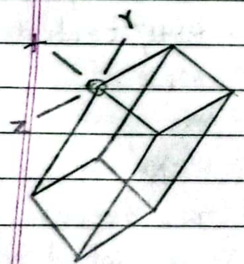
Isometric (cubic)



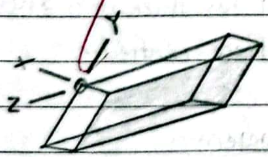
Tetragonal



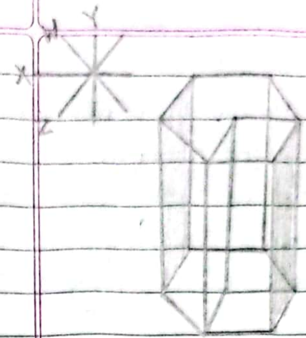
Orthorhombic



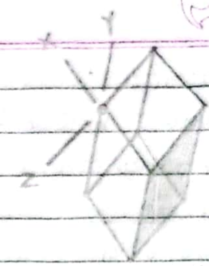
Monoclinic



Triclinic



Hexagonal



Rhombohedral (Trigonal)

* Physical &/ Chemical ~~and Optical~~ Properties of Minerals.

• Physical Properties

1.) Color

Quartz – Aqua, Pink, Purple, Dark green, etc

2.) Streak

Powder made from rubbing a mineral across a streak plate; Sometimes shows a different color than the mineral appears to be.

3.) Lustre

This property describes the appearance of reflected light from the minerals surface.

4.) Hardness

Mohs Hardness Scale:-

01	:	Talc	07	:	Quartz
02	:	Gypsum	08	:	Topaz
03	:	Calcite	09	:	Corundum
04	:	Fluorite	10	:	Diamond
05	:	Apatite			
06	:	Feldspar			

5) Transparency

- determines how well light passes through a mineral. Three degrees i.e. Transparent, translucent, Opaque.

6.) Specific Gravity

It is the weight of a mineral compared to the weight of an equal volume of water. Eg:- PbS has sp. gravity of 7.6.

7.) Tenacity

Behaviour of mineral towards the forces that tend to break, bend, cut or crust. Types:- Sectile, malleable, brittle, flexible and elastic

8.) Cleavage

It is the tendency of a mineral to break along smooth planes parallel to zones of weak bonding. Types:- Muscovite, Feldspar, halite & calcite

9.) Fracture

The tendency of a mineral to break along curved surfaces without a definite shape. These minerals do not have planes of weakness and break irregularly. Types:- Even, uneven, conchoidal, hackly and earthy fracture.

- Chemical Properties of minerals:

Related to chemical composition of minerals:- ~~that~~

1.) Isomorphism

Substances are said to be isomorphous which are in similar in ~~cry~~ crystalline form are in chemical properties, can be represented by similar formulae. Eg:- Cu, Ag-cubic structure

2.) Polymorphism

When a substance exists in more than one crystalline form, the different form are designated as polymorphs and the phenomenon as polymorphism. Eg:-

- carbon : diamond in a cubic
- Graphite in sheet of a hexagonal lattice.

3.) Pseudomorphism

Replacement of one mineral by another is pseudomorphism. It preserves the external form of original mineral.

Eg:- quartz (hexagonal) replacing fluorite (isometric)

Questions.

1.) Define Moh's scale of Hardness.

→ Moh's scale of Hardness is a qualitative scale used to measure the scratch resistance of minerals. It ranges from 1 (softest, talc) to 10 (hardest, diamond).

2.) Describe crystal symmetry and elements of crystal.

→ Crystal symmetry refers to the repeating pattern of arrangements within a crystal lattice.

→ Elements of crystals :-

- Interfacial angles :-
  The angle between normal of two adjacent faces is called interfacial angle.
- Crystallographic Axes :-
  To describe faces and symmetry of crystal, a set of three or four reference axes are established. These imaginary reference lines are called crystallographic
- Axial Ratio :-
  It is the ratio between the lengths of different crystallographic axes in a given crystal systems and is always constant for that crystal.
- Crystal faces :-
  The crystals are rounded by flat surfaces which are known as faces.

3.) Describe the isometric system of crystal.

→ Isometric system includes all the crystals which are referred to three equal and mutually perpendicular axes.

$$a_1 = a_2 = a_3$$
$$\alpha = \beta = \gamma = 90^\circ$$

4.) Define minerals. How do you differentiate between silicate and carbonate minerals in field?

→ Minerals are naturally occurring, inorganic substances with a definite chemical composition and an ordered atomic arrangement. They form through geological processes and often have distinctive physical properties.

→

Silicate Minerals	Carbonate minerals.
• It does not react with acid (Generally)	• It reacts with dil. HCl producing bubble of CO_2.
• It has diverse colors.	• It is commonly white or colorless.
• Higher hardness than carbonate minerals	• Lower hardness than silicate minerals.
• Disply diverse cleavage patterns	• Often exhibit perfect or good cleavage in one or more directions.

5.) Write short notes on: streak of minerals, tenacity of mineral and ~~optical properties of minerals.~~

→ • Streak of Minerals :-
Streak is the color of mineral's powdered form. It is determined by rubbing the mineral on an unglazed porcelain plate. Streak can differ from the mineral's external ~~ex~~ color. It aids in minerals ~~external color. It aid~~ identification as it is a more consistent property.

• Tenacity of Mineral:-

Tenacity describes a mineral's response to stress or deformation. It reflects how a mineral behaves when subjected to pressure, bending, or breaking.

Types of tenacity :-

- Brittle
- Sectile
- Elastic
- Malleable
- Flexible

6.) Define rock forming minerals and Ore forming minerals.

→ Rock forming Minerals are fundamental constituents of Earth's crust, serving as the building blocks of various types of rocks.
Eg:- Quartz, Feldspar, Mica, Olivine, Calcite, Pyroxene, etc

→ Ore-forming minerals are minerals that contain economically valuable elements or compounds, forming the basis of ore deposits.
Eg:- Chalcopyrite, Galena, Hematite, sphalerite, etc.

7.) Compare the cleavage and fracture of minerals.

→

Cleavage is the tendency of a mineral to break along specific planes or directions, resulting in smooth, flat surfaces WHEREAS Fracture is the way a mineral breaks where it doesn't exhibit cleavage (means it breaks irregularly or in non-uniform way)

8.) ~~Optical and~~ Chemical Properties :-

→ • Isomorphism:-

Substance which are similar in crystalline form and similar in chemical properties.

• Polymorphism:- when substance exists in more than one crystalline form.
• Pseudomorphism:- replacement of one mineral by another.

Questions of Petrology

1.) What is Petrology? Describe an engineering significance of Metamorphic and Igneous rocks.

→ Petrology is the branch of science concerned with the origin, structure and composition of rocks.

The significance of metamorphic rock is that these are chosen for building materials and artwork. Marble is used for statues and decorative items. Quartzite is very hard and is often crused and used in building rail road tracks.

Also, the igneous rock can be crushed and used for construction in highway engineering. Igneous rocks are hard wearing and do not absorb water so are good in lower courses of a building. Crushed rock aggregates are used in construction, industrial and highway engineering.

2.) • How do you differentiate rock and minerals?

→

Rock	Minerals
• It involves minerals.	• It doesn't involve rocks.
• It do not has definite chemical composition.	• It has definite chemical composition
• Classification: Ignous, Sedimentory, Metamorphic	• Classification: Silicates, Non-silicates
• It can be organic	• It is inorganic

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9.) How are igneous rocks formed?

→ Igneous rocks are formed ~~when hot, molten rock~~ through the solidification and cooling of molten magma or lava. (Intrusive when with magma & Extrusive when with lava)

11.) Describe the texture, structure and types of igneous, sedimentary and metamorphic rocks.

→ Igneous Rocks:

Texture → Can be fine-grained, coarse-grained, glossy or porphyritic

Structure → vesicles, phenocrysts

Types →

Sedimentory Rocks:

Texture → Can be clastic, chemical or organic

Structure → Bedding, layering or fossils, ripple marks.

Types →

Metamorphic Rocks.

Texture → Exhibits foliation or non-foliation.

Structure → Cleavage along layers.

10.) Characteristics of igneous, sedimentary and metamorphic rocks

→ Igneous Rocks: diverse texture and mineral composition

Sedimentary Rocks: diverse texture, often with bedding and fossils

Metamorphic Rocks: foliated or non foliated with changed mineral composition.

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12.) Describe physical properties of Marble, granite and Sandstone with engineering properties.

→ Marble:

Physical Property: Smooth, crystalline appearance

Engineering Property: High compressive strength, suitable for various constructions

Granite:

Physical Property: Coarse-Grained texture

Engineering Property: Excellent hardness, ideal for countertops and monuments

Sandstone:

Physical property: Classic texture.

Engineering property: Varies in porosity; used for ~~facades~~ facades and paving.

Field Identification ~~Criteria of Rock~~

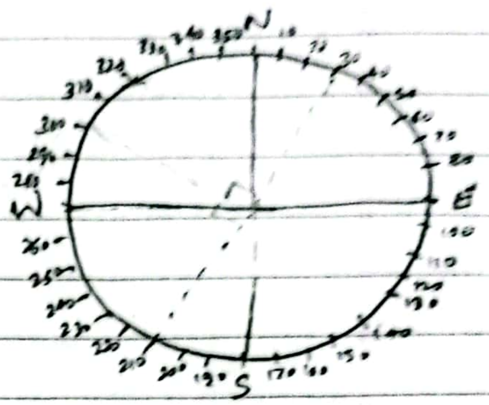
Igneous. • Hard & Massive • Random orientation of minera[l]
• Xenolith structure • Absence of Bedding & Foliation plane

Sedimentory • Bedding plane is present • Presence of fossils
• Primary geological structures are present.

Metamorphic • Perfectly orientation of mineral
• Having clevage • Have Foliation plane

1.) A sandstone bed rock dips 32° towards $N60^\circ W$. Find out strike of bed rock with illustration.

Soln :



Given,

Dip amt : 32°

Dip direction : $N60^\circ W$

$= 300^\circ$

Strike = ?

Now,

Strike = dip direction $\pm 90^\circ$

+ve

Strike $= 300 + 90$

$= 390$

$= 30^\circ$

$= N30^\circ E$

-ve

Strike $= 300 - 90$

$= 210$

$= S\,30^\circ W$

Hence, Strike $= N30^\circ E$ or $S\,30^\circ W$

13Q.) Calculate the true dip amount from given apparent dips 1:14 due N45°W and 1:20 due N20°E.

Sol^n:-

Given:

(δ) Apparent dip : 1:14 & 1:20

Apparent direction : N45°W & N20°E

(315° & 20°)

Strike = ? (x suppose)

(δ) True dip amt = ? (y suppose)

Now,

$\tan \delta = \tan \delta \times \sin \alpha$

$\frac{1}{14} = \tan y \times \sin(x - 315) \quad \dots (i)$

$\frac{1}{20} = \tan y \times \sin(x - 20^\circ) \quad \dots (ii)$

Dividing eq^n (i) & (ii) we get.

$$\frac{\frac{1}{14}}{\frac{1}{20}} = \frac{\cancel{\tan y} \times \sin(x - 315)}{\cancel{\tan y} \times \sin(x - 20)}$$

or, $\frac{10}{7} = \frac{\sin(x-315)}{\sin(x-20)}$

or, $7\sin(x-315) = 10\sin(x-20)$

or, $x = -118^\circ \ (+242^\circ)$

$x = 62$

Using calculator,

$x = 782^\circ$

$= 62^\circ$

Now,

$\frac{1}{20} = \tan y \times \sin(62 - 20)$

$\tan y = \frac{\sin 42}{20}$

$\therefore y = 1.916$

$\therefore \frac{1}{14} = \tan y \times \sin(62 - 315)$

$\therefore y = -4.273$ ← neglecting −ve sign

$\therefore y = 4.2731$ //

Finally,

∴ Strike is N62°E or S62°W //

&

∴ True Dip Amount is 4.2731 //

12Q.) The apparent dips of limestone beds are 36° in the direction N 80°E and 47° in the direction N60°W. Find the true dips.

Sol^n:-

(δ) Apparent dips : 36° & 47°

Apparent directions : N80°E & N60°W

(80° & 300°)

(δ) True dips : ? (y suppose)

Strike = ? (x suppose)

Now,

$\tan \delta = \tan \delta \times \sin \alpha$

$\tan 36^\circ = \tan y \times \sin(x - 80^\circ) \quad \dots (i)$

$\tan 47^\circ = \tan y \times \sin(x - 300^\circ) \quad \dots (ii)$

Dividing (i) & (ii) we get.

$$\frac{\tan 36^\circ}{\tan 47^\circ} = \frac{\cancel{\tan y}}{\cancel{\tan y}} \times \frac{\sin(x-80^\circ)}{\sin(x-300^\circ)}$$

or, $x = -84$ (276°) (N84°W)

Now,

$\tan 36 = \tan y \times \sin (276-80)$

$\therefore y = -69.22$

↳ neglecting -ve sign.

$\therefore$ True dip $= 69.22^\circ$ //

$\therefore$ Strike = N84°W //

10 Q) The true dip of coal seam is 14° in the direction due to South. Find the direction in which apparant dip will be 8°

Sol^n:-

(δ) True dip = 14°   True dip direction = S = 180°

apparent dip direction = ?

(δ) Apparant dip = 8°

Now,

$\tan \delta = \tan \delta \times \sin \alpha$

$\tan 8^\circ = \tan 14^\circ \times \sin \alpha$

$\therefore \alpha = 34.31$

Again,

Direction $= 180^\circ - 34.31^\circ$

$= 145.69^\circ$

$=$ S34°E

Strike = dip direction ± 90

$= 180 + 90$ $= 180 - 90$

$= 270$ or $= 90$

$\tan 8^\circ = \tan 14^\circ \times \sin (270 - x)$

or, $\sin (270 - x) = 0.5536$

$\therefore x = -124$

$= 236^\circ$

Now,

$236 = y + 90$ $236 = y - 90$

$\therefore y = 326$ $\therefore y = 146$

N34°W   S34°E

Now,

Strike = True dip direction ± 90

$= 180 \pm 90$

Either 270° or 90°

Again

$\tan \delta = \tan \delta \times \sin \alpha$

$\tan 8^\circ = \tan 14^\circ \times \sin (270 - x)$

$\therefore x = 124.31^\circ$

$\therefore$ Apparent dip direction $= 124.31^\circ$ //

2.) ~~A sands~~ Find out the strike of an inclined plane if the dip direction of the bed is N20°E with neat sketch.

Sol^n:-

Strike = ?

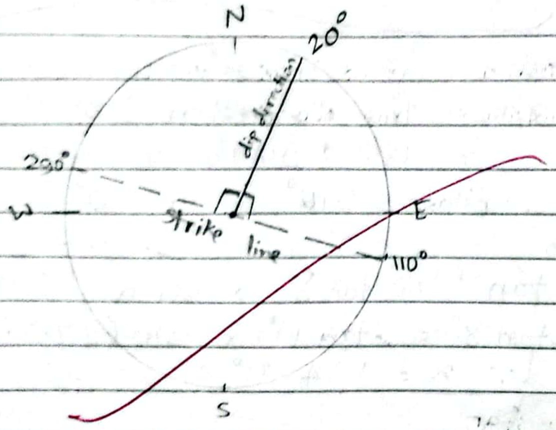
Dip direction = N20°E

= 20°

Now,

Strike = Dip direction ± 90°

+ve	-ve
Strike = 20° + 90°	strike = 20° - 90°
= 110°	= -70°
[redacted]	[redacted]
= S70°E //	= N70°W //



∴ The strike is S70°E or N70° W

3.) Determine the strike direction of bedding plane where dip direction is N 40° W.

Sol^n:-

Dip Direction = N40°W = 320°

Strike = ?

Now,

Strike = dip direction ± 90°

+ve	-ve
Strike = 320° + 90°	Strike = 320° - 90°
= 410°	= 230°
= 50°	= S50°W
= N50°E	

∴ The strike direction is N 50° E or S 50° W

4.) Dip direction of gneiss bedrock is S17°E. Find out strike of such rock with neat diagram.

Sol^n:-

Dip direction = S17°E = 163°

Strike = ?

Now,

Strike = dip direction ± 90°

Strike = 163° + 90°

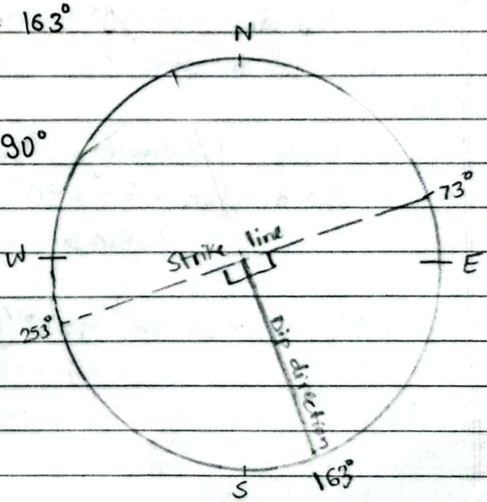
= 253°

= S73°W

Strike = 163° - 90°

= 73°

= N73°E



∴ Strike is S73°W or N73°E.

5.) Determine the strike direction of bedding plane of limestone bedrock which dips towards N31°W.

Sol^n:-

Dip direction : N31° W : 329°

Strike : ?

Now,

Strike = dip direction ± 90°

+ve	-ve
Strike = 329 + 90	Strike = 329 - 90°
= 419°	= 239°
= 59°	= S59° W
= N59°E	

∴ Strike is N59°E or S59°W

6.) Determine the dip direction of a bedding plane of limestone bed which has strike N55°E and dip amt. 30°.

Sol^n:-

Strike = N55°E : 55°

dip amt : 30°

Dip direction = ?

Now,

Strike = Dip direction ± 90°

Dip direction = 55° ± 90°

= Either 145° or -35°

i.e. 325°

∴ Dip direction is 145° (S35°E) or ~~235° (N55°W)~~ 325° (N35° W)

7.) Dip direction N40°W and dip amount is 64°. Find the strike with diagram.

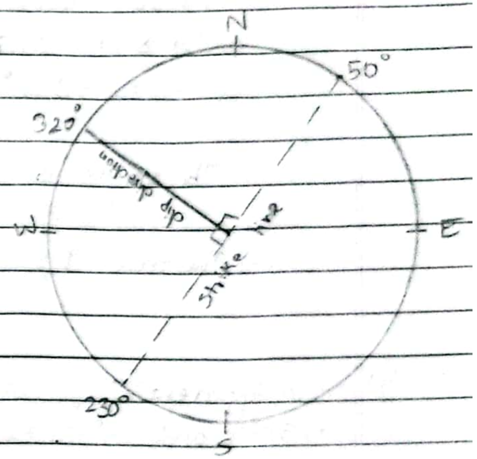
Sol^n:-

Dip direction = N40°W

= 320°

Dip amt = 64°

Strike = ?



Now,

Strike = Dip direction ± 90°

= 320° ± 90°

Either	Or
= 410°	= 230°
= 50°	= S50°W
= N50°E	

∴ Strike is N50°E or S50°W

8.) Appearent dips 20° and 30° and appearent dip direction 296° and 046°. Find the true dip and strike direction.

Sol^n:-

(β) Appearent dip = 20° & 30°

Appearent dip direction = 296° & 46°

(δ) True dip = ?

Strike = ? (x suppose)

Now,

$\tan\beta = \tan\delta \times \sin\alpha$

$\tan 20° = \tan\delta \times \sin(x - 296°)$ ... (i)

$\tan 30° = \tan\delta \times \sin(x - 46°)$ ... (ii)

~~Now dividing it we get~~

~~0.63 = $\frac{\sin(x-296)}{\sin(x-46)}$~~

Now, using calculator, we get, $x = 450°$

$= 90°$ (N90°E)

Now,

from (i)

$\tan 20° = \tan \delta \times \sin(90° - 296°)$

$\tan \delta = \dfrac{\tan 20}{\sin(90-296)}$

$\therefore \delta = 39.7°$

∴ The strike is N90°E or N90°W or S90°E or S90°W. //

∴ The true dip is 39.7 //

9.) Two apparent dips of coal seam are 22° in the direction N50°E and 34° in the direction N60°E. Find the amount and direction of dip.

Soln.-

(δ) Apparent dip : 22° & 34°

Apparent dip direction : N50°E (50°) & N60°E (60°)

(δ) True Dip amt : ?

Strike : ? (x suppose)

Now,

$\tan \delta = \tan \delta \times \sin \alpha$

$\tan 22° = \tan \delta \times \sin(x - 50°)$ ... (i)

$\tan 34° = \tan \delta \times \sin(x - 60°)$ ... (ii)

Now,

Using calculator we get, $x = 755.768$

$= 395.768$

$= 35.768$

$=$ N 35.768°E

Now, from (i)

$\tan 22° = \tan \delta \times \sin(35.768° - 50°)$

$\tan \delta = \dfrac{\tan 22°}{\sin(35.768 - 50)}$

$\therefore \delta = -58.68$

↳ neglecting -ve sign

$\therefore \delta = 58.68$

∴ Strike direction is N35.768°E //

∴ True dip amount is 58.68 //

11.) A sandstone bed has a true dip of 30° in the direction N45°W. Calculate the apparent dip in the N50W direction.

Soln.:

(δ) True dip : 30°

Dip direction = N45°W

= 315°

(δ) Apparent dip = ?

Apparent dip direction : N50°W

: 310°

Now,

Strike = True dip direction ± 90°

= 315° ± 90°

= Either 405° (i.e. 45°) or 225°

(N45°E) or (S45°W)

Again,

$\tan \delta = \tan \delta \times \sin \alpha$

$\tan \delta = \tan 30° \times \sin(45° - 310°)$

$\delta = 30°$

∴ Strike direction is N45°E or S45°W & apparent dip is 3

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Q.) What are application of engineering geology in the field of civil engineering.

→ Engineering geology plays a crucial role in civil engineering by providing valuable in sights into the geological conditions of a site. Some application are:

- Site Selection :
  Identifies suitable locations based on geological conditions.
- Foundation Design :
  Guides stable foundation construction by analyzing soil and rock properties.
- Slope Stability Analysis :
  Assesses and mitigates risks related to slope stability for safer infrastructure.
- Tunneling Guidance :
  Informs underground construction by considering soil and rock characteristics.
- Earthquake Engineering :
  Helps design structures to withstand earthquakes, enhancing overall safety.
- Groundwater Assessment :
  Evaluates groundwater conditions for effective drainage and prevention of water-related issues

Thus, engineering geology acts as a foundation for informed decision-making in civil engineering, promoting the safety, efficiency and sustainability of construction project.

Q.) How do you understand by plate tectonics? How do you classify minerals?

→ Plate tectonics is the theory that Earth's lithosphere is divided into plates that move atop the semi-fluid asthenosphere. Driven by internal heat, these plates interact at boundaries, leading to phenomena like earthquakes, volcanic activity, and the shifting of continents. It explains the dynamic nature of Earth's surface and geological features.

→ Minerals are classified as:-

a.) Chemical Composition :-
- Silicates :- Contain silicon and oxygen.
- Non-silicates :- include minerals without silicon-oxygen structures

b.) Crystal Structure :-
- Isometric :- Have a cubic crystal structure.
- Orthorhombic
- Tetragonal
- Hexagonal
- Monoclinic
- Triclinic

c.) Physical Properties :-
- Hardness :- Based on Mohs scale.
- Cleavage and Fracture :- Describes how minerals break along planes or irregular surfaces.
- Color, Streak, Luster :- Additional characteristics used for identification.

d.) Mineral Groups :-
- Feldspars, Quartz, Micas.

e.) Economic Significance :-
- Ore Minerals :- Classified based on their economic value, such as ores containing valuable metals.