भूगोल
Geography

कक्षा / Class XI

2026-27

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Student Support Material

केन्द्रीय विद्यालय संगठन~Kendriya Vidyalaya Sangathan

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संदेश

शिक्षा केवल पुस्तकों तक सीमित ज्ञान नहीं है; यह स्वयं को पहचानने, अपने विचारों को विस्तार देने और जीवन की चुनौतियों का आत्मविश्वास से सामना करने की सतत् यात्रा है। केन्द्रीय विद्यालय संगठन का सदैव यह प्रयास रहा है कि प्रत्येक विद्यार्थी के लिए ऐसा शिक्षण वातावरण हो, जहाँ जिज्ञासा को प्रोत्साहन मिले, सीखना आनंददायी बने और प्रत्येक बालक अपनी अंतर्निहित क्षमताओं को पहचानकर उन्हें विकसित कर सके।

राष्ट्रीय शिक्षा नीति 2020 ने शिक्षा को सिर्फ रटने से समझने, सूचना से ज्ञान और ज्ञान से जीवनोपयोगी दक्षताओं की ओर अग्रसर किया है। आज का समय कृत्रिम बुद्धिमत्ता (Artificial Intelligence – AI), डिजिटल नवाचार और निरंतर बदलती तकनीकों का है। ऐसे युग में केवल तथ्यों का ज्ञान पर्याप्त नहीं है; आवश्यक है कि विद्यार्थी मनन- चिंतन करना सीखें, प्रश्न पूछें, समस्याओं का समाधान खोजें और नए विचारों के साथ आगे बढ़ें। यही क्षमताएँ उन्हें भविष्य के लिए तैयार करेंगी।

इन्हीं उद्देश्यों को ध्यान में रखते हुए केन्द्रीय विद्यालय संगठन के पाँचों आंचलिक शिक्षा एवं प्रशिक्षण संस्थानों (ZIETs) के माध्यम से, समर्पित एवं अनुभवी शिक्षकों द्वारा कक्षा 9 से 12 के विद्यार्थियों के लिए यह विद्यार्थी सहायक सामग्री तैयार की गई है। यह केवल परीक्षा की तैयारी की संकलन सामग्री नहीं है, बल्कि विषयों को सरलता से समझने, अवधारणाओं को स्पष्ट करने, नियमित अभ्यास करने और आत्मविश्वास के साथ आगे बढ़ने का एक विश्वसनीय साथी है।

इस सामग्री में विषय-वस्तु को विद्यार्थियों की आवश्यकताओं के अनुरूप सरल, व्यवस्थित एवं दक्षता-आधारित दृष्टिकोण से प्रस्तुत किया गया है। मुझे प्रसन्नता है कि इसे हमारे शिक्षकों के अनुभव, नवाचार और विद्यार्थियों के प्रति उनकी प्रतिबद्धता ने समृद्ध बनाया है। मुझे विश्वास है कि यह सामग्री विद्यार्थियों की सीखने की यात्रा को अधिक सहज, रोचक और प्रभावी बनाएगी तथा उन्हें बोर्ड परीक्षाओं के साथ-साथ जीवन की व्यापक चुनौतियों के लिए भी तैयार करेगी।

मेरा विश्वास है कि जब एक जिज्ञासु विद्यार्थी, प्रेरित शिक्षक और सार्थक शिक्षण संसाधन एक साथ आते हैं, तब शिक्षा केवल उपलब्धि का माध्यम नहीं रहती, बल्कि व्यक्तित्व निर्माण की एक सशक्त प्रक्रिया बन जाती है। यही भावना इस विद्यार्थी सहायक सामग्री के केंद्र में है।

मेरी हार्दिक शुभकामनाएँ हैं कि आप सभी सीखने की इस यात्रा में निरंतर आगे बढ़ें, अपने सपनों को नए आयाम दें और ज्ञान, संवेदनशीलता तथा नवाचार के साथ राष्ट्र निर्माण में अपना महत्वपूर्ण योगदान दें।

शुभकामनाओं सहित।

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INDEX

SR. NO.	NAME OF CONTENTS	PAGE NO.
1	Course Structure	4-10
2	List of Map Items	10-12
3	Geography As a Discipline	13-15
4	The Origin and Evolution of the Earth	15-20
5	Interior of the Earth	20-25
6	Distribution of oceans and continents	25-28
7	Geomorphic Processes	28-32
8	Landform and their Evolution	32-39
9	Composition and Structure of Atmosphere	39-43
10	Solar Radiation, Heat balance and Temperature	43-48
11	Atmospheric Circulations and Weather Systems	48-51
12	Water in the Atmosphere	52-56
13	World Climate and Climate Change (To be tested through internal assessments in the form of project and presentation)	56-56
14	Water (Oceans)	56-58
15	Movements of Ocean Water	58-63
16	Biodiversity and Conservation (To be tested through internal assessments in the form of project and presentation)	63-63
17	India- Location	63-66
18	Structure and Physiography	66-69
19	Drainage System	69-73
20	Climate	74-78
21	Natural Vegetation	78-82
22	Natural Hazards and Disasters (To be tested through internal assessment in the form of Projects and presentation)	82-82
23	Map Items	83-94
24	Question Papers	95-113

CLASS XI
COURSE STRUCTURE
FUNDAMENTALS OF PHYSICAL GEOGRAPHY

Chapter No.	Chapter name	Weightage
Unit- I Geography as a Discipline		
1	Geography as a Discipline	3
Unit II The Earth		
2	The Origin and Evolution of the Earth	9
3	Interior of the Earth	
4	Distribution of oceans and continents	
Unit- III Landforms		
5	Geomorphic Processes	6
6	Landform and their Evolution	
Unit-IV Climate		
7	Composition and Structure of Atmosphere	8
8	Solar Radiation, Heat balance and Temperature	
9	Atmospheric Circulations and Weather Systems	
10	Water in the Atmosphere	
11	World Climate and Climate Change (To be tested through internal assessments in the form of project and presentation)	
Unit-V Water (Oceans)		
12	Water (Oceans)	4
13	Movements of Ocean Water	
Unit VI Life on the Earth		
14	Biodiversity and Conservation (To be tested through internal assessments in the form of project and presentation)	_
	Map Work	5
Total		35

Book-India Physical Environment

Chapter No.	Chapter Name	Weightage
Unit-I Introduction		
1	India- Location	5
Unit II Physiography		
2	Structure and Physiography	13
3	Drainage System	
Unit III Climate Vegetation and Soil		
4	Climate	12
5	Natural Vegetation	
Unit-IV Natural Hazards and Disasters: Causes Consequences and Management		
6	Natural Hazards and Disasters (To be tested through internal assessment in the form of Projects and presentation)	_
	Map	5
Total		**35**

COURSE CONTENT – XI

Book- Fundamentals of Physical Geography

Unit 1: Geography as a Discipline	**Chapter 1 Geography as a Discipline** ● Introduction to Geography as a discipline ● Geography as an integrating discipline: Spatial and Temporal synthesis ● Approaches to study Geography: Systematic and Regional ● Branches of Geography: Physical Geography, Human Geography and Bio Geography ● Physical Geography and its importance.

Unit 2: The Earth	**Chapter 2 The Origin and Evolution of The Earth** ● Origin and evolution of the earth ● Early theories: Origin of the Earth ● Modern Theories: Origin of the universe ● Formation of Stars and Planets ● Evolution of the Earth: Lithosphere, Atmosphere and Hydrosphere ● Origin of Life **Chapter 3 Interior of the Earth** ● Sources of Information about the Interior of the Earth (Direct and Indirect) ● Earthquakes: Earthquake Waves, Shadow zones, Types, Scales to measure earthquake intensity, effects, frequency of earthquake occurrences ● Structure of the Earth ● Volcanoes and Volcanic landforms

	Chapter 4 Distribution of Oceans and Continents ● Continental Drift Theory, and Evidence in support of Continental Drift and Force for Drift ● Post Drift Studies ● Ocean Floor Configuration ● Distribution of Earthquakes and Volcanoes ● Concept of Seafloor Spreading ● Plate Tectonics: Types of Plate boundaries, Rate and forces for the Plate Movement ● Movement of the Indian Plate
Unit 3: Landforms	**Chapter 5 Geomorphic processes** ● Geomorphic processes: Exogenic and Endogenic ● Endogenic Process: Diastrophism, Volcanism ● Exogenic Processes Weathering, landslides. ● Soil: Processes and factors of Soil Formation **Chapter 6 Landforms and their Evolution** ● **Running water:** Erosional and Depositional Landforms ● **Wind:** Erosional and Depositional Landforms

Unit 4: Climate	**Chapter 7 Composition and Structure of Atmosphere** ● Atmosphere- composition and structure; elements of weather and climate **Chapter 8 Solar Radiation, Heat Balance and Temperature** ● Solar radiation: Variability of Insolation. ● Processes of Heating and Cooling of Atmosphere ● Terrestrial Radiation ● Heat budget of the earth ● Temperature- Factors controlling temperature; Horizontal distribution of temperature; Inversion of temperature **Chapter 9 Atmospheric Circulation and Weather Systems** ● Atmospheric Pressure: Horizontal and Vertical Variation of Pressure ● Forces affecting velocity and direction of Wind ● General Circulation of the atmosphere: Pressure belts; Winds: Planetary, Seasonal and Local; Air masses and Fronts; Tropical and Extratropical cyclones; Thunderstorms and Tornadoes **Chapter 10 Water in the Atmosphere** ● Humidity-Absolute and Relative humidity ● Evaporation and condensation- ● Different Forms of Condensation: dew, frost, fog, mist and cloud;
	● Precipitation ● Types of Rainfall and world distribution of rainfall **Chapter 11 World Climate and Climate Change** **(To be tested through internal assessments in the form of project and presentation)**

Unit 5: Water (Oceans)	**Chapter 12 Water (Oceans)** ● Hydrological Cycle ● Major and Minor Relief Features of the Ocean Floor ● Temperature and Salinity of Ocean Waters: Factors, Horizontal and Vertical distribution of temperature and Salinity **Chapter 13 Movements of Ocean Water** ● Movements of ocean water- Waves, Tides and Currents.
Unit 6: Life on the Earth	**Chapter 14 Biodiversity and Conservation** **(To be tested through internal assessments in the form of project and presentation)**
Book- India- Physical Environment	
Unit 1: Introduction	**Chapter 1** India — Location, Size, Latitudinal and Longitudinal extent, Indian Standard time, India and its neighbours
Unit 2: Physiography	**Chapter 2 Structure and Physiography** ● Physiographic Divisions: (1) The Northern and North-eastern Mountains (2) The Northern Plain (3) The Peninsular Plateau (4) The Indian Desert (5) The Coastal Plains (6) The Islands. **Chapter 3 Drainage System** ● Drainage patterns ● Concepts of River basin, Catchment Area, Watershed ● Drainage and River systems of India: the Himalayan and the Peninsular ● Extent of Usability of River Water- linking of rivers, problems in using river water and water pollution
Unit 3: Climate, Vegetation and Soil	**Chapter 4 Climate** ● Weather and climate ● Unity and diversity in the Monsoon Climate ● Factors determining the climate of India ● The Nature and characteristics on Indian Monsoon ● The Rhythm of Seasons ● Distribution of Rainfall

	● Monsoon and the Economic Life in India ● Global Warming **Chapter 5 Natural Vegetation** ● Natural vegetation - Introduction ● Forest types and distribution ● Conservation of forests ● Wildlife; conservation; biosphere reserves
Unit 4: Hazards and Disasters: Causes, Consequences and Management	**Chapter 6 Natural Hazards and Disasters** **(To be tested through internal assessment in the form of Projects and presentation)**
Book- Geography Practical Part I	
Chapter 1 Introduction to Maps **Chapter 2 Map Scale** **Chapter 3 Latitude, Longitude and Time** **Chapter 4 Map Projections** **Chapter 5 Topographical Maps** **Chapter 6 Introduction to Remote Sensing**	

Map Work **Book- Fundamentals of Physical Geography** **(Map items for locating and labelling only on the outline political world map)**	
Chapter	**Map item (Map present on official website of Govt. of India should be used)**
Chapter 4 Distribution of oceans and continents	● Political Map of all Continents of the world. ● Major Oceans of the world: Indian Ocean, Pacific Ocean, Atlantic Ocean, Arctic Ocean, Southern Ocean · Major lithospheric plates and Minor lithospheric plates, Ring of fire (Pacific Ocean), Mid-Atlantic Ridge.

<table>
<tr><td>Chapter 9
Atmospheric Circulations and
Weather Systems</td><td>Major Hot Deserts of the world:
Mojave Desert- Nevada, US
Patagonian Desert- Argentina
Sahara- Africa
Gobi Desert- Mongolia, Asia
Thar desert- India
Great Victoria Desert- Australia</td></tr>
<tr><td>Chapter 12
Water (Oceans)</td><td>Major Seas
Black sea
Baltic sea
Caspian Sea
Mediterranean Sea
North Sea
Red sea
Bay of Fundy (Canada)-Famous for the highest tides in the world</td></tr>
<tr><td>Chapter 13
Movements of Ocean Water</td><td>Ocean Currents<table><tr><th>Cold currents</th><th>Warm currents</th></tr><tr><td>Humboldt c.
California c.
Falkland c.
Canaries c.
West Australian c.
Oyashio c.
Labrador c</td><td>Alaska c.
Brazilian c.
Agulhas c.
Kuroshio c.
Gulf stream c.</td></tr></table></td></tr>
</table>

Chapter 14 Biodiversity and Conservation	**Ecological hotspots** ● Eastern Himalaya, India ● Western ghats, India ● Indonesia, Asia ● Eastern Madagascar, Africa ● Upper Guinean forests, Africa ● Atlantic forest, Brazil Tropical Andes

Map Work **Book- India Physical Environment** **(Map items for locating and labelling only on the outline political map of India)**	
Chapter	**Map item (Map present on official website of Govt. of India should be used)**
Chapter 1 **India- Location**	● Latitudinal extent of India ● Longitudinal extent of India ● Standard Meridian of India ● Important latitude passing through India (Tropic of Cancer) ● Southern Most Point of mainland of India (Kanya Kumari)
Chapter 2 Structure and Physiography	• Mountains: Karakoram Range, Garo- Khasi- Jaintia hills, Aravalli Range, Vindhyan Range, Satpura Range, Western ghats & Eastern ghats • Peaks: K2, Kanchenjunga, Nandadevi, Nanga Parvat, Namcha Barwa and Anaimudi • Passes: Shipkila, Nathula, Palghat, Bhor ghat and Thal ghat • Plateaus: Malwa, Chhotnagpur, Meghalaya and Deccan Plateau. • Coastal Plains: Saurashtra, Konkan, North and South Kanara, Malabar, Coromandel and Northern Circars • Islands: Andaman & Nicobar Islands and Lakshadweep Islands

Chapter- 3 Drainage System	• Rivers: Brahmaputra, Indus, Satluj, Ganga, Yamuna, Chambal, Damodar, Mahanadi, Krishna, Kaveri,Godavari, Narmada, Tapti and Luni • Lakes: (Identification)Wular, Sambhar, Chilika, Kolleru, Pulicat & Vembanad • Straits, Bays , Gulfs: Palk Strait, Rann of Kachch, Gulf of Kachch, Gulf of Mannar & Gulf of Khambat
Chapter-4 Climate	• Area with highest temperature in India • Area with lowest temperature in India • Area with highest rainfall in India • Area with lowest rainfall in India
Chapter-5 Natural Vegetation	(Identification on an outline map of India) Tropical evergreen, Tropical deciduous, Tropical thorn, Montane and Littoral/ Swamp forests. Wildlife reserves: (locating and labeling) • National Parks: Corbett, Kaziranga, Ranthambore. Shivpuri, Simlipal • Bird Sanctuaries: Keoladev Ghana and Ranganathitto • Wild life Sanctuaries: Periyar, Rajaji, Mudumalai, Dachigam

FUNDAMENTALS OF PHYSICAL GEOGRAPHY
CHAPTER 1
GEOGRAPHY AS A DISCIPLINE

Geography can be said that Geography is the description of the earth.
POINT: Why Do We Study Geography?
We study geography to understand:

- Landforms
- Climate
- Rivers and oceans
- Forests and animals
- Human activities
- Relationship between humans and nature

The term geography was first coined by Eratosthenes, a Greek scholar (276-194 BC.).
Geography as a discipline is concerned with three sets of questions: ***What, Where*** and ***Why*****?**

Geography studies:	
● Physical environment ● Human activities ● Interaction between humans and nature ● Spatial variations on earth	● Geography as a Study of Areal Differentiation ● Different regions have different: o Climate o Soil o Vegetation o Culture o Occupations

- Geography attempts SPATIAL synthesis and history attempts TEMPORAL synthesis.
- The major approaches to study geography have been (i) Systematic and (ii) Regional.
- The Systematic geography approach is the same as that of general geography. This approach was introduced by Alexander Von Humboldt, a German geographer (1769-1859).
- In systematic approach, to study geography a phenomenon is studied world over as a whole, and then the identification of typologies or spatial patterns is done.
- The Regional approach to study geography was developed by another German geographer, Karl Ritter (1779-1859).
- In the regional approach, the world is divided into regions at different hierarchical levels and then all the geographical phenomena in a particular region are studied.
- Dualism finally leads to 'dichotomy' which means the bifurcation of any subject into branches of knowledge.

- Geography as an Integrating Discipline
- Geography links natural sciences and social sciences.
- It studies spatial organization and spatial integration.
- Related subjects:
  - Geology
  - Meteorology
  - Economics
  - Sociology
  - History
  - Political Science

Branches of Geography (based on Systematic approach)

1.Physical Geography.

a) Geomorphology
b) Climatology
c) Hydrology
d) Soil Geography

2.Human Geography

a) Social/Cultural Geography
b) Population and settlement Geography
c) Economic Geography
d) Historical Geography
e) Political Geography

3.Biogeography

a) Plant Geography
b) Zoo Geography
c) Ecology/Ecosystem
d) Environmental Geography

Systematic Approach	**Regional Approach**	**Dualism in Geography**

● Introduced by Alexander von Humboldt.
● Also called **General Geography**.
● Studies one geographical phenomenon worldwide.
● Example:
● Study of natural vegetation across the world.
● Types identified:
  ○ Equatorial rain forests
  ○ Coniferous forests
  ○ Monsoon forests
	● Developed by Karl Ritter.
	● World is divided into regions.
	● All geographical features of one region are studied together.
	● Types of regions:
	● Natural regions
	● Political regions
	● Designated regions
	● Studies unity in diversity in a holistic manner.
		● Geography has two major aspects:
		● Physical Geography
		● Human Geography
		● Earlier focus was mainly on physical geography.
		● Later, importance of human activities led to development of human geography.

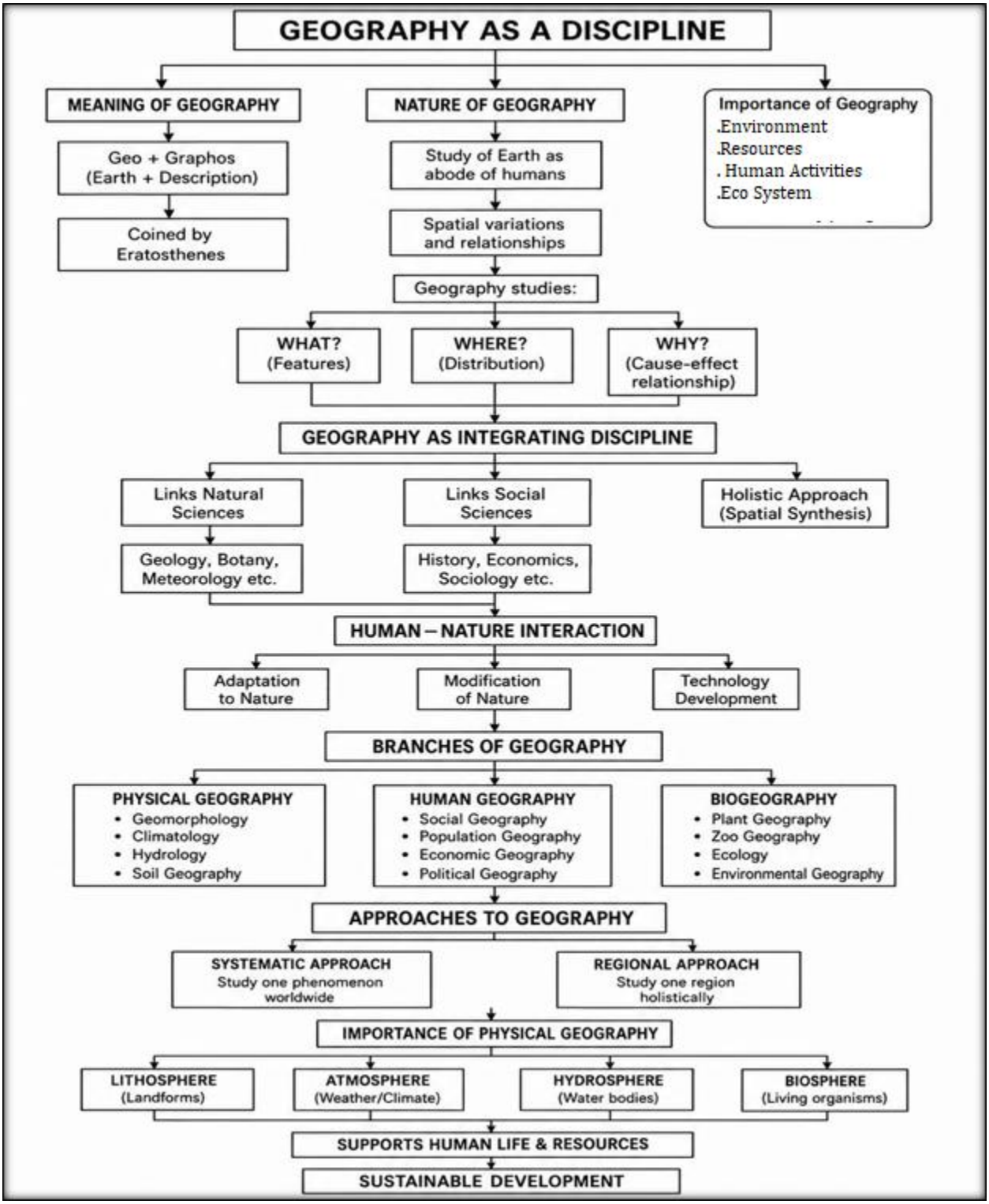
Branches of Geography (based on Regional approach)

A. Regional Studies
B. Regional Planning
C. Regional Development
D. Regional Analysis

- **Pedogenesis:** the process by which soil is formed

- **Definition by Richard Hartshorne:** Geography is concerned with the description and explanation of the areal differentiation of the earth's surface.
- **Definition by Hettner:** Geography studies the differences of phenomena usually related with different parts of the earth's surface.

Term	**Meaning**
Areal Differentiation	Variations from place to place
Spatial Organization	Arrangement of phenomena over space
GIS	Geographic Information System
GPS	Global Positioning System
Ecology	Study of interaction between organisms and environment



SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. The term 'Geography' was coined for the first time by which Greek scholar?

A. Herodotus
B. Eratosthenes
C. Aristotle
D. Ptolemy

2. The word Geography is derived from two Greek roots: Geo (Earth) and Graphos (Description). Put together, it literally means:

A. The explanation of mapping networks
B. The description of the earth
C. The calculation of planetary orbits
D. The system of human adaptation

3. Geography studies the variations in natural and cultural phenomena over the earth's surface. This core concept is known as:

A. Areal Differentiation
B. Spatial Distribution
C. Environmental Determinism
D. Spatial Interaction

4. The Systematic approach to geographic study was introduced by which eminent German geographer?

A. Karl Ritter
B. Alexander von Humboldt
C. Richard Hartshorne
D. Alfred Hettner

5. The philosophy of dualism in geography arose primarily from the conceptual conflict between:

A. History and Economics
B. Physical Geography and Human Geography
C. Systematic Planning and Regional Development
D. Philosophy and Biogeography

6. Which branch of Human Geography deals with the spatial attributes of population, including density, distribution, migration, and demographic structures?

A. Cultural Geography
B. Economic Geography
C. Population Geography
D. Social Geography

7. Match the sub-branch of Geography in Column-I with its core Focus of Study in Column-II using the options table:

Column-I (Sub-branch)	Column-II (Focus of Study)
1. Hydrology	a. Dynamic studies of the atmosphere, weather, and climate elements
2. Climatology	b. Spatial distribution, traits, and boundaries of soils over landforms
3. Soil Geography	c. Study of water realms including oceans, lakes, and rivers

Options Table:

Option	1 (Hydrology)	2 (Climatology)	3 (Soil Geography)
A	c	a	b
B	a	c	b
C	c	b	a
D	b	a	c

8. Assertion (A): No geographical phenomenon remains static over time; landforms, climates, and human societies are constantly modifying.
Reason (R): Geography is the study of the interactive relationship between a dynamic earth and an untiring, active human being.
Options:

A. Both (A) and (R) are true, and (R) is the correct explanation of (A).

B. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).
C. (A) is true, but (R) is false.
D. (A) is false, but (R) is true.

9. The modern technological method that allows geographers to map, store, analyze, and retrieve spatial data layered into computer databases is known as:
A. Global Positioning System (GPS)
B. Geographic Information System (GIS)
C. Digital Cartography
D. Qualitative Surveys

10. Which parameter answers the quintessential question "Where" when exploring geographical phenomena?
A. Causality / Reason
B. Temporal change / Evolution
C. Spatial Location / Distribution
D. Structural composition / Type

Answers –

1. Answer: B. Eratosthenes
2. Answer: B. The description of the earth
3. Answer: A. Areal Differentiation
4. Answer: B. Alexander von Humboldt
5. Answer: B. Physical Geography and Human Geography
6. Answer: C. Population Geography
7. Answer: A (1-c, 2-a, 3-b)
8. Answer: A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
9. Answer: B. Geographic Information System (GIS)
10. Answer: C. Spatial Location / Distribution

SECTION - B (SOURCE BASED QUESTIONS)

11. Read the given text carefully and answer the questions that follow:
"You have already studied geography as one of the components of your Social Science course up to the secondary stage... Now, you will study 'Geography' as an independent subject and learn about the physical environment of the earth, human activities and their interactive relationships. Therefore, a pertinent question you can ask at this stage is 'Why should we study geography?' We live on the surface of the earth. Our lives are affected by our surroundings in many ways. We depend on the resources to sustain ourselves in the surrounding areas. Primitive societies subsisted on 'natural means of subsistence'—edible plants and animals. With the passage of time, we developed technologies and started producing our food using natural resources such as land, soil, and water."

Questions & Answers:

a. Based on the passage, define what a student learns when studying Geography as an independent subject.
Answer: When studying Geography as an independent subject, a student learns about the physical environment of the earth, human activities, and their interactive relationships.

b. How did primitive human societies differ from advanced societies in their interaction with the surrounding physical environment?
Answer: Primitive societies directly depended on their immediate physical environment and subsisted entirely on "natural means of subsistence" like edible

plants and animals. In contrast, advanced societies developed technology over time, allowing them to modify their natural environment and produce food using resources like land, soil, and water.

c. Explain why the development of technology is crucial to human interactions with natural resources like soil and water.
Answer: Technology is crucial because it helps humans start producing food using natural resources, loosens the hard shackles of the physical environment, reduces the harshness of labor, increases labor efficiency, and creates new structural possibilities in collaboration with nature.

SECTION - C (SHORT ANSWER QUESTIONS)

12. Explain the concept of 'Areal Differentiation' as a primary objective of geographical studies.
Answer: Core Philosophy: The surface of the earth is not uniform and exhibits extensive variations in both its physical features (like mountains, plains, and deserts) and cultural features (like villages, cities, and roads).

- Focus of Study: Perceiving geography as the study of 'areal differentiation' means systematically understanding all those natural and cultural phenomena that vary across different spaces.
- Causal Relationships: It does not merely record these variations but deeply investigates the specific associations, causes, and factors responsible for creating such patterns over time and space.

13. Distinguish between Physical Geography and Human Geography, highlighting their primary elements of concern.

Answer:

Parameter	Physical Geography	Human Geography
Primary Focus	Studies the natural, non-living elements of the earth's surface and biosphere.	Studies human activities, social dynamics, and the cultural footprints left by society.
Core Elements / Branches	Includes Geomorphology (landforms), Climatology (weather/climate), Hydrology (water bodies), and Soil Geography (soil profiles).	Includes Social/Cultural Geography, Population and Settlement Geography, Economic Geography, Political Geography, and Historical Geography.
Sustaining Base	Provides the essential physical stage, climate controls, and resource base (like minerals, plains, and water).	Enacts the social drama, builds infrastructure, and establishes networks using creative tools and technologies.

14. "Technology has enabled humans to loosen the shackles of the physical environment." Elaborate on this statement by discussing the stages of human adaptation and modification of the earth.

Answer:

- Stage of Necessity (Primitive Interaction): In early human history, primitive societies were directly dependent on their immediate natural environment for survival,

subsisting purely on edible plants and animals. They adjusted their food and clothing strictly to prevailing weather patterns.

- Development of Technology: With the passage of time, human beings invented tools and evolved their creative skills. Technology helped reduce the harshness of manual labor, heightened overall labor efficiency, and offered the leisure required to pursue higher organizational needs.
- Stage of Freedom (Modification & Humanized Nature): By utilizing technology, present societies expanded their horizon of operation. They began modifying their physical environment—harnessing land, soil, and water to produce food , establishing transport/communication networks , and shifting completely from a stage of absolute necessity to a stage of freedom where they create new possibilities in collaboration with nature.

CHAPTER 2
THE ORIGIN AND EVOLUTION OF THE EARTH

Early Theories: Origin of the Earth

- **Nebular Hypothesis (Kant & Laplace, 1796)**
  - Planets formed from a rotating cloud of material around a youthful Sun.
  - Popular early explanation.
- **Revised Nebular Hypothesis (1950s – Otto Schmidt, Carl Weizsäcker)**
  - Sun surrounded by solar nebula (hydrogen, helium, dust).
  - Collisions & friction → disk-shaped cloud.
  - Planets formed by accretion (gradual accumulation of particles).
- **Later Focus**
  - Scientists shifted from Earth's origin to studying the origin of the universe as a whole.
- **Modern Theory – Big Bang Theory**

Big Bang Theory / Expanding Universe Hypothesis

- The most popular theory about the origin of the universe is the Big Bang Theory.
- It is also called the Expanding Universe Hypothesis.
- Edwin Hubble provided evidence in 1920 that the universe is expanding.
- Galaxies are moving farther apart with time.
- The distance between galaxies keeps increasing.

There are three Stages of Big Bang Theory

(i) Initial Stage

- All matter of the universe existed in one place.
- It was a:
  - Tiny ball (singular atom)
  - Infinite density
  - Infinite temperature
  - Extremely small

(ii) The Big Bang Explosion

- The tiny ball exploded violently.
- This caused huge expansion of the universe.
- The Big Bang happened about 13.7 billion years ago.
- Expansion still continues today.
- Energy changed into matter.

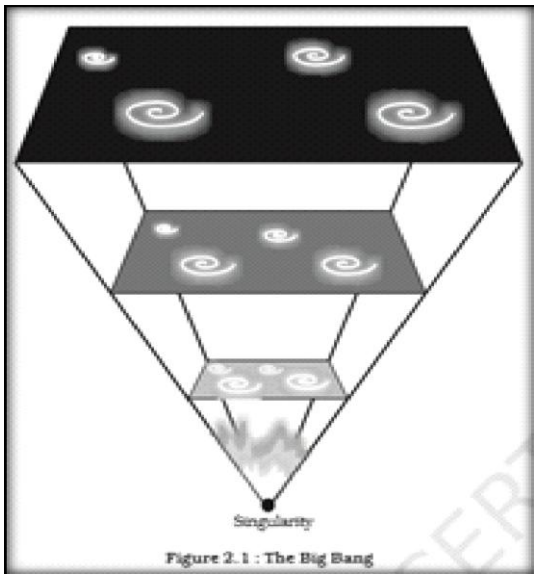


Figure 2. 1 : The Big Bang

- Expansion was very rapid in the beginning.
- Later, the speed of expansion slowed down.
- Within first 3 minutes:
  - First atoms began to form.

(iii) Formation of Atomic Matter

  - After about **300,000 years**:
  - Temperature dropped to **4,500 K**.
  - Atomic matter formed.
  - The universe became transparent.

Formation of Stars and Galaxies

- Uneven distribution of matter caused gravitational attraction.
- Hydrogen gas clouds formed nebulae.
- Dense regions in nebulae developed into stars.
- Galaxies contain millions of stars.

Light Year --Unit of distance.

- Distance travelled by light in one year: $(9.46 \times 10^{12}$ km)

Formation of Planets:

- Accretion- Process where particles in the nebula collided and stuck together to form planetesimals, which further coalesced into planets.
- Differentiation- Heavy elements sank to the center, and lighter ones floated to the surface, leading to the formation of core, mantle, and crust.
- - Heavier elements (iron, nickel) sank to form the core, while lighter elements (silicon, oxygen) rose to form the mantle and crust.

Evolution of Earth

- Initial Earth
- Hot, rocky, barren surface.
- Thin atmosphere of hydrogen and helium.
- Differentiation Process
  - Heavy materials like iron sank inward.
  - Light materials moved upward.
  - Earth developed layers:

Plate Tectonics

- The theory that explains the movement of Earth's tectonic plates.
- Responsible for the formation of mountains, earthquakes, and volcanic activity.
- Continents have drifted over geological time, leading to the current configuration.
- Early Earth:
- Initially, Earth was in a molten state due to intense heat from gravitational compression, radioactive decay, and frequent collisions.
- As it cooled, the outer layer solidified to form a crust.

Evolution of Hydrosphere

- Water vapour condensed as Earth cooled.
- Continuous rainfall occurred.
- Carbon dioxide dissolved in rainwater.
- Temperature decreased further.
- More condensation and rainfall took place.
- Rainwater collected in depressions.
- Oceans were formed.
- Oceans formed about **4000 million years ago**.
  - Water vapour condensed into rain.
  - Rainwater collected in depressions forming oceans.

Evolution of Atmosphere

FIRST STAGE	**SECOND STAGE**	**THIRD STAGE**
Loss of Primordial Atmosphere	**Formation of Secondary Atmosphere**	**Modification by Living Organisms**
● Early atmosphere contained: ○ Hydrogen ○ Helium ● Solar winds removed these gases. ● This happened on all terrestrial planets.	● Earth cooled gradually. ● Gases and water vapour escaped from Earth's interior. ● This process is called **degassing**. ● Volcanic eruptions released gases into atmosphere. ● Gases Present in Early Atmosphere ● Water vapour, Nitrogen, Carbon dioxide, Methane, Ammonia, very little free oxygen	● Photosynthesis evolved around: 2,500–3,000 million years ago ● Early life existed in oceans. ● Photosynthesis released oxygen into oceans. ● Oceans became saturated with oxygen. ● Around 2,000 million years ago: ● Oxygen spread into atmosphere.

Life on Earth:

Chemical Evolution: Simple organic molecules formed in the primordial soup, eventually leading to complex molecules.

Biological Evolution: First simple life forms (prokaryotes) appeared around 3.8 billion years ago.

Oxygen production began with the advent of photosynthetic organisms, leading to the development of the ozone layer.

SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. The Nebular Hypothesis regarding the origin of the earth was revised in 1796 by which eminent mathematician?

A. Immanuel Kant
C. Otto Schmidt
B. Laplace
D. Edwin Hubble

2. According to modern scientists, life on the earth first emerged or appeared around how many years before the present?

A. 13.7 billion years
C. 3.8 billion years
B. 4.6 billion years
D. 3.8 million years

3. Q3. The process by which the volatile material and gases were outpoured from the interior of the cooling earth to form its early atmosphere is known as:

A. Condensation
C. Planetary Accretion
B. Degassing
D. Lithification

4. The Big Bang Theory, which explains the expanding nature of our universe, is also formally known as:

A. Binary Star Hypothesis
C. Nebular Synthesis
B. Expanding Universe Hypothesis
D. Planetesimal Accretion Theory

5. Match the cosmic/planetary stage in Column-I with its core characteristic process in Column-II using the options table:

Column-I (Cosmic Stage)	Column-II (Characteristic Process)
1. Planetoids / Planetesimals	a. Large number of smaller bodies condensing through gravitational cohesion
2. Nebular Rotation	c. A spinning flat disc of gas and dust associated with a youthful sun
3. Differentiation	b. Segregation of lighter and heavier matter into concentric interior zones

Options Table:

Option	1 (Planetoids)	2 (Nebular Rotation)	3 (Differentiation)
A	a	c	b
B	c	a	b
C	a	b	c
D	b	a	c

6. **Assertion (A):** The early Earth remained in a hot, volatile, and molten state for a long duration during its initial accretion period.
Reason (R): Continuous collision of planetesimals and intense gravitational compression generated enormous amounts of heat.
Options:

A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
B. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).
C. (A) is true, but (R) is false.
D. (A) is false, but (R) is true.

Answers -

1. Answer: B. Laplace
2. Answer: C. 3.8 billion years
3. Answer: B. Degassing
4. Answer: B. Expanding Universe Hypothesis
5. Answer: A (1-a, 2-c, 3-b)
6. Answer: A. Both (A) and (R) are true, and (R) is the correct explanation of (A).

SECTION - B (SOURCE BASED QUESTIONS)

7. Read the given text carefully and answer the questions that follow:
"The modern theory regarding the origin of the universe is the Big Bang Theory... Edwin Hubble, in 1920, provided evidence that the universe is expanding. As time passes, galaxies move further and further apart... In the beginning, all matter forming the universe existed in one place in the form of a 'tiny ball' (singular atom) with an unimaginably small volume, infinite temperature and infinite density. At the Big Bang, the 'tiny ball' exploded violently. This led to a huge expansion. It is now generally accepted that the event of Big Bang took place 13.7 billion years ago from the present."

Questions & Answers:

a. Name the scientist who first provided empirical evidence in 1920 that the universe is expanding.
Answer: Edwin Hubble.

b. Describe the physical attributes (volume, temperature, density) of the universe's matter prior to the Big Bang explosion.
Answer: Prior to the explosion, all matter existed in a single place as a "tiny ball" (singular atom) featuring an unimaginably small volume, infinite temperature, and infinite density.

c. What does the expression "galaxies moving further and further apart" signify in modern cosmological studies?
Answer: It signifies the actual expansion of the universe, demonstrating that the physical space between galaxies is continuously increasing over time.

SECTION - C (SHORT ANSWER QUESTIONS)

8. Briefly trace the structural stages through which the early primordial atmosphere of the Earth evolved into its modern composition.
Answer: The evolution of the atmosphere occurred in three major stages:

1. **Loss of Primordial Atmosphere:** The Earth's earliest atmosphere, filled with hydrogen and helium, was completely stripped off and blown away by powerful solar winds.
2. **Internal Degassing:** As the hot interior of the early Earth cooled down, it erupted into massive volcanic activities. This process, called degassing, outpoured huge quantities of water vapour, nitrogen, carbon dioxide, methane, and ammonia, with almost no free oxygen.
3. **Photosynthetic Modification:** Finally, the evolution of life and photosynthetic marine organisms gradually added free oxygen to the waters and eventually flooded the atmosphere around 2,000 million years ago, paving the way for its modern composition.

SECTION - D (LONG ANSWER QUESTIONS)

9. Give a comprehensive, explanatory note on the 'Big Bang Theory' regarding the origin and evolution of our universe, highlighting its major operational stages.
   Answer: The Big Bang Theory, also known as the Expanding Universe Hypothesis, is the most widely accepted explanation for cosmic origin. It operates through the following defining stages:

- **The Singularity Stage:** In the absolute beginning, all cosmic matter was concentrated in a single location as a "tiny ball" (singular atom). This ball had an unimaginably small volume, infinite temperature, and infinite density.
- **The Violent Explosion:** Roughly 13.7 billion years ago, this tiny ball exploded with immense violence, starting a rapid expansion that continues to this day. Within fractions of a second, an extraordinary expansion occurred, turning raw energy into the first forms of matter.
- **Atomic Matter Formation:** The initial expansion slowed down after the initial fraction of a second. Within the first three minutes of the Big Bang, the very first basic atoms began to organize.
- **The Cooling and Transparency:** Within 300,000 years of the explosion, the temperature dropped significantly to 4,500 Kelvin. This cooling allowed atomic matter to stabilize properly, clearing the cosmic haze and making the universe transparent. Over time, space between galaxies continued to widen.

10. Describe the Nebular Hypothesis of planetary formation. Contrast the early version put forth by Immanuel Kant and Laplace with the revisions made by modern scientists like Otto Schmidt.
    Answer: The Core Nebular Hypothesis: This hypothesis suggests that planets were formed from a vast cloud of gas and cosmic dust, called a solar nebula, which was spinning slowly and wrapped around a youthful, developing sun.

- **Early Version (Kant and Laplace):** Formulated by Immanuel Kant and revised by Laplace in 1796, this model assumed that a slowly rotating, uniform cloud of material associated with a youthful sun condensed over time to shed rings of matter, which eventually formed individual planets.
- **Modern Revisions (Otto Schmidt and Carl Weizascar):** In 1950, Schmidt (Russia) and Weizascar (Germany) revised this framework. They specified that the solar nebula was mostly hydrogen and helium along with dust particles. They explained that internal friction and collisions among these moving particles caused them to flatten into a disk-shaped cloud. Instead of basic condensation, the planets were built step-by-step through a concrete process called **accretion**, where smaller particles collided and bound together into larger bodies.

11. Trace the origin and evolution of life on Earth. Explain how life altered the chemical configuration of the oceans and the atmosphere.
    Answer: **Origin via Chemical Reaction:** Initially, the primitive, hot Earth had a volatile atmosphere that could not support life. Modern science states that life began around 3,800 million years ago as a complex chemical reaction. This reaction generated intricate organic molecules and assembled them into structures capable of duplicating themselves, effectively turning inanimate matter into living substance.

The oldest remnants are found as fossilized microscopic structures of blue algae in ancient rock formations.

- **Altering the Oceans:** For a vast period of geological history, life remained restricted entirely to the oceans. Around 2,500 to 3,000 million years ago, these marine organisms evolved the process of **photosynthesis**. They used solar energy to release oxygen directly into the seawater. Over a long period, the oceans absorbed this byproduct until the marine system became completely saturated with oxygen.
- **Altering the Atmosphere:** Once the oceans were fully saturated, free oxygen began escaping the waters. Around 2,000 million years ago, oxygen began to flood the atmosphere in massive amounts. This completely transformed the Earth's air from an ancient, toxic mix of methane, ammonia, and carbon dioxide into an oxygen-rich atmosphere that could support advanced terrestrial living forms.

ORIGIN & EVOLUTION OF THE UNIVERSE AND EARTH

1. EARLY THEORIES

Nebular Hypothesis (Kant & Laplace, 1796)

↓

Rotating cloud around young Sun

↓

↓

Planets formed

Revised Nebular Hypothesis (1950s)

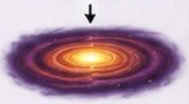
↓

Solar nebula (H, He, dust)

↓

Collisions → Disc-shaped cloud

↓



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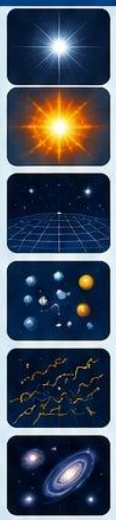
Accretion → Planets

2. MODERN THEORY : BIG BANG THEORY



Tiny Singularity

↓

Big Bang (~13.7 billion years ago)

↓

Rapid Expansion of Universe

↓

Matter & Atoms Formed

↓

Universe Became Transparent

↓

Galaxies and Stars Formed

3. STAR FORMATION

Hydrogen Gas Clouds (Nebula)

↓

Gravitational Clumping

↓

Formation of Galaxies

↓

Formation of Stars (~5–6 bya)

4. FORMATION OF PLANETS

Gas Lumps Around Young Sun

↓

Core + Rotating Disc

↓

Condensation

↓

Planetesimals Formed

↓

Collision & Accretion

↓

Planets Formed

5. EVOLUTION OF EARTH

Hot, Rocky Earth

↓

Differentiation (Heavy materials sank)

↓

Formation of: Crust → Mantle → Core

↓

Moon Formation (Giant Impact)

6. ATMOSPHERE & HYDROSPHERE

1. Loss of Primordial Atmosphere

↓

2. Volcanic Degassing (H_2O, CO_2, N_2, CH_4, NH_3)

↓

3. Oceans Formed (~4 bya)

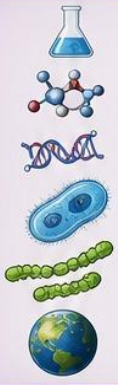
↓

4. Photosynthesis

↓

Oxygen Added (~2 bya)

7. ORIGIN OF LIFE



Chemical Reactions

↓

Organic Molecules

↓

Self-Replicating Molecules

↓

First Life (~3.8 bya)

↓

Photosynthetic Organisms

↓

Oxygen-rich Atmosphere

8. IMPORTANT FACTS

Age of Earth → **4.6 billion years**

Life appeared → **3.8 billion years ago**

Differentiation **NOT** related to atmosphere formation

☆ **Abbreviations:** bya = billion years ago

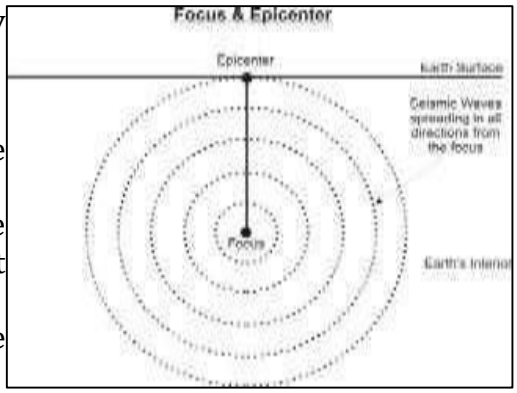
CHAPTER 3: INTERIOR OF THE EARTH

Interior of the Earth

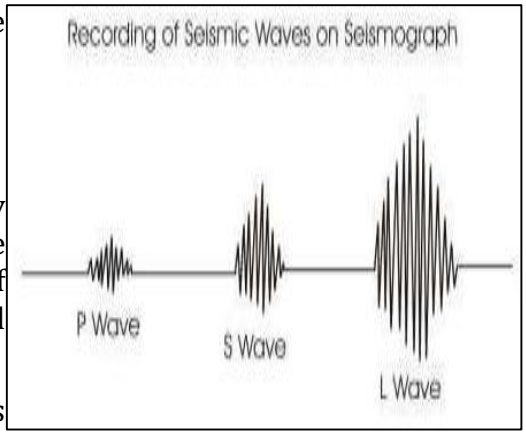
- Earth's radius is about 6,378 km.
- Direct observation of the Earth's interior is not possible.
- Knowledge is obtained through:
  - **Direct Sources**: mining, drilling projects, volcanic eruptions.
  - **Indirect Sources**: seismic waves, gravity, magnetic field, meteors.

Earthquakes

- Earthquakes occur due to sudden release of energy along faults.



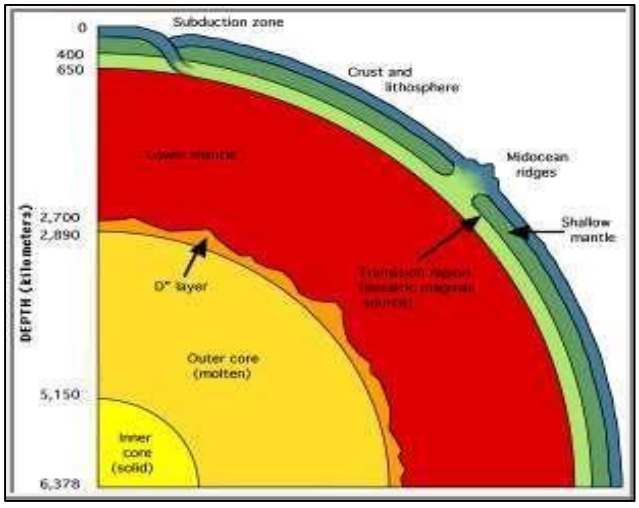
- Key terms:
  - **Focus/Hypocentre** – point inside Earth where energy is released.
  - **Epicentre –** It is a point on the earth surface which records the seismic waves for the first time.
  - **Seismograph:-**An instrument which record the earthquake waves.



- Measurement of earthquake
  a. Richter Scale
  b. Mercalli Scale
- Earthquake Waves: Body waves and surface waves.
- P and S waves are called as 'Body Waves' as they move inside the body of the earth. P waves are the fastest wave that move parallel to the direction of waves. These waves can move in solid, liquid and gaseous material.
- S waves are slower than P waves. It moves perpendicular to the direction of the waves. These waves move only in solid and disappear in liquid.
- L waves are the slowest waves. It moves on the earth surface. It causes maximum destruction on the earth surface.

Effects Of Earthquakes

(i)Ground Shaking
(ii) Differential ground settlement
(iii) Land and mud slides
(iv) Soil liquefaction
(v) Ground lurching
(vi) Avalanches
(vii) Ground displacement
(viii) Floods from dam and levee failures
(ix) Fires
(x) Structural collapse



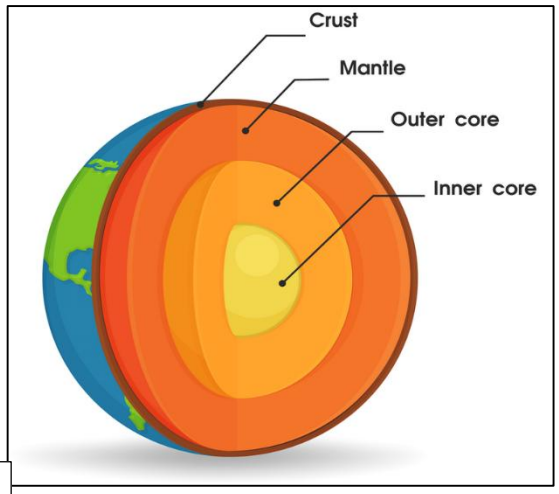
(xi) Falling objects
(xii) Tsunami

Causes of earthquake:

- movement of plates,
- rising of magma,
- folding and faulting,
- violent volcanic eruption.

SHADOW ZONE

- Areas where seismic waves are not detected.
- S-waves do not pass through liquid outer core.
- Helps scientists understand Earth's layered structure.

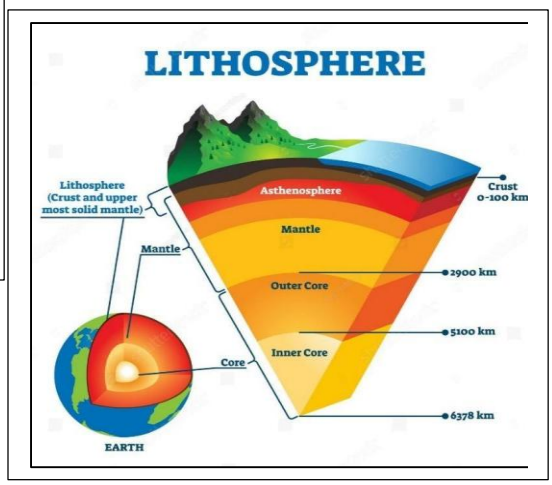


STRUCTURE OF THE EARTH

1. The Crust

- Outermost solid layer of the Earth. Brittle in nature.

Oceanic Crust	Continental Crust
• Thinner than continental crust. • Average thickness: **5 km**.	• Thicker than oceanic crust. • Average thickness: **30 km**. • Thickest under major mountain ranges. • Himalayan region crust thickness: **about 70 km**.



2. The Mantle

- Located below the crust.
- Extends from **Moho's discontinuity** to a depth of **2,900 km**.

Asthenosphere	Lithosphere	**The Core**
• Upper portion of the mantle. • "Astheno" means **weak**. • Extends up to **400 km** depth. • Main source of **magma** during volcanic eruptions.	• Made up of: ○ Crust ○ Uppermost mantle • Thickness ranges from **10–200 km**.	• Core-mantle boundary lies at **2,900 km** depth. • Discovered through the study of **earthquake waves**.

3. The Core

- Located below the mantle.
- Mainly made of:
  - Nickel
  - Iron

- Also called the NIFE layer.

Outer Core	Inner Core
Exists in **liquid state**.	Exists in **solid state**.

VOLCANO: - Volcano means the vent through which magma and other substances erupt to the surface.

TYPES OF VOLCANOES

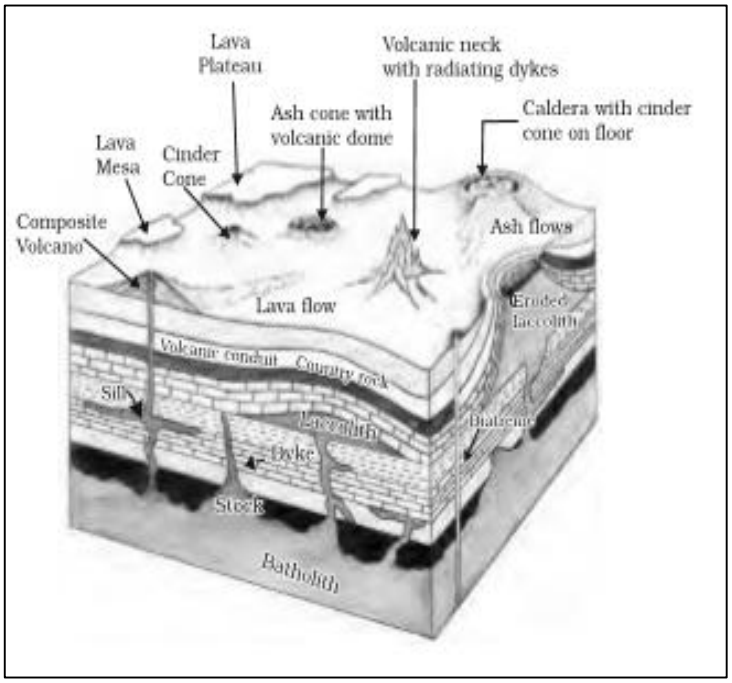
Classification of volcanoes based on nature of eruption and land forms developed on the surface.

1. **SHIELD VOLCANO-** Largest of volcanoes, Hawaiian Islands are best examples, Basalt lava flow, Lava is very fluid, they are not steep.
2. **COMPOSITE VOLCANOES-** Cool and more viscous lava, Explosive eruptions, they erupt pyroclastic and ashes along with lava, layers are formed.
3. **CALDERA-** A Most explosive type of volcanoes. These volcanoes collapse onto themselves, collapsed depressions are called caldera, and the magma chamber is huge and close to surface.
4. **FLOOD BASALT PROVINCES-** Consists of highly fluid lava, Some parts of the world are covered by thousands of sq.km of basalt, There can be the series of flows, Average thickness is more than 50 meter, Individual flow is 100 of sq.k.m, Ex. Deccan plateau.
5. **MID OCEANIC RIDGE VOLCANOES-** Found in oceanic surfaces, more than 70,000 km length, Frequent volcanic eruptions, Ex. Mid Atlantic ridge

INTRUSIVE VOLCANIC LANDFORMS

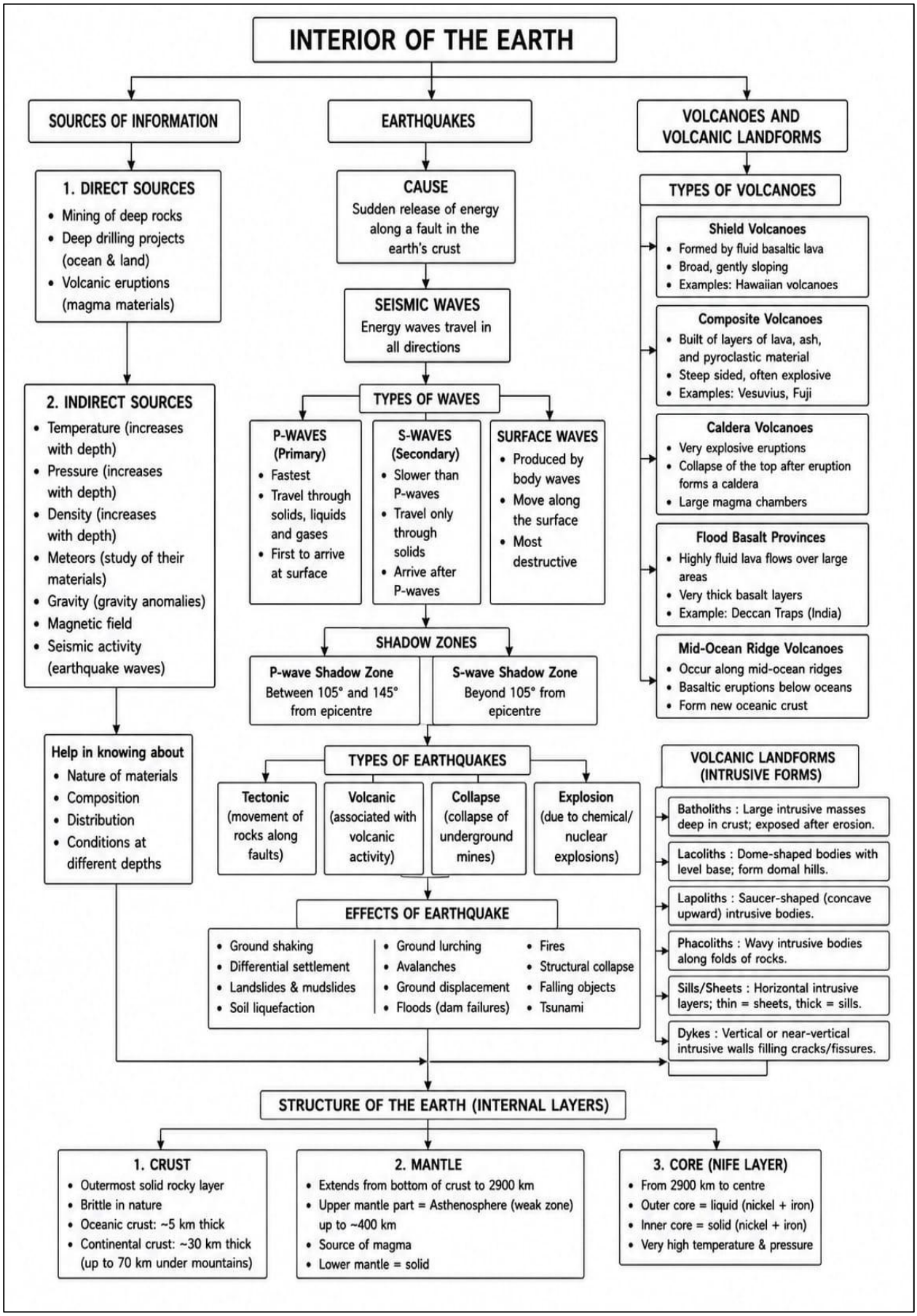
When lava comes out forms volcanic rocks, some part cools down in the lower portion forms plutonic rocks.

1. **BATHOLITH:** A large part of the magma material that cools in the deeper depth of the crust. They are dome shaped, cover large areas. They come out when erosion takes place. They are granite bodies.
2. **LACCOLITHS:** Large dome shaped intrusive bodies. Consists of level bodies connected through pipe like conduit from below.
3. **LAPOLITHS:** concave shaped lava formation.
4. **PHACOLITH:** wave typed lava formation.
5. **SILL**: horizontal deposit of lava.
6. **DYKES**: vertical lava formation



Mid-Ocean Ridge Volcanoes

- These volcanoes are found in **oceanic areas**.
- Mid-ocean ridges form a huge underwater mountain system.
- The ridge system is more than **70,000 km long**.
- It stretches through all the **major ocean basins** of the world.
- The central part of these ridges experiences **frequent volcanic eruptions**.


INTERIOR OF THE EARTH
SOURCES OF INFORMATION
1. DIRECT SOURCES
• Mining of deep rocks
• Deep drilling projects (ocean & land)
• Volcanic eruptions (magma materials)
2. INDIRECT SOURCES
• Temperature (increases with depth)
• Pressure (increases with depth)
• Density (increases with depth)
• Meteors (study of their materials)
• Gravity (gravity anomalies)
• Magnetic field
• Seismic activity (earthquake waves)
Help in knowing about
• Nature of materials
• Composition
• Distribution
• Conditions at different depths
EARTHQUAKES
CAUSE
Sudden release of energy along a fault in the earth's crust
SEISMIC WAVES
Energy waves travel in all directions
TYPES OF WAVES
P-WAVES (Primary)
• Fastest
• Travel through solids, liquids and gases
• First to arrive at surface
S-WAVES (Secondary)
• Slower than P-waves
• Travel only through solids
• Arrive after P-waves
SURFACE WAVES
• Produced by body waves
• Move along the surface
• Most destructive
SHADOW ZONES
P-wave Shadow Zone
Between 105° and 145° from epicentre
S-wave Shadow Zone
Beyond 105° from epicentre
TYPES OF EARTHQUAKES
Tectonic (movement of rocks along faults)
Volcanic (associated with volcanic activity)
Collapse (collapse of underground mines)
Explosion (due to chemical/ nuclear explosions)
EFFECTS OF EARTHQUAKE
• Ground shaking
• Differential settlement
• Landslides & mudslides
• Soil liquefaction
• Ground lurching
• Avalanches
• Ground displacement
• Floods (dam failures)
• Fires
• Structural collapse
• Falling objects
• Tsunami
VOLCANOES AND VOLCANIC LANDFORMS
TYPES OF VOLCANOES
Shield Volcanoes
• Formed by fluid basaltic lava
• Broad, gently sloping
• Examples: Hawaiian volcanoes
Composite Volcanoes
• Built of layers of lava, ash, and pyroclastic material
• Steep sided, often explosive
• Examples: Vesuvius, Fuji
Caldera Volcanoes
• Very explosive eruptions
• Collapse of the top after eruption forms a caldera
• Large magma chambers
Flood Basalt Provinces
• Highly fluid lava flows over large areas
• Very thick basalt layers
• Example: Deccan Traps (India)
Mid-Ocean Ridge Volcanoes
• Occur along mid-ocean ridges
• Basaltic eruptions below oceans
• Form new oceanic crust
VOLCANIC LANDFORMS (INTRUSIVE FORMS)
Batholiths : Large intrusive masses deep in crust; exposed after erosion.
Lacoliths : Dome-shaped bodies with level base; form domal hills.
Lapoliths : Saucer-shaped (concave upward) intrusive bodies.
Phacoliths : Wavy intrusive bodies along folds of rocks.
Sills/Sheets : Horizontal intrusive layers; thin = sheets, thick = sills.
Dykes : Vertical or near-vertical intrusive walls filling cracks/fissures.
STRUCTURE OF THE EARTH (INTERNAL LAYERS)
1. CRUST
• Outermost solid rocky layer
• Brittle in nature
• Oceanic crust: ~5 km thick
• Continental crust: ~30 km thick (up to 70 km under mountains)
2. MANTLE
• Extends from bottom of crust to 2900 km
• Upper mantle part = Asthenosphere (weak zone) up to ~400 km
• Source of magma
• Lower mantle = solid
3. CORE (NIFE LAYER)
• From 2900 km to centre
• Outer core = liquid (nickel + iron)
• Inner core = solid (nickel + iron)
• Very high temperature & pressure

SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. Which of the following is considered a direct source of information about the interior of the Earth?

A. Gravitational Force
B. Deep Ocean Drilling Projects
C. Seismic Wave Propagation
D. Meteors

2. The configuration of the surface of the Earth is largely a joint product of both exogenic and endogenic processes. Endogenic processes are driven by:

A. Solar radiation and atmospheric winds
B. Forces operating in the interior of the Earth
C. Tidal forces of the Moon and Sun
D. Gravitational pulling of surface water

3. Scientists are working on two major deep-ocean drilling projects: "Deep Ocean Drilling Project" and "Integrated Ocean Drilling Project". The deepest drilling so far has been made at Kola in the Arctic Ocean, reaching a depth of:

A. 6 km B. 12 km C. 18 km D. 24 km

4. Earthquakes generate seismic waves that travel through the planet. The point where the energy is released inside the crust is called the focus or:

A. Epicenter
B. Hypocenter
C. Anticline
D. Core-Mantle Boundary

5. The point on the surface of the Earth, nearest to the focus, which experiences the seismic waves first is known as the:

A. Fault line
B. Hypocenter
C. Epicenter
D. Lithospheric plate

6. Earthquake waves are broadly classified into Body waves and Surface waves. Body waves are generated due to:

A. Interaction between surface rocks and atmospheric pressure
B. Release of energy at the focus travelling in all directions
C. Tidal pull exerted by oceanic tides on continental boundaries
D. Friction along the transform plate boundaries only

7. Which type of seismic waves are the last to report on a seismograph, move along the crustal surface, and are considered the most destructive?

A. P-waves
B. S-waves
C. Surface waves
D. Mantle waves

8. The structural layer of the Earth that comprises both the crust and the uppermost solid part of the mantle is technically termed as the:

A. Asthenosphere
B. Lithosphere
C. Barysphere
D. Mesosphere

9. Assertion (A): The outer core of the Earth is in a liquid state, while the inner core is in a solid state.

Reason (R): S-waves completely disappear at the core-mantle boundary, whereas P-waves travel through the core though they get deflected.

Options:

A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
B. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).
C. (A) is true, but (R) is false.
D. (A) is false, but (R) is true.

10. When cooling magma cools within the crustal layers without reaching the surface, it develops into intrusive landforms. A massive chamber of solidified horizontal plutonic rock that forms the core of huge mountain tracts is called:

A. Laccolith
B. Lopolith
C. Batholith
D. Phacolith

11. Which type of volcanic eruption has been responsible for creating the massive landscape configurations of the Deccan Traps in India?

A. Shield Eruptions
B. Composite Eruptions
C. Caldera Collapses
D. Flood Basalt Eruptions

Answers –

1. Answer: B. Deep Ocean Drilling Projects
2. Answer: B. Forces operating in the interior of the Earth
3. Answer: B. 12 km
4. Answer: B. Hypocenter
5. Answer: C. Epicenter
6. Answer: B. Release of energy at the focus travelling in all directions
7. Answer: C. Surface waves
8. Answer: B. Lithosphere
9. Answer: A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
10. Answer: C. Batholith
11. Answer: D. Flood Basalt Eruptions

SECTION - B (SOURCE BASED QUESTIONS)

12. Read the given text carefully and answer the questions that follow:

"Earthquake waves get recorded in seismographs located at far off locations. However, there exist some specific areas where the waves are not reported. Such a zone is called the 'shadow zone'. The study of earthquake events reveals that for each earthquake, there exists a sharp distinctive shadow zone. It was observed that seismographs located at any distance within 105^0 from the epicentre, recorded both P and S-waves. However, the seismographs located beyond 145^0 from epicentre; record the arrival of P-waves, but not S-waves. Thus, a zone between 105^0 and 145^0 from epicentre is identified as the shadow zone for both the types of waves."

a. What is meant by an earthquake 'shadow zone'?

Answer: An earthquake shadow zone refers to specific geographic areas on the Earth's surface where specific seismic waves are not reported or recorded by seismographs**.**

b. Which type of seismic wave is completely absent in the shadow zone extending beyond 105^0 from the epicenter?

Answer: S-waves (Secondary waves) are completely absent in the entire zone extending beyond 105^0 from the epicenter.

c. What does the complete absence of this wave beyond 105^0 tell us about the nature of the Earth's core?
Answer: Since S-waves can travel only through solid materials, their complete absence beyond 105^0 proves that the outer core of the Earth is in a fluid or liquid state, which blocks them from propagating through.

SECTION - C (SHORT ANSWER QUESTIONS)

13. Differentiate between Body waves and Surface waves based on their origin, path of travel, and destructive capacity.
Answer: Origin: Body waves are generated due to the direct release of energy at the focus (hypocentre) , whereas surface waves are generated when these body waves interact with the surface rocks.

- Path of Travel: Body waves travel through the entire interior body of the Earth in all directions. Surface waves move strictly along the outer crustal surface.
- Destructive Capacity: Body waves cause early vibrations but are less damaging. Surface waves are the last to report on a seismograph and are far more destructive, causing physical rock displacement and collapse of structures**.**

14. Explain how volcanic activity acts as a direct source of information about the Earth's interior, and mention its major limitation. *
Answer: Direct Evidence: During a volcanic eruption, molten rock material (magma) is thrown out from the mantle onto the Earth's surface as lava. This material becomes directly available for chemical and structural laboratory analysis, providing clues about deeper zones.
Major Limitation: The critical limitation is that it remains highly difficult to precisely ascertain or find out the exact depth of the source of such magma chamber.

15. Describe the following intrusive volcanic landforms with the help of a brief explanation: (a) Dikes (Dykes) (b) Sills / Sheets
Answer: (a) Dikes: When upward-moving lava forces its way through vertical cracks and fissures inside the crust, it solidifies almost perpendicular to the ground. On cooling, it develops a wall-like vertical structure.
(b) Sills / Sheets: When lava moves along weak horizontal planes inside the crust and cools as near-horizontal bodies, it creates flat deposits. Thicker horizontal deposits are termed sills, while thinner horizontal sheets are called sheets.

16. What are shadow zones? Draw a neat, labeled structural diagram to show the difference between the shadow zone of P-waves and S-waves.
Answer: Shadow zones are specific zones where incoming earthquake waves are not reported by sensitive seismographs.

- P-wave Shadow Zone: Forms a band or ring around the Earth between 105^0 and 145^0 away from the epicentre.
- S-wave Shadow Zone: Extends comprehensively as a massive continuous zone everywhere beyond 105^0 from the epicenter, covering a little over 40% of the Earth's entire surface.

SECTION - D (LONG ANSWER QUESTIONS)

17. Elaborate on the indirect sources of information that help scientists decode the structural layers of the Earth's interior, explaining at least four distinct sources.
Answer: Since humanity cannot directly reach past a few kilometres into the crust , scientists rely heavily on indirect parameters:

1. Mining Material Properties (Temperature, Pressure & Density): Observations from deep mining prove that temperature, internal pressure, and rock density increase consistently with depth. By analyzing these changing rates over the total thickness of the Earth, scientists estimate the values of these properties at different depths.
2. Meteors: Meteors that occasionally land on Earth are solid bodies composed of materials similar to our planet. Analyzing their structural core provides an excellent indirect model of the composition of the Earth's interior.
3. Gravitational Anomalies : The gravitational force is uneven across the globe, being stronger near the poles and weaker at the equator due to distance variations from the center. Variations from expected values—known as gravity anomalies—reveal the uneven distribution of mass inside the crust.
4. Magnetic Fields & Seismic Activity: Magnetic crustal surveys identify where magnetic raw materials are concentrated. Most importantly, seismic waves (P and S waves) change velocity and paths depending on the density and state of materials, providing a complete picture of the layered interior.

18. Discuss the propagation of earthquake waves through different rock masses. Explain the structural changes and damage caused by P-waves, S-waves, and Surface waves as they pass through the crust.
Answer: As seismic waves propagate through different geological rock strata, they cause distinctive patterns of physical vibration:

- P-waves (Primary Waves): These move rapidly like sound waves and can travel through gases, liquids, and solids. They vibrate parallel to the direction of propagation, which exerts direct pressure on the rock material. This movement causes stretching and squeezing (compression and expansion), creating density variations in the crust.
- S-waves (Secondary Waves): These travel slower than P-waves and can pass only through solid materials. They vibrate perpendicular to the direction of wave travel in the vertical plane. This movement creates distinct vertical crests and troughs within the rocks, shaking the material sideways.
- Surface Waves: These expand along the outer crustal layer. Unlike body waves, they vibrate the material perpendicular to the path of propagation, creating extensive rock displacement. Because they register the maximum amplitude on a seismograph, they cause severe structural collapse, structural failures, and represent the most damaging waves during a quake.

19. Describe the internal structure of the Earth by dividing it into the Crust, Mantle, and Core. Highlight changes in density and composition from the surface to the center.
Answer: The interior of the Earth is structured into concentric layers, categorized by distinct chemical configurations and densities:

- The Crust: The outermost solid, brittle layer. Its thickness varies between oceanic areas (averaging 5 km) and continental sectors (averaging 30 km, reaching up to 70 km under the Himalayas). It has the lowest material density.
- The Mantle: Extends from Moho's discontinuity down to a depth of 2,900 km. Its upper portion, up to 400 km deep, is the asthenosphere, a weak, semi-fluid zone that acts as the primary source of magma. Below this, the lower mantle is solid and denser than the crust. Together, the crust and the uppermost solid mantle form the lithosphere (10–200 km thick).
- The Core: Located below the 2,900 km boundary. It is divided into a liquid outer core and a solid inner core. The core is composed of highly dense, heavy metals—predominantly nickel and iron and is referred to as the nife layer. Density increases steadily from the outer crust down to the central core.

20. What are Intrusive Forms? Explain the structural formation and shapes of Batholiths, Laccoliths, Lopoliths, and Phacoliths.
Answer: Intrusive forms are distinct igneous rock structures created when molten magma fails to reach the surface and instead cools and solidifies within the Earth's crust.

- Batholiths: Massive bodies of magmatic material that cool deep within the crust, forming extensive granitic domes. They represent the cooled cores of ancient magma chambers and are exposed on the surface only after heavy erosion removes the overlying rock strata.
- Laccoliths: Large, dome-shaped intrusive structures featuring a flat base. They are connected to a deeper magma supply via a pipe-like vertical conduit. They look like the surface domes of a composite volcano but are located deep inside the crust.
- Lopoliths: When upward-moving magma spreads horizontally into a weak structural basin, it cools into a distinct saucer-shaped body that is concave toward the sky.
- Phacoliths: Wavy mass of intrusive rocks found at the base of synclines or at the top of anticlines within folded mountain terrains. These formations are fed by a definite conduit from a magma chamber below.

CHAPTER 4: DISTRIBUTION OF OCEANS AND CONTINENTS

Continental Drift

- This similarity suggested that these continents were once joined together. a single landmass and later slowly drifted apart to their present positions over millions of years.
- Abraham Ortelius was the first scientist to suggest this idea in **1596**.
- Antonio Pellegrini later drew a map showing the continents joined together.
- The idea later became known as the **Continental Drift Theory**.
- The theory was fully explained by Alfred Wegener in **1912**.
- Wegener proposed that all continents were once part of a single supercontinent called **Pangaea**.
- Over millions of years, the continents drifted apart to their present positions.

Continental Drift Theory

- Alfred Wegener proposed the **Continental Drift Theory** in **1912**.

- The theory explained the distribution of continents and oceans.
- According to Wegener:
  - All continents were once joined together as a single landmass.
  - A huge ocean surrounded this landmass.

Important Terms

● Pangaea ● The supercontinent was called **Pangaea**. ● Meaning: **"All Earth"**.	● Panthalassa ● The giant surrounding ocean was called **Panthalassa**. ● Meaning: **"All Water"**.

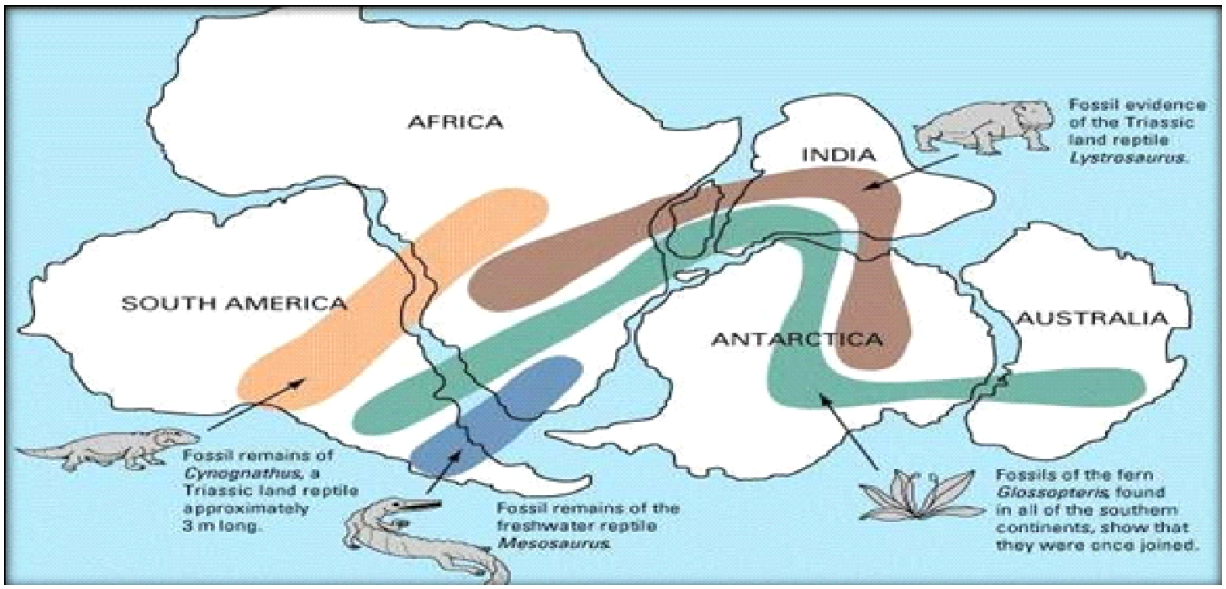
LAURASIA Northern part

GONDWANALAND Southern part

- Later, these landmasses further broke into smaller continents.
- These smaller parts gradually formed the present-day continents.

Break-up of Pangaea - Around 200 million years ago, Pangaea started breaking apart. It first split into two major landmasses.

EVIDENCE IN SUPPORT OF CONTINENTAL DRIFT



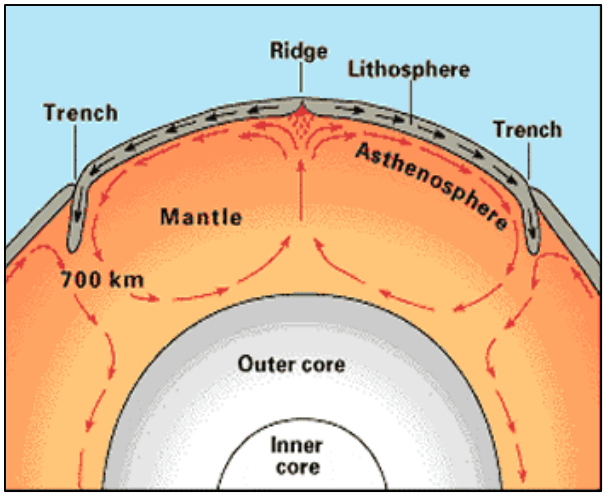
1. Matching of Continents (Jig-Saw Fit)	he coastlines of **Africa** and **South America** fit together like puzzle pieces. Their matching shape suggests they were once joined.
2. Rocks of Same Age Across the Oceans	Similar ancient rocks are found on opposite sides of the Atlantic Ocean. Rocks from **Brazil** match with rocks from **Western Africa**. These rocks are about **2,000 million years old**. Marine deposits along South America and Africa belong to the **Jurassic Age**. This indicates that the Atlantic Ocean did not exist before that time.
3. Tillite Deposits	Tillite is a sedimentary rock formed from glacier deposits. Gondwana sediments in India match with similar deposits in: Africa, Falkland Islands, Madagascar, Antarctica & Australia
4. Placer Deposits	Rich gold placer deposits are found on the coast of **Ghana**. Similar gold-bearing rocks are present in **Brazil**. This suggests Ghana and Brazil were once joined together.
5. Distribution of Fossils	Similar plant and animal fossils are found on continents now separated by oceans. Lemurs Fossils found in: India , Madagascar & Africa This led to the idea of a connected landmass called **Lemuria**.
Main Idea of the Theory	***Continents are not fixed.*** ***They slowly drifted to their current positions over millions of years.***

Force for Drifting

- Alfred Wegener suggested two forces responsible for continental drifting:
  1. Pole-fleeing force : Related to the **rotation of the Earth**.
  2. Tidal force: Caused by the gravitational attraction of: The Moon & The Sun

Convectional Current Theory

- Proposed by Arthur Holmes in the 1930s.
- He suggested that convection currents operate inside the mantle.



Cause of Convection Currents

- Radioactive elements inside Earth produce heat.
- Heat creates temperature differences in the mantle.
- Hot material rises upward.
- Cooler material sinks downward.
- This circular movement forms convection currents.

Importance

- Holmes explained the possible force

behind continental movement.

- This idea later supported:
  - Sea Floor Spreading
  - Plate Tectonics Theory
- It helped solve the weakness in Wegener's theory.

Concept of Sea Floor Spreading Theory

- Post-drift studies provided new evidence supporting continental movement.
- Ocean floor mapping and palaeomagnetic studies were very important.
- Harry Hess proposed the Sea Floor Spreading Theory in 1961.
  Hess explained that:
  Lava rises through cracks at mid-oceanic ridges.
  New crust is formed from cooling lava.
  The new lava pushes older oceanic crust away on both sides.
  Thus, the ocean floor spreads continuously.

Consumption of Oceanic Crust

- Old oceanic crust sinks into deep ocean trenches.
- This process is called subduction.
- The crust gets destroyed or consumed inside the Earth.
- New oceanic crust is continuously created at ridges.
- Old oceanic crust is destroyed at trenches.
- This process explains the movement of continents and oceans.

PLATE TECTONICS THEORY

- The concept of Plate Tectonics developed after the discovery of sea floor spreading.
- In 1967, Dan McKenzie, Robert Parker and Jason Morgan independently proposed the theory.

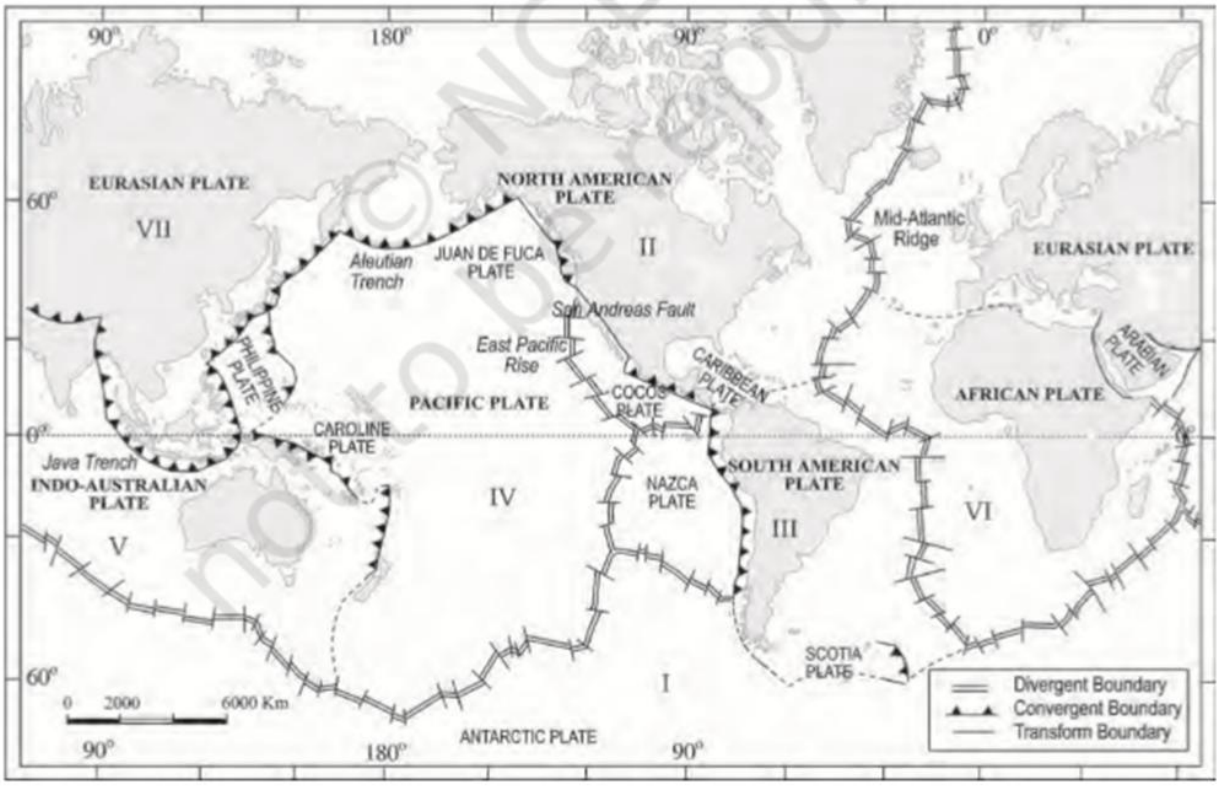
Meaning of Plate Tectonics

- A tectonic plate or lithospheric plate is a large, irregular slab of solid rock.
- It consists of:
  - Continental lithosphere
  - Oceanic lithosphere
- Plates move horizontally over the asthenosphere.
- They move as rigid units.

Thickness of Lithosphere

Area	Thickness
Oceanic areas	5–100 km
Continental areas	About 200 km

MAJOR AND MINOR PLATES OF THE WORLD
Types of Plate Boundaries



Divergent Boundaries	Convergent Boundaries	Transform Boundaries
• At divergent boundaries, plates move away from each other. • New crust is formed here. • These areas are called **spreading sites**. • Magma rises from below and forms new oceanic crust.	• At convergent boundaries, plates move towards each other. • One plate sinks below another plate. • Crust is destroyed here. • **Subduction Zone** • The area where one plate sinks is called a **subduction zone**.	• Plates slide horizontally past each other. • Crust is neither created nor destroyed. • Horizontal movement of plates

Rates of Plate Movement

- Plate movement is continuous but very slow.
- Different plates move at different speeds
- Arctic Ridge: Less than **2.5 cm per year**
- Fastest Moving Ridge: East Pacific Rise. More than **15 cm per year.**

Movement of the Indian Plate

Boundaries of the Indian Plate

- **Northern Boundary**
  - Formed by the **Himalayas**.
  - It is a **continent–continent convergence zone**.
  - Indian **Plate** collides with the Eurasian Plate

- **Eastern Boundary**
  - Extends through:
  - Rakinyoma Mountains of Myanmar
  - Includes a spreading site east of Australia in the Southwest Pacific.

- **Western Boundary**
  - Follows:
  - Kirthar Mountains of Pakistan
  - Connects with the spreading site from the Red Sea Rift through the Chagos Archipelago.

- **Southern Boundary**
  - Boundary between Indian Plate and Antarctic Plate.
  - Marked by an oceanic ridge (divergent boundary).

1.	**Journey of the Indian Plate** • India was once a large island near Australia. • It was separated from Asia by the **Tethys Sea**. • About **200 million years ago**, India started moving northward after the breakup of Pangaea. Around **40–50 million years ago**, India collided with Asia
2.	**Formation of the Himalayas** • Collision of Indian Plate and Eurasian Plate caused uplift of the Himalayas. Scientists believe the Himalayas are still rising today
3.	**Position of India in the Past** • About **140 million years ago**, India was located near **50° South latitude**. • The Tethys Sea separated India from Asia.
4.	**Formation of Deccan Traps** • During the northward movement of India: • Massive lava eruptions occurred. • This led to the formation of the **Deccan Traps**. • The eruptions started around **60 million years ago**.

Key points

- *The Indian Plate moved northward over millions of years.*
- *Its collision with Eurasia formed the Himalayas and changed the geography of Asia.*

SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. Alfred Wegener, a German meteorologist, put forward a comprehensive argument for continental drift in 1912. This was known as the:
A. Plate Tectonics Theory
B. Seafloor Spreading Theory
C. Continental Drift Theory
D. Convection Current Theory

2. Gold-bearing placer deposits occur abundantly along the coast of Ghana (West Africa), yet their absolute source rocks are completely absent there. These source gold veins are found across the Atlantic Ocean in:
A. Madagascar B. Brazil C. Australia D. Antarctica

3. What force did Alfred Wegener suggest was responsible for the equator-ward movement of the drifting continents?
A. Tidal Force
B. Convectional Currents
C. Pole-fleeing Force (due to Earth's rotation)
D. Geomagnetic Reversal Force

4. In the 1930s, Arthur Holmes discussed the possibility of a mechanism operating in the mantle to explain the movement of continents. This mechanism was based on:
A. Gravitational Plucking
B. Convection Currents
C. Tidal Drag
D. Solar Winds

5. Why are the rocks of the oceanic crust significantly younger than those of the continental crust?
A. Continental rocks are constantly buried by deep wind deposits.
B. Oceanic crust is continuously sinking into trenches and getting consumed, while new crust forms at mid-oceanic ridges.
C. Oceanic basins are free from any volcanic activity.
D. Tidal forces melt the ocean floor every few million years.

6. The conceptual model formulated by Harry Hess in 1961 to explain volcanic activity and magnetic stripes along mid-oceanic ridges is known as:
A. Continental Drift
B. Seafloor Spreading
C. Polar Wandering
D. Isostatic Adjustment

7. Assertion (A): Mid-oceanic ridges experience frequent, shallow-focus earthquakes and active volcanic eruptions.
Reason (R): These ridges represent divergent plate boundaries where magma constantly rises from the mantle to form new oceanic crust.
Options:
A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
B. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).
C. (A) is true, but (R) is false.
D. (A) is false, but (R) is true.

8. The extensive sedimentary rock layers formed from glacial deposits across the continents of the Southern Hemisphere provide evidence for Gondwanaland's shared climate history. These rocks are known as:

A. Bauxites
B. Tillites
C. Granites
D. Schists

9. What geological event occurred on the Indian landmass during its northward drift toward Asia, resulting in widespread volcanic outpourings?
A. Formation of the Himalayas
B. Formation of the Deccan Traps
C. Subsidence of the Indo-Gangetic Trough
D. Creation of the Andaman Trench

Answers-

1. Answer: C. Continental Drift Theory
2. Answer: B. Brazil
3. Answer: C. Pole-fleeing Force (due to Earth's rotation)
4. Answer: B. Convection Currents
5. Answer: B. Oceanic crust is continuously sinking into trenches and getting consumed, while new crust forms at mid-oceanic ridges.
6. Answer: B. Seafloor Spreading
7. Answer: A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
8. Answer: B. Tillites
9. Answer: B. Formation of the Deccan Traps

SECTION - B (SOURCE BASED QUESTIONS)

10. Read the given text carefully and answer the questions that follow:
"The ocean floor mapping and the palaeomagnetic studies of rocks of oceanic regions revealed some remarkable facts. Along the mid-oceanic ridges, volcanic eruptions are common and they bring huge amounts of lava to the surface in this area. The rocks equidistant on either side of the crest of mid-oceanic ridges show remarkable similarities in terms of period of formation, chemical compositions and magnetic properties. Rocks closer to the mid-oceanic ridges have normal polarity and are the youngest. The age of the rocks increases as one moves away from the crest."

a. What notable feature do rocks located equidistant on either side of a mid-oceanic ridge share?
Answer: Rocks located equidistant on either side of the crest show remarkable similarities in their period of formation, chemical compositions, and magnetic properties.

b. How does the age of oceanic crust rocks change as you move away from the ridge crest toward continental margins?
Answer: The rocks closer to the mid-oceanic ridges are the youngest, and their age increases as one moves further away from the crest toward the margins.

c. Name the theory that utilized these observations as its primary evidence.
Answer: This is the theory of "Seafloor Spreading," proposed by Harry Hess in 1961.

SECTION - C (SHORT ANSWER QUESTIONS)

11. Explain the concept of the 'Jigsaw-Fit' of opposing coastlines along the Atlantic Ocean as evidence for Continental Drift.
Answer: Coastline Symmetry: The shorelines of South America and Africa facing each other display a remarkable and unmistakable structural match.

- Perfect Assembly: This symmetrical alignment led scientists to deduce that the Americas, Europe, and Africa were once joined together as a single landmass.
- Computerized Verification: In 1964, Bullard used a computer program to map the Atlantic margins at the 1,000-fathom line, proving that this continental fit is mathematically near-perfect.

12. Describe how convectional currents are initiated and maintained within the Earth's mantle according to Arthur Holmes.
Answer: Thermal Source: Convection currents are initiated inside the mantle due to intense heat generated by radioactive decay and residual heat trapped deep inside the Earth.

- Current Cycle: This thermal disparity forces hot, softened mantle material to rise to the surface. As it hits the rigid upper boundary, it spreads, cools off, and sinks back into deeper internal depths.
- Maintenance: This repeating heating and cooling loop creates an ongoing circular convective flow that sustains a system of currents across the entire mantle portion.

13. Differentiate between a Divergent Plate Boundary and a Convergent Plate Boundary, providing a real-world geographic example of each.
Answer: Divergent Plate Boundary: This occurs where tectonic plates pull apart from each other, generating a spreading site where rising magma creates new oceanic crust. *Example:* The Mid-Atlantic Ridge, which separates the American plates from the Eurasian and African plates.

- Convergent Plate Boundary: This occurs where tectonic plates collide and push against each other, causing one plate to dive under another into a subduction zone where old crust is destroyed. *Example:* The Himalayan mountain range, which represents continent-continent convergence where the Indian plate meets the Eurasian plate.

SECTION - D (LONG ANSWER QUESTIONS)

14. Provide a detailed summary of the biological and geological evidence supporting Alfred Wegener's Continental Drift Theory.
Answer: Alfred Wegener compiled a robust array of geological and biological clues from separate landmasses to validate his drift theory:

- The Jig-Saw-Fit: The shorelines of West Africa and eastern South America showcase a striking geological match, indicating they were once locked together like puzzle pieces.
- Identical Rock Belts Across Oceans: Radiometric dating correlates ancient rocks across the vast Atlantic Ocean. For instance, a 2,000-million-year-old belt of ancient rocks on the Brazilian coast perfectly matches the rock assemblies found in western Africa. Furthermore, early marine deposits on both coasts belong to the Jurassic age, proving that the intervening ocean did not exist before that timeline.
- Glacial Tillite Deposits: Tillite is a sedimentary rock left behind by ancient glaciers. Thick tillite sequences at the base of the Gondwana system in India are identically shared by six distinct landmasses in the Southern Hemisphere: Africa, the Falkland

Islands, Madagascar, Antarctica, and Australia. This proves these distant lands shared an identical palaeoclimate and location.

- Ghana's Placer Deposits: The Ghana coast holds rich placer deposits of gold despite having absolute zero source rock inside the entire region. The original gold-bearing parent veins sit across the ocean in the Brazilian plateau, confirming the two landmasses lay side-by-side when the gold eroded.
- Fossil Distribution: Skeletons of the Mesosaurus, a small reptile adapted to shallow brackish water, are uniquely discovered in only two spots worldwide: the Southern Cape province of South Africa and the Iraver formations of Brazil—which are today separated by a 4,800 km wide marine ocean. Similarly, identical occurrences of Lemurs across India, Madagascar, and Africa led scientists to infer a contiguous ancestral landmass named "Lemuria" linking them.

15. Discuss Harry Hess's theory of Seafloor Spreading. Explain how volcanic activity at mid-oceanic ridges and consumption at deep trenches help keep the Earth's total surface area constant.
Answer: The Concept of Spreading: Harry Hess proposed his landmark hypothesis in 1961, building upon detailed post-war ocean floor mapping and palaeomagnetic discoveries. Hess argued that continuous volcanic eruptions take place all along the central crests of mid-oceanic ridges. As massive amounts of hot lava reach the ocean floor, they fracture the oceanic crust. This young lava wedges tightly into the fresh crack, physically driving the older oceanic crust outward on both sides.

- Supporting Facts: This mechanism explains why oceanic crust rocks are remarkably young (nowhere exceeding 200 million years old) compared to ancient continental rocks that are up to 3,200 million years old. It also explains why ocean sediments are unexpectedly thin, and why rocks equidistant from the ridge crest share identical age, chemical content, and magnetic polarity.
- The Balancing Mechanism: If the ocean floor is constantly spreading everywhere, the Earth's volume should theoretically expand. To address this issue, Hess explained that the Earth's total surface area remains completely constant because the crust is consumed at the same rate it is produced. While new crust is born at the mid-oceanic ridges, the older, expanding ocean floor gets pushed all the way to the continental margins. There, it plunges down into deep oceanic trenches, sinks into the mantle, and gets fully consumed and melted down. This balanced loop of ridge production and trench destruction keeps the planet's size stable.

16. What is a Tectonic Plate? Name the seven major plates of the Earth's lithosphere and outline their boundaries.
Answer: Definition: A tectonic plate (or lithospheric plate) is a massive, irregularly-shaped slab of solid rock composed of both continental and oceanic lithosphere. These rigid units vary in thickness from 5 to 100 km in oceanic parts up to 200 km in continental regions, and they slide horizontally over the weaker asthenosphere.

- The Seven Major Plates & Their Boundaries: According to plate tectonics, these plates are surrounded by active systems of young fold mountain ridges, deep trenches, and faults:
    1. Antarctic Plate: Comprises Antarctica and its surrounding oceanic plate sections.

2. North American Plate: Includes the North American continent, bounded by the western Atlantic floor up to the Caribbean islands.
3. South American Plate: Includes South America, separated from the northern block near the Caribbean islands, containing the western Atlantic floor.
4. Pacific Plate: A massive, almost entirely oceanic plate occupying the bulk of the Pacific Ocean basin.
5. India-Australia-New Zealand Plate: A complex composite plate bounded north by the Himalayan subduction zone and extending east past the Java Trench.
6. African Plate: Includes the African landmass along with the eastern Atlantic ocean floor.
7. Eurasian Plate: A predominantly continental plate holding the massive European **and Asian landmasses up to adjacent oceanic boundaries.**

17. Trace the geological journey of the Indian Plate from its separation from Gondwanaland to its collision with the Eurasian Plate. Highlight the major landscape changes that resulted from this movement.
Answer: The geological journey of the Indian Plate stands as one of the most dynamic drifting events in history:

- The Island Phase: Initially, India was a large island located off the Australian coast in a vast ocean. Up until about 225 million years ago, a wide sea named the Tethys Sea separated the Indian landmass from the massive Asian continent.
- The Northward Journey: When the supercontinent Pangaea broke apart around 200 million years ago, India separated from the southern Gondwanaland group and began a rapid northward journey. Around 140 million years before the present, the subcontinent was positioned deep in the Southern Hemisphere at roughly 50°S latitude.
- Outpouring of the Deccan Traps: As the Indian plate kept moving north toward the equator around 60 million years ago, it passed over a highly active volcanic region. This triggered an immense outpouring of lava across its surface, creating the extensive volcanic rock formations known today as the Deccan Traps.
- The Asian Collision & Rise of the Himalayas: Around 40 to 50 million years ago, the northward-moving Indian plate collided directly into the solid Eurasian plate. This massive continent-continent convergence squeezed the sediments of the Tethys Sea, resulting in a rapid, dramatic uplift of the Himalayas. This mountain-building process remains active today, causing the height of the Himalayas to rise to this very date.

CHAPTER 5: GEOMORPHIC PROCESS

Introduction to Earth's Dynamic Surface

The Earth’s surface (crust) is not static—it is Dynamic. It has moved and moves vertically and horizontally. It moved a bit faster in the past than the rate at which it is moving now.

Why is the surface of the earth uneven?

The variations in the outer surface of the crust are responsible because of two opposing forces operating continuously:

1. Internal Forces (Endogenic Forces) – Operating from within the earth.
2. External Forces (Exogenic Forces) – Originating within the earth's atmosphere.

1. Endogenic Forces

- Origin: From within the earth.

- Main Role: These are mainly land building forces because they continuously elevate or build up parts of the earth's surface.

2. Exogenic Forces

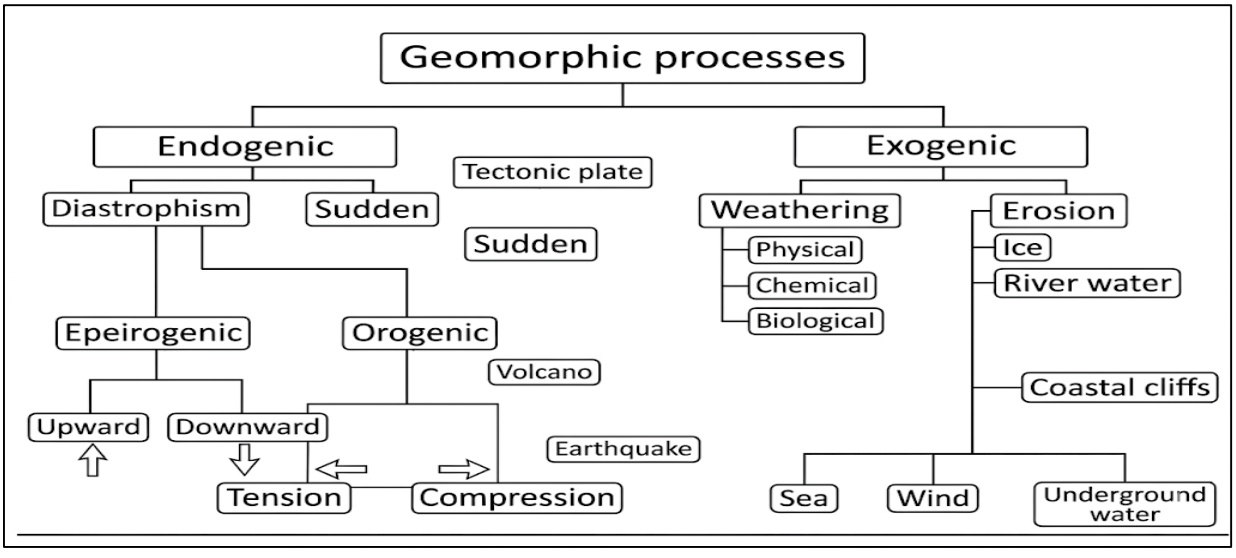
- Origin: Within the earth's atmosphere.
- Induced basically by: Energy (Sunlight).
- Main Role: These are mainly land wearing forces.
  Their actions result in two processes:

  GRADATION: Gradation is the process of leveling the Earth's surface. The phenomenon of wearing down of relief variations of the surface of the earth through erosion is known as Gradation.
  Endogenic Forces (Build Up)↔ Exogenic Forces (Wear Down)
- The endogenic forces continuously elevate or build up parts of the earth's surface.
- Because of this continuous upliftment, the exogenic processes fail to even out the relief variations.
- Therefore, variations remain as long as the opposing actions of exogenic and endogenic forces continue.

Key Definition:
Geomorphic Processes
The endogenic and exogenic forces causing physical stresses and chemical actions on earth materials and bringing about changes in the configuration of the surface of the earth are known as geomorphic processes.

Classification of Geomorphic Processes
A Process: It is a force applied on earth materials affecting the same (e.g., stress, chemical action).

- An Agent: It is a mobile medium (like running water, moving ice masses, wind, waves, and currents) which removes, transports, and deposits earth materials.



THE ROLE OF GRAVITY AND GRADIENTS

The entire mechanism relies on two invisible structural factors: Gravity and Gradients (slopes).

1. Gravity:

Gravity is a directional force activating all downslope movements of matter.

- It causes physical stresses on the earth's materials.
- Indirect Role: Indirect gravitational stresses activate wave and tide-induced currents and winds.
- Gravity is the force keeping us in contact with the surface and switches on the movement of all surface material on earth.

2. Gradients:

All movements—either within the earth or on the surface of the earth—occur due to gradients.

- Matter always moves from higher levels to lower levels, or from high-pressure to low-pressure areas.

The Ultimate Rule: Without gravity and gradients, there would be no mobility. Hence, no erosion, transportation, or deposition would be possible on Earth!

ENDOGENIC PROCESSES

Internal Energy

The energy emanating from within the earth is the main force behind endogenic geomorphic processes. This energy is mostly generated by:

1. Radioactivity
2. Rotational and tidal friction
3. Primordial heat (heat left over from the origin of the earth)

[Internal Energy Sources] ⟶ Geothermal Gradients & Heat Flow ⟶ Induces Diastrophism & Volcanism

Why is the Tectonic Crust Uneven?

The action of endogenic forces is not uniform across the globe. This non-uniformity happens due to variations in three major factors:

- Variations in geothermal gradients
- Variations in heat flow from within
- Variations in crustal thickness and strength

Result: Because these internal forces act differently in different places, the tectonically controlled original crustal surface is inherently uneven.

ENDOGENIC PROCESSES

1. Diastrophism

All processes that move, elevate, or build up portions of the earth's crust come under diastrophism.

The Four Component Processes of Diastrophism:

- Orogenic processes: Involve mountain building through severe folding, affecting long and narrow belts of the earth's crust.
- Epeirogenic processes: Involve the uplift or warping of large parts of the earth's crust.
- Earthquakes: Involve local, relatively minor crustal movements.

- Plate tectonics: Involve the horizontal movements of crustal plates.

Orogeny vs. Epeirogeny (Key Differences)

- Orogeny is a mountain-building process, whereas epeirogeny is a continental-building process.
- During orogeny, the crust is severely deformed into folds, while epeirogeny results in simple deformation (uplift or warping).

Geological Impact:

- Both processes, alongside earthquakes and plate tectonics, cause faulting and fracturing of the crust.
- All of these movements cause Pressure, Volume, and Temperature (PVT) changes, which induce the metamorphism of rocks.

2. Volcanism

- Definition: Volcanism includes the movement of molten rock (magma) onto or toward the earth's surface.
- Forms: It includes the formation of many intrusive (below the surface) and extrusive (on the surface) volcanic forms.

EXOGENIC PROCESSES & THE DYNAMICS OF STRESS

Exogenic processes derive their energy from the atmosphere (determined by ultimate energy from the sun) and the gradients created by tectonic factors.

The Role of Forces and Stress

- Force vs. Stress: Force applied per unit area is called stress. Stress is produced in a solid by pushing or pulling, inducing deformation.
- Gravitational Stress: Gravitational force acts upon all earth materials having a sloping surface, producing a downward movement of matter.
- Shear Stress (Separating Forces): Forces acting along the faces of earth materials are called shear stresses. This is the specific stress that breaks rocks and other materials, resulting in angular displacement or slippage.
- Molecular Stresses: Caused by factors such as temperature changes, crystallization, and melting.
- Chemical Processes: Lead to the loosening of bonds between grains, dissolving soluble minerals, or breaking down cementing materials.

Core Concept: The basic reason that leads to weathering, mass movements, and erosion is the development of stresses within the body of earth materials.

Denudation

All exogenic geomorphic processes are covered under the general term denudation. The word *'denude'* means to strip off or to uncover.

DENUDATION ⟹ Weathering
- ⟹ Mass Wasting / Movements
- ⟹ Erosion
- ⟹ Transportation

3. The Influence of Rock Structure

Climatic factors being equal, the intensity of action depends entirely on the type and structure of rocks.

What does "Rock Structure" include?

- Folds, faults, orientation, and inclination of beds.

- Presence or absence of joints and bedding planes.
- Hardness or softness of constituent minerals.
- Chemical susceptibility of mineral constituents, permeability, or impermeability.

Differential Rates of Erosion:

- Different rocks offer varying resistance to geomorphic processes. A rock may be highly resistant to one process but completely non-resistant to another.
- Under varying climatic conditions, the same rock type may exhibit different degrees of resistance.
- Because they operate at differential rates, they give rise to differences in topography.

WEATHERING

- Definition: Weathering is the mechanical disintegration and chemical decomposition of rocks through the actions of various elements of weather and climate.
- On-Site (In-Situ) Process: It is strictly an on-site process because very little or no motion of materials takes place.
- Controlling Factors: Weathering processes are conditioned by a complex mix of geological, climatic, topographic, and vegetative factors.
- Role of Climate: Climate is the most important factor. It determines both the specific weathering process and the depth of the weathering mantle (the layer of loosened material).

2. The Three Major Groups of Weathering

There are three major groups of weathering processes :
(i) chemical;
(ii) physical or mechanical;
(iii) biological weathering processes.

3. Chemical Weathering Processes

Chemical weathering acts on rocks to decompose, dissolve, or reduce them to a fine clastic state through chemical reactions.

Key Requirements to Speed Up Chemical Reactions:

- Presence of Water and Air (Oxygen and Carbon Dioxide).
- Presence of Heat.
- Underground carbon di oxide Source: The decomposition of plants and animals increases the quantity of carbon dioxide underground, which accelerates these reactions.

Main Chemical Weathering Processes :

- Solution: Soluble minerals dissolve completely when they come into contact with water or weak acids.
- Carbonation: The reaction of carbonate or bicarbonate ions with rock minerals (highly active in breaking down limestone).
- Hydration: The chemical addition of water to minerals, causing the rock material to expand and change its structural form.
- Oxidation: The reaction of rock minerals with oxygen (commonly seen as rusting in iron-rich rocks).

- Reduction: Occurs in environments lacking oxygen (such as waterlogged areas), altering the chemical stability and color of the rocks.

PHYSICAL WEATHERING PROCESSES

Physical (mechanical) weathering processes break down rocks without changing their chemical composition. They depend on specific applied forces that lead to rock fracture.

1. Applied Forces Driving Physical Weathering

- Gravitational forces: Overburden pressure, load, and shearing stress.
- Expansion forces: Due to temperature changes, crystal growth, or animal activity.
- Water pressures: Controlled by wetting and drying cycles.

2. Main Mechanism: Repetitive Fatigue

- Most physical weathering processes are caused by thermal expansion and pressure release.
- These processes are small and slow.

They cause great damage because of continued rock fatigue resulting from repeated cycles of contraction and expansion.

BIOLOGICAL ACTIVITY AND WEATHERING

Biological weathering involves the contribution to or removal of minerals/ions from the weathering environment, as well as physical changes caused by the growth or movement of organisms.

- Burrowing and Wedging: Organisms like earthworms, termites, and rodents expose new surfaces to chemical attack and help moisture and air penetrate.
- Human Activity: Disturbing vegetation, ploughing, and cultivating soils mixes materials and creates new contacts between air, water, and minerals.
- Organic Acids: Decaying plant and animal matter produces humic, carbonic, and other acids, enhancing rock decay and mineral solubility.
- Plant Roots: Growing roots exert tremendous mechanical pressure on earth materials, breaking them apart.

SPECIAL EFFECTS OF WEATHERING

Exfoliation

- Nature: Exfoliation is a result of weathering, not a process itself.
- Mechanism: It is the flaking off of more or less curved sheets or shells from over rocks or bedrock, resulting in smooth and rounded surfaces.
- Causes: It can occur due to expansion and contraction induced by temperature changes.
- Landforms Created:
  - Exfoliation domes result from unloading (pressure release).
  - Tors result from thermal expansion.

SIGNIFICANCE OF WEATHERING

Weathering is vital because it breaks down rocks into smaller fragments and prepares the way for subsequent surface processes:

- Foundation for Erosion and Mass Movements: Erosion cannot be significant if the rocks are not weathered first. Weathering directly aids mass wasting and erosion.
- Soil Formation: Weathering prepares the raw material (regolith) required for soil formation.

- Supporting Biodiversity: Biomes and biodiversity are a result of forests, and forests depend directly on the depth of weathering mantles.
- Economic Value (Ore Enrichment): Weathering helps in the enrichment and concentration of valuable ores (such as iron, manganese, aluminium, and copper), which are of great importance to the national economy.

MASS MOVEMENTS

Mass movements transfer the mass of rock debris down the slopes under the direct influence of gravity.

1. Key Characteristics

- Range: Movements range from slow to rapid, and affect shallow to deep columns of materials.
- Types of Movements: Includes creep, flow, slide, and fall.
- Relationship with Weathering: Weathering is not a pre-requisite for mass movement, though it aids it. Mass movements are far more active over weathered slopes than unweathered materials.
- Resistance: Materials over slopes yield only when the gravitational force becomes greater than the shearing resistance of the materials.

2. Conditions that promote Mass Movements

- Weak, unconsolidated materials or thinly bedded rocks.
- Faults and steeply dipping beds.
- Vertical cliffs or steep slopes.
- Abundant precipitation and torrential rains.
- Scarcity of vegetation.

3. Activating Causes

Mass movements are preceded by several activating causes:

- Removal of support from below through natural or artificial means.
- Increase in gradient (slope angle) and height of slopes.
- Overloading through natural addition of materials or artificial filling.
- Overloading due to heavy rainfall, causing saturation and lubrication of slope materials.
- Removal of material or load from over the original slope surfaces.
- Occurrence of earthquakes, explosions, or machinery vibrations.
- Excessive natural seepage.
- Heavy drawdown of water from lakes, reservoirs, and rivers leading to slow outflow of water from under the slopes or banks.
- Indiscriminate removal of natural vegetation.

4. Three Core Forms of Movements

The structural relationships and types of mass movements depend on their relative rates of movement and moisture limits, taking three primary forms:

LANDSLIDES

Landslides are rapid, perceptible, and relatively dry mass movements.

The size and shape of the detached mass depend on:

1. Discontinuities (cracks/joints) in the rock.

2. Degree of weathering.
3. Steepness of the slope.

Types of Landslides

1. **Slump:** Slipping of rock debris with a backward rotation relative to the slope.

2. **Debris Slide:** Rapid rolling or sliding of earth debris without backward rotation.
3. **Debris Fall:** Nearly a free fall of earth debris from a vertical or overhanging face.
4. **Rockslide:** Extremely fast and destructive sliding of individual rock masses along steeply dipping bedding planes or joints (deep-seated failure).
5. **Rock Fall:** Free falling of rock blocks away from a steep slope, affecting only the superficial (surface) layers.
6. **Mass Movement vs. Mass Wasting:** *Mass Movement* is the preferred term because it accurately describes the physical downward displacement of debris under gravity, whereas *wasting* implies a gradual loss or wearing away.
7. **Solifluction:** It is a slow flowage process (saturated soil oozing over permafrost). Because it is imperceptibly slow, it cannot be classified under rapid flow movements.

I. Erosion and Deposition

Erosion and deposition are continuous, interrelated geomorphic processes that reshape the Earth's surface.

Erosion: The acquisition and transportation of rock debris degraded by weathering.

- Climate-Independent Agents
  - *Waves:* Controlled by coastal location (interface of lithosphere and hydrosphere).
  - *Groundwater:* Controlled by lithology. Permeable, soluble rocks form Karst topography if water is available.

Deposition: A consequence of erosion. When agents lose velocity on gentler slopes, materials settle out.

- Coarser materials settle first; finer ones later.
- It acts as an aggradational process that fills up depression

II. Soil Formation (Pedogenesis)

Soil is a dynamic, evolving body featuring constant chemical, physical, and biological activities that fluctuate with seasons.

The Soil Formation Process

1. Weathering: Creates the basic input mantle.
2. Colonization: Bacteria, mosses, lichens, and minor organisms occupy the mantle.
3. Humus Accumulation: Dead remains of plants and organisms accumulate.
4. Maturation: Plant roots penetrate deep, burrowing animals make it porous, and a mature mixture of mineral and organic products forms.

Five Core Soil-Forming Factors

Soil formation is controlled by the interplay of five distinct factors:

1. Parent Material (Passive)

Soil comes from weathered rock or transported deposits.
Controls soil texture, structure, and minerals.
Young soils resemble their parent rock.

2. Topography (Passive)

Slope affects soil depth and erosion.
Steep slopes → thin soils.
Flat/gentle slopes → thick, fertile soils.

3. Climate (Active)

Rain moves minerals down (eluviation/illuviation).
Heavy rain removes silica/minerals (desilication).
Dry climates → salt crusts (hardpans) or calcium nodules (kanker).
Heat speeds soil formation; cold slows it.

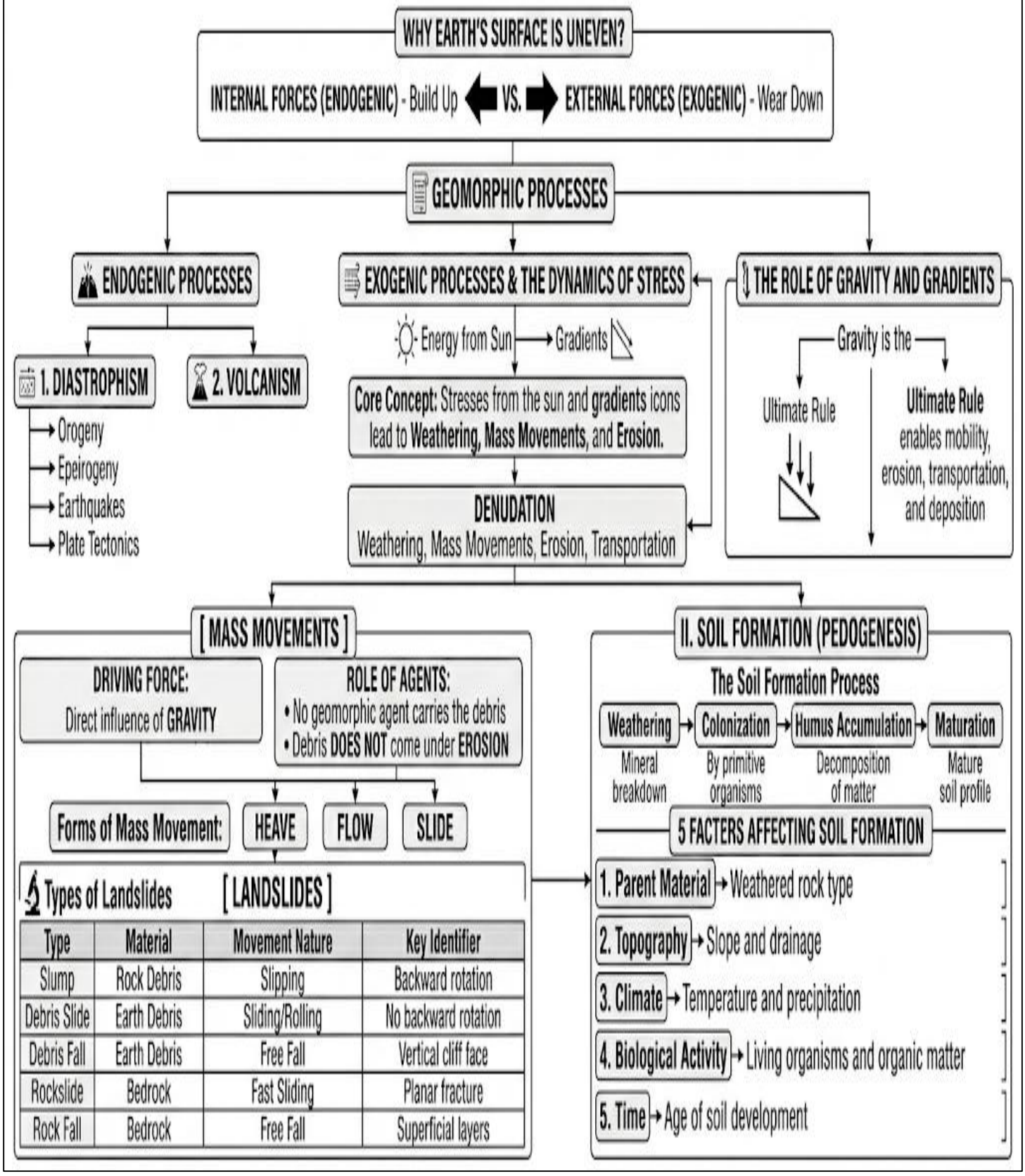
4. Biological Activity (Active)

Plants add humus; bacteria decompose matter.
Cold → peat layers; tropics → low humus.
Nitrogen-fixing bacteria enrich soil.
Animals (worms, ants, rodents) mix soil.

5. Time (Neutral)

Young soils → no clear layers.
Mature soils → distinct horizons after long processes
Based on your provided formatting and structured notes on Chapter: Geomorphic Processes, here is a comprehensive test paper designed exactly to match the pattern, structure, and mark distribution of the

CHAPTER: GEOMORPHIC PROCESSES | INTRODUCTION TO EARTH'S DYNAMIC SURFACE



Type	Material	Movement Nature	Key Identifier
Slump	Rock Debris	Slipping	Backward rotation
Debris Slide	Earth Debris	Sliding/Rolling	No backward rotation
Debris Fall	Earth Debris	Free Fall	Vertical cliff face
Rockslide	Bedrock	Fast Sliding	Planar fracture
Rock Fall	Bedrock	Free Fall	Superficial layers

SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. The phenomenon of leveling the Earth's surface by wearing down relief variations through erosion is known as:

A. Aggradation
B. Degradation
C. Gradation
D. Diastrophism

Answer: C. Gradation

2. Consider the following statements regarding Endogenic and Exogenic forces:
1. Endogenic forces originate from within the earth and act mainly as land-building forces.
2. Exogenic forces are driven basically by solar energy and act as land-wearing forces.
Which of the statements given above is/are correct?

A. 1 only
B. 2 only
C. Both 1 and 2
D. Neither 1 nor 2

Answer: C. Both 1 and 2

3. Match Column-I with Column-II and select the correct option
Mass Movements and Their Key Identifiers

Column-I (Mass Movement)	**Column-II (Key Identifier)**
1. Slump	b. Slipping of debris with a backward rotation
2. Debris Slide	c. Rapid rolling of earth debris without rotation
3. Rock Fall	a. Free fall affecting superficial surface layers only

Answer: 1-b, 2-c, 3-a

4. **Assertion (A):** Weathering is strictly considered an on-site (in-situ) geomorphic process.
Reason (R): Weathering involves mechanical disintegration and chemical decomposition where very little or no motion of materials takes place.
Options:

A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
B. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).
C. (A) is true, but (R) is false.
D. (A) is false, but (R) is true.

Answer: A. Both (A) and (R) are true, and (R) is the correct explanation of (A).

5. Which of the following is considered a PASSIVE factor in the process of Pedogenesis (soil formation)?

A. Climate
B. Biological Activity
C. Topography
D. Time

Answer: C. Topography

SECTION - B (SOURCE BASED QUESTION)

6. Read the given passage carefully and answer the questions that follow: > "The entire mechanism of exogenic geomorphic processes relies on two invisible structural factors: Gravity and Gradients. Gravity is a directional force activating all downslope movements of matter, causing physical stresses on earth materials. Indirectly,

gravitational stresses activate wave, tide-induced currents, and winds. On the other hand, all movements—either within the earth or on its surface—occur due to gradients. Matter always moves from higher levels to lower levels, or from high-pressure to low-pressure areas. The ultimate rule remains: without gravity and gradients, there would be no mobility, and hence no erosion, transportation, or deposition would be possible on Earth."

a. Explain why gravity is termed a "directional force" in geomorphic processes.
Answer: Gravity is called a directional force because it acts directly upon earth materials to activate all downslope movements of matter toward a lower point.

b. ii. Give an example of how gravity plays an indirect role in activating exogenic forces.
Answer: Indirectly, gravitational stresses activate wave and tide-induced currents as well as surface winds within the earth's atmosphere.

c. iii. State the "Ultimate Rule" regarding mobility on the Earth's surface if gradients were completely absent.
Answer: The ultimate rule states that without gradients and gravity, there would be no mobility of matter, meaning that no erosion, transportation, or deposition would be possible on Earth.

SECTION - C (SHORT ANSWER QUESTIONS)

7. Distinguish clearly between Orogenic processes and Epeirogenic processes under Diastrophism.
Answer: Orogenic Processes: This is a mountain-building process involving severe folding and deforming of long, narrow belts of the earth's crust.
Epeirogenic Processes: This is a continental-building process involving simple deformation, uplift, or upward/downward warping of large regional parts of the earth's crust.

8. "The basic reason that leads to weathering, mass movements, and erosion is the development of stresses within the body of earth materials." Justify this statement by explaining the types of stresses involved.
Answer: Stresses break down and deform earth materials. The main types involved are:
Shear Stresses: Separating forces acting along the faces of materials, leading to rock fracture, angular displacement, or slippage.
Gravitational Stresses: Direct downward pulling or pushing forces operating on slopes.
Molecular Stresses: Internal forces caused by factors like temperature changes, crystal growth, or wetting/drying cycles.

9. Identify and explain any three conditions that actively promote rapid Mass Movements along hillslopes.
Answer: Rapid mass movements along hillsides are actively promoted by:

1. **Abundant Precipitation:** Torrential rains and water logging fill the pores, causing saturation and lubrication of slope materials.
2. **Steep Slopes or Vertical Cliffs:** Increase in the gradient and height of slopes under the direct pull of gravity.
3. **Scarcity of Vegetation:** Indiscriminate removal of natural vegetation decreases the binding capability of the ground, making slopes weak and unstable.

SECTION - D (LONG ANSWER QUESTIONS)

10. Draw a comparative analysis between Endogenic and Exogenic forces. Why does the surface of the Earth remain permanently uneven despite continuous land-wearing exogenic actions?
Answer: Comparative Analysis

Feature	Endogenic Forces	Exogenic Forces
Source of Energy	Driven by radioactivity, rotational friction, tidal friction, and primordial internal heat.	Driven by atmospheric elements determined by solar energy and gravity.
Primary Action	Act continuously to elevate, warp, or build up portions of the crust.	Act continuously to wear down elevations (degradation) and fill up depressions (aggradation).
Nature of Processes	Land-building forces (e.g., Diastrophism, Volcanism).	Land-wearing forces (e.g., Weathering, Mass Wasting, Erosion).

11. What is Weathering? Discuss the significance of weathering in terms of soil formation, biodiversity support, and economic ore enrichment.
Answer: Definition: Weathering is the mechanical disintegration and chemical decomposition of rocks through the on-site (*in-situ*) action of various elements of weather and climate.
Significance of Weathering

- **Soil Formation (Pedogenesis):** Weathering processes break down solid rocks into smaller loose fragments, preparing a weathering mantle or regolith. This weathered mantle is the absolute basic input required for soil profile formation and maturity.
- **Biodiversity Support:** Whole biomes and biological ecosystems across the earth depend directly upon forests and vegetation covers. These complex plant structures can only flourish if there is an adequate depth of weathered materials to anchor their roots and supply nutrients.
- **Economic Ore Enrichment:** Weathering helps in the structural concentration and chemical enrichment of valuable national minerals and ores like iron, manganese, copper, and aluminum. When rocks undergo weathering, chemical and physical leaching removes soluble elements via groundwater, thereby increasing the remaining concentration of these valuable elements to an economically viable mining level.

12. Explain how Soil Formation (Pedogenesis) works as a dynamic process. Analyze how Parent Material and Climate control the characteristics of a mature soil profile.
Answer: * **Dynamic Nature of Pedogenesis:** Soil formation is a highly active and evolving sequence. First, the raw weathered rock mantle or transported sediment is colonized by simple organisms like bacteria, mosses, and lichens. Organic matter increases over seasons as organic components decompose, generating humic acids that help accumulate humus. Burrowing animals and expanding plant roots turn this mass into a porous, sponge-like structure capable of holding air and water, leading to a mature soil profile.

Control of Parent Material and Climate

Parent Material (Passive Control): Parent material acts as a passive background guide. It dictates the basic texture (debris size), mineralogy, structural alignment, and chemical composition of the young soil. The rock's vulnerability determines the depth and rate of weathering of the mantle. Young or immature soils show exceptionally strong links with their parent bedrocks.

Climate (Active Control): Climate is the primary active master factor controlling pedogenesis through moisture (precipitation) and temperature.

- *Moisture and Precipitation:* Excess water promotes chemical actions and drives **eluviation** (downward transport of components) and **illuviation** (deposition in lower layers). In hot, wet equatorial areas, high rainfall triggers **desilication** by leaching away silica and basic minerals. In arid regions, high evaporation forces groundwater to rise via capillary action, leaving salt crusts called **hardpans**.
- *Temperature:* Controls chemical reactions and the pace of biological decomposition. Warm tropical climates create deep, thick soil profiles due to accelerated chemical reactions. In sub-arctic frozen tundras, slow bacterial activity causes organic matter to collect in thick layers of **peat**, leaving the rest of the soil to consist mostly of mechanically fractured fragments.

OR

What are Landslides? Detail the key structural differences, material types, and movement natures of Slumps, Debris Slides, and Rockslides.

Answer: Definition of Landslides: Landslides are rapid, highly perceptible downslope movements of relatively dry blocks of rock mass or earth debris under the direct force of gravity.

Key Distinctions between Slumps, Debris Slides, and Rockslides

Type of Landslide	Material Involved	Nature of Movement	Key Structural Difference
Slump	Regolith or loose earth debris.	Slipping of one or several units over a curved surface.	Characterized by a distinct **backward rotation** of the moving mass relative to the slope.
Debris Slide	Loose earth debris and un-consolidated materials.	Rapid rolling or sliding downward.	The mass slides forward as a planar failure **without any backward rotation**.
Rockslide	Massive individual bedrock or jointed rock blocks.	Slips rapidly down pre-existing structural lines.	Moves along deep-seated structural defects like **bedding planes, joints, or fault surfaces** that dip steeply; very fast and destructive.

CHAPTER 6: LANDFORMS AND THEIR EVOLUTION

- **Landforms & Landscapes:** Small to medium parcels of the Earth's surface with distinct shapes and sizes are called landforms, which together combine to make up larger landscapes.
- **Origin:** Each landform is created by the slow, long-term actions of specific geomorphic processes and agents (like running water, wind, or glaciers) performing erosion and deposition.

- **Evolution:** Landform evolution is the transformation of a landform over time, meaning every landform has a distinct developmental history.
- **Modifications:** Changes in climatic conditions or vertical and horizontal tectonic movements can alter the intensity of geomorphic processes, leading to newly modified landforms.
- **Life Stages:** A developing landmass passes through sequential evolutionary stages that are comparable to the stages of human life: youth, maturity, and old age.

EROSIONAL LANDFORMS BY RUNNING WATER

Running water carves out distinct structural depressions on the land surface over time.

1. Valleys

Valleys undergo a structural development process expanding from minor surface irregularities into major drainage networks:

"Rills (Small & Narrow) → Gullies (Long & Wide) → Valleys (Deepened & Widened)"

Gorge: A deep valley with very steep to straight, uniform sides. It is almost equal in width at its top as well as its bottom, typically forming in hard rocks.

Canyon: Characterized by steep, step-like side slopes. Unlike a gorge, a canyon is wider at its top than at its bottom and commonly forms in horizontally bedded sedimentary rocks.

2. Potholes and Plunge Pools

Potholes: More or less circular depressions formed over rocky stream beds due to stream erosion aided by the abrasion of grinding rock fragments.

Plunge Pools: Large, deep, and wide holes formed at the foot of waterfalls. They result from the sheer impact of falling water and the rotational grinding of boulders.

3. Incised or Entrenched Meanders

In rapid streams flowing over steep gradients, erosion cuts vertically into the bottom of the channel rather than laterally.

However, very deep and wide loops can be cut directly into hard bedrock. These are called **incised or entrenched meanders**, showing structural loops deep within the rock substrate.

4. River Terraces

Definition: Surfaces marking old valley floors or former floodplain levels.

Origin: They are products of erosion resulting from a river cutting vertically into its own depositional floodplain.

Paired Terraces: Terraces that occur at the exact same elevation on either side of the river channel.

DEPOSITIONAL LANDFORMS BY RUNNING WATER

When a river loses velocity due to gentler gradients, it unloads its sediment budget to construct distinct depositional features.

1. Alluvial Fans

Formed when mountain streams break onto foot-slope plains of low gradient.

The coarse load becomes too heavy to transport and unloads as a broad, cone-shaped deposit.

Streams shift positions across the fan, breaking into multiple unconfined channels called **distributaries**.

- *Humid Climates:* Low cones with gentle slopes from head to toe.
- *Arid/Semi-Arid Climates:* High cones featuring steep slopes.

2. Deltas

Similar to alluvial fans but develop at the mouth of the river where it meets the sea. Unlike fans, delta deposits are very well-sorted with clear stratification. Coarsest materials settle out first near the coast, while fine silts and clays carry further into the sea.

3. Floodplains, Natural Levees, and Point Bars

Floodplain: A major landform of river deposition. Fine sand, silt, and clay are deposited over the active bed or spill over the banks during flood events.

Active Floodplain: The river bed composed of active river deposits.

- *Inactive Floodplain:* Land above the banks built by shifted channels containing flood and channel deposits.

Natural Levees: Low, linear, parallel ridges of coarse deposits found directly along the banks of large rivers.

Point Bars (Meander Bars): Sediment deposited in a linear fashion along the **concave** (inside) side of meanders in large rivers.

4. Meanders

Meander is a channel pattern, not an independent landform, developing due to three factors:

1. The propensity of water moving over low gradients to work laterally on banks.
2. Unconsolidated alluvial bank deposits with irregularities.
3. The deflection of fluid water by the **Coriolis force**.

Mechanism: Water erodes the outside bank (**concave/cut-off bank**), forming a steep scarp, and deposits sediment on the inside bank (**convex bank**). Deep loops eventually cut off at inflection points, leaving abandoned water bodies called **ox-bow lakes**.

GROUNDWATER AND KARST TOPOGRAPHY

In regions rich in calcium carbonate (limestone or dolomite), surface and groundwater chemically react through **solution and precipitation** to form **Karst Topography**.

1. Erosional Karst Landforms

1. **Sinkholes:** Circular surface openings that are funnel-shaped at the bottom, varying from under a meter to over thirty meters deep.
2. *Solution Sinks:* Formed solely through chemical solution action.
3. *Collapse Sinks (Dolines):* Formed when the roof of an underground cave collapse void gives way.
4. **Uvalas (Valley Sinks):** Long, narrow-to-wide trenches formed when individual sinkholes or dolines join due to margin slumping or roof collapses.
5. **Lapies & Limestone Pavements:** Highly irregular, maze-like surfaces of grooves, ridges, and points formed by differential solution activity along rock joints. These can eventually smooth down into limestone pavements.
6. **Caves:** Long, narrow-to-wide underground gaps formed where water percolates through joints and horizontally dissolves thick limestone beds. Caves with openings at both ends are called **tunnels**.

2. Depositional Karst Landforms

Formed inside caves when mineral-saturated water evaporates, releasing its carbon dioxide and precipitating calcium carbonate.

1. **Stalactites:** Icicle-like forms hanging from the cave ceiling, broad at the base and tapering downward.
2. **Stalagmites:** Columns or discs rising up from the cave floor, formed by water dripping from above.
3. **Pillars:** Columns formed when a hanging stalactite and a rising stalagmite fuse together.

GLACIERS

Glaciers are large masses of ice moving slowly down slopes over land due to the force of gravity.

1. Erosional Glacial Landforms

1. **Cirque:** Deep, long, wide troughs or basins with steep, vertically dropping walls at their heads and sides. After the ice melts, these basins often hold water, forming **cirque or tarn lakes**.
2. **Horns:** High, sharp-pointed, steep-sided mountain peaks formed when three or more radiating glaciers erode headward until their cirques meet (e.g., Mount Everest).
3. **Arêtes:** Narrow, sharp, saw-toothed or serrated ridges that form the divides between cirque walls.
4. **Glacial Valleys (Troughs):** Trough-like, **U-shaped valleys** featuring broad floors and smooth, steep sides. Deep glacial troughs filled with seawater in high latitudes are known as **fjords**.

2. Depositional Glacial Landforms

1. **Glacial Till:** Unassorted, unstratified, angular coarse and fine rock debris dropped directly by melting ice.
2. **Outwash Deposits:** Assorted, roughly stratified, and rounded debris washed down and deposited by meltwater streams beyond the glacier.
3. **Moraines:** Long ridges of deposited glacial till.

a. *Terminal Moraines:* Ridges deposited at the toe (end) of a glacier.
b. *Lateral Moraines:* Ridges formed parallel along the sides of glacial valleys.
c. *Medial Moraines:* Ridges formed in the center of a valley where lateral moraines meet.
d. *Ground Moraines:* An irregular sheet of till left over valley floors by rapidly retreating glaciers.

4. **Eskers:** Sinuous ridges formed when rough gravel and boulders settle within the channels of meltwater streams flowing beneath the ice.
5. **Outwash Plains:** Broad, flat plains beyond the glacier limits, made of joined glacio-fluvial alluvial fans.
6. **Drumlins:** Smooth, oval-shaped ridges composed of till, where the long axis runs parallel to ice movement. The glacier-facing end (**stoss end**) is blunter and steeper than the tapered **tail**.

WAVES AND CURRENTS

Coastal landforms develop rapidly due to high-energy wave impact, depending on whether a coast is emerging (low sedimentary) or submerging (high rocky).

1. High Rocky Coasts

Erosion processes dominate along these highly irregular, indented coastlines.

1. **Cliffs & Wave-cut Platforms:** High waves break with force, scouring coastal slopes into steep cliffs. Continued pounding makes cliffs recede, leaving a flat **wave-cut platform** in front.
2. **Sea Caves, Arches & Stacks:** Wave lashing smashes debris against the cliff base, hollows expand into **sea caves**. When cave roofs collapse, isolated resistant rock pillars are left standing in the water as **sea stacks**.
3. **Spits & Lagoons:** Eroded materials travel via longshore currents to form beach ridges or underwater **bars**. A bar tied to a headland is a **spit**. When bars block a bay's entrance, they enclose a body of water called a **lagoon**.

2. Low Sedimentary Coasts

Depositional processes dominate along these smooth, gently sloping plains.

1. **Bars, Barriers, and Spits:** Breaking waves churn bottom sediments easily, constructing linear sand bars parallel to the coast. If exposed above water, they become **barrier bars**.
2. **Beaches and Dunes:** Deposited sand forms temporary **beaches** along the shore. Winds winnow this sand, depositing it just behind the beach as long ridges called **sand dunes**.

WINDS IN HOT DESERTS

Winds drive desert erosion through three distinct processes: **Deflation** (lifting and removing dust), **Abrasion** (sand-blasting surfaces), and **Impact** (sheer momentum force). General mass erosion is assisted by short, torrential **sheet floods**.

1. Erosional Desert Landforms

1. **Pediments & Pediplains:** Gently inclined rocky floors at the foot of mountains formed by lateral stream erosion and sheet floods. Slopes undergo **parallel retreat (backwasting)**, cutting back mountain fronts until they are reduced to low, featureless plains called **pediplains**, leaving isolated mountain remnants called **inselbergs**.
2. **Playas:** Nearly level, shallow desert basins that temporarily fill with water after rains. When the water evaporates, it leaves behind salt-covered surfaces called **alki flats**.
3. **Deflation Hollows & Caves:** Persistent wind blows out weathered mantles to create shallow depressions called **deflation hollows** or deeper **blowouts** which can expand into caves.
4. **Mushroom Rocks:** Rock outcrops where softer bottom layers are worn away faster by wind abrasion, leaving a slender stalk and a broad, polished cap resembling a mushroom.

2. Depositional Desert Landforms (Sand Dunes)

Wind sorts and deposits dry sand against obstacles into distinct types of dunes:

1. **Barchans:** Crescent-shaped dunes with points/wings directing **away** from the wind direction (downwind); forms where wind direction is constant.
2. **Parabolic Dunes:** U-shaped dunes that are reversed barchans, forming when sandy surfaces are partially anchored by vegetation.
3. **Seif:** Similar to a barchan but features only **one wing**, developing when wind conditions shift contextually.
4. **Longitudinal Dunes:** Long ridges of sand that form parallel to the prevailing direction of the wind.

SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. **Which of the following statements best distinguishes between a Gorge and a Canyon?**

A. Gorges are wider at the top than at the bottom, while canyons maintain equal width throughout.
B. Gorges commonly form in horizontally bedded sedimentary rocks, while canyons form in hard rocks.
C. A gorge features steep, step-like side slopes, while a canyon has uniform, straight sides.
D. A gorge is almost equal in width at its top as well as its bottom, whereas a canyon is wider at its top than its bottom.

2. **Large, deep, and wide depressions formed at the foot of waterfalls due to the sheer impact of falling water and the rotational grinding of boulders are termed:**

A. Potholes
B. Tarns
C. Plunge Pools
D. Sinkholes

3. **River terraces that occur at the exact same elevation on either side of a river channel are referred to as:**

A. Unpaired Terraces
B. Non-structural Terraces
C. Paired Terraces
D. Fluvial Terraces

4. **Which of the following options represents a pair of PASSIVE factors controlling landform evolution?**

A. Wind action and Glacial movement
B. Running water and Tectonic movements
C. Rock structure and Topography
D. Climate changes and Coriolis force

5. **Match the types of Sinkholes in Column-I with their corresponding Genesis in Column-II using the options table:**

Column-I (Sinkhole Type)	**Column-II (Genesis)**
1. Solution Sink	a. Formed when the roof of an underground cave void gives way
2. Collapse Sink (Doline)	b. Formed when individual depressions join due to margin slumping
3. Uvala	c. Formed solely through chemical solution action

Options Table:

Option	**1 (Solution Sink)**	**2 (Collapse Sink)**	**3 (Uvala)**
A	a	b	c
B	c	a	b
C	c	b	a
D	b	a	c

6. When a hanging stalactite and a rising stalagmite fuse together inside a limestone cave, they form:

A. Curtain
B. Pillar
C. Doline
D. An Esker

7. High, sharp-pointed, steep-sided mountain peaks formed when three or more radiating glaciers erode headward until their cirque walls meet are called:

A. Arêtes
B. Horns
C. Fjords
D. Drumlins

8. Match the Glacial Moraines in Column-I with their exact Location/Position in Column-II:

Column-I (Moraine Type)	**Column-II (Position/Location)**
1. Terminal Moraine	a. Formed parallel along the sides of glacial valleys
2. Lateral Moraine	b. Formed in the center where two glaciers meet
3. Medial Moraine	c. Deposited at the toe or furthest end of a glacier

Options Table:

Option	**1 (Terminal)**	**2 (Lateral)**	**3 (Medial)**
A	c	a	b
B	a	c	b
C	c	b	a
D	b	a	c

9. Assertion (A): Drumlins are smooth, oval-shaped ridges whose blunt, steeper end faces the direction of glacial ice movement.
Reason (R): The glacier-facing end is called the stoss end, while the tail is long and tapered.
Options:

A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
B. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).
C. (A) is true, but (R) is false.
D. (A) is false, but (R) is true.

10. Gently inclined rocky floors at the foot of mountains in hot deserts formed by lateral stream erosion and sheet floods are called:

A. Playas
B. Pediments
C. Pediplains
D. Inselbergs

11. Crescent-shaped sand dunes whose tips or wings point downwind, away from the prevailing wind direction, are called:

A. Seifs
B. Parabolic Dunes
C. Barchans
D. Longitudinal Dunes

SECTION - B (SOURCE BASED QUESTIONS)

12. Read the given text carefully and answer the questions that follow:

"Meander is a channel pattern, not an independent landform. It develops due to three structural factors: the propensity of water moving over low gradients to work laterally on banks; unconsolidated alluvial bank deposits with irregularities; and the deflection of fluid water by the Coriolis force. The mechanism involves water eroding the outside bank (concave or cut-off bank), forming a steep scarp, and depositing sediment on the inside bank (convex bank). Deep loops eventually cut off at inflection points, leaving abandoned water bodies called ox-bow lakes."

a. Why is a meander classified as a channel pattern rather than an independent landform?

b. Name the primary planetary force responsible for deflecting fluid water to assist meandering.

c. Contrast the geomorphic action occurring at the concave bank with that occurring at the convex bank of a meander loop.

SECTION - C (SHORT ANSWER QUESTIONS)

13. "A developing landmass passes through sequential evolutionary stages comparable to human life." Explain the three life stages of landform evolution.

14. Differentiate between Alluvial Fans and Deltas based on their location, sorting, and stratification of sediments.

15. Describe the three distinct processes through which wind drives erosion in hot deserts. OR Explain how a Mushroom Rock is sculpted in a desert ecosystem, highlighting the differential rates of wind abrasion.

SECTION - D (LONG ANSWER QUESTIONS)

16. Give a comprehensive account of Groundwater erosion in limestone regions. Explain how Lapies, Solution Sinks, and Caves are formed via chemical solution.

17. Discuss the depositional mechanism of Karst topography. Detail the structural differences between Stalactites, Stalagmites, and Pillars with the help of a descriptive sequence.

18. What are Glaciers? Describe the erosional features created by glaciers, focusing on the characteristics of Cirques, Horns, and U-shaped Valleys.

19. Elaborate on the concept of Moraines as glacial depositional features. Differentiate between Terminal, Lateral, Medial, and Ground Moraines.

ANSWER KEY & MARKING SCHEME

SECTION – A

1. **D. A gorge is almost equal in width at its top as well as its bottom, whereas a canyon is wider at its top than its bottom.** (Canyons exhibit step-like slopes and are characterized by a profile where the top width significantly exceeds the bottom width).
2. **C. Plunge Pools** (Large potholes formed at the base of waterfalls via hydraulic plunge and abrasion).
3. **C. Paired Terraces** (Terraces occurring at identical heights on opposite sides point to uniform, rapid vertical rejuvenation).

4. **C. Rock structure and Topography** (Rock type/structure and initial slope are passive variables, whereas geomorphic agents like wind/water are active forces).
5. **B. 1-c, 2-a, 3-b** (Solution sink = chemical dissolve; Collapse sink = roof cave-in; Uvala = compound depression).
6. **B. A Pillar** (Continuous precipitation binds the upper hanging forms and lower ground peaks into columns).
7. **B. Horns** (Formed by the progressive headward retreat of three or more adjacent cirques).
8. **A. 1-c, 2-a, 3-b** (Terminal = toe/snout; Lateral = valley flanks; Medial = central junction line).
9. **A. Both (A) and (R) are true, and (R) is the correct explanation of (A).** (The geometry directly outlines the direction of paleo-ice flows).
10. **B. Pediments** (Low-angle bedrock plains situated right below backing mountain fronts).
11. **C. Barchans** (Classic crescentic dunes with points migrating in the downwind direction).

SECTION - B

12. **Source-Based Analysis:**

a. It is classified as a channel pattern because it describes the progressive path geometry and looping behavior of a single river channel across a valley floor rather than a standalone feature cut or piled out of raw bedrock.

b. The **Coriolis Force**.

c. At the **concave bank**, high-velocity water collides directly to cause **lateral erosion and undercutting** (forming a steep scarp). Conversely, at the **convex bank**, water velocity drops, triggering **sediment deposition** (forming gentle slip-off point bars).

SECTION - C

13. **Stages of Landform Evolution:**
    - **Youthful Stage:** Rivers exhibit steep V-shaped valleys, minimal floodplains, prominent waterfalls, rapids, and intense vertical downcutting.
    - **Mature Stage:** Vertical erosion slows down while lateral erosion expands. Valleys broaden, extensive floodplains emerge, and distinct river meanders start to form.
    - **Old Stage:** The landscape is reduced close to a flat base level (peneplain) with low residual hills (monadnocks). Rivers migrate sluggishly with massive alluvial deposits, common ox-bow lakes, and extensive delta systems.
14. **Alluvial Fans vs. Deltas:**
    - **Location:** Alluvial fans form at mountain breaks where streams transition from high-velocity steep slopes to gentle plains. Deltas form at river mouths where streams enter a standing body of water (oceans/lakes).
    - **Sorting & Stratification:** Alluvial fans contain coarser, poorly sorted debris because of sudden energy drops. Deltas feature fine, highly sorted silts and clays that are well-stratified into distinct top-set, fore-set, and bottom-set layers.
15. **Wind Erosion Processes:**
    - **Deflation:** The lifting and blowing away of dry, loose, fine-grained sand and dust particles by wind currents, lowering the desert floor.
    - **Abrasion:** The sand-blasting mechanism where wind-driven sand grains scratch, gouge, and wear down standing rock structures.

- **Attrition:** The mutual collisions of saltating and rolling sand grains against one another, causing them to break into smaller, rounder fragments.
- **OR (Mushroom Rock Alternative):** Wind abrasion carries the maximum amount of coarse sand particles very close to the ground (usually up to 3 feet). This causes high-intensity abrasion at the lower base of an isolated rock outcrop, while the upper top experiences minimal wear. Over time, the base thins significantly while the top remains wide, carving a mushroom shape.
-

SECTION - D

16. Groundwater Erosion in Karst Regions:

- Underground water mixed with atmospheric carbon dioxide forms weak carbonic acid (H_2CO_3), which chemically dissolves calcium carbonate (CaCO_3) rocks.
- **Lapies:** Formed when surface limestone is unevenly dissolved along joints, leaving a network of sharp, narrow ridges and rough, grooved furrows.
- **Solution Sinks:** Circular or funnel-shaped surface depressions formed where solution action widens structural joints, allowing surface runoff to sink underground.
- **Caves:** Massive underground open voids formed when subterranean streams dissolve along horizontal bedding planes or weaker rock zones over long periods.

17. Depositional Mechanisms & Forms in Karst Topography:

- Calcium-bicarbonate-rich water seeps through cave roofs. When it enters the open cave chamber, evaporation occurs and carbon dioxide escapes, causing calcium carbonate to precipitate.
- **Stalactites:** Slender, icicle-like stone structures that grow downward from the cave ceiling as water drops crystallize.
- **Stalagmites:** Broad, conical mounds that grow upward from the cave floor, formed by water droplets splashing directly from the ceiling.
- **Pillars:** Over time, a downward-growing stalactite and an upward-growing stalagmite align and fuse into a continuous vertical limestone column.

18. Glacial Erosional Features:

- Glaciers are massive blocks of ice moving slowly down mountain slopes under the force of gravity.
- **Cirques:** Deep, bowl-shaped, amphitheater-like depressions carved into mountain walls by plucking and abrasion at the glacier's head. When the ice melts, they often hold water to form tarn lakes.
- **Horns:** Sharp, pyramid-shaped, steep peaks that form when three or more adjacent cirques erode backward toward a central point.
- **U-shaped Valleys:** Glaciers fill old V-shaped river valleys, plucking their floors and scouring their vertical walls. This widens and flattens the valley into a broad, steep-sided U-shape trough.

19. Glacial Moraines:

- Moraines are unstratified, unsorted piles of glacial debris (till) deposited directly by melting ice.
- **Terminal Moraine:** A long ridge of debris deposited across the valley at the furthest snout or toe of the glacier.
- **Lateral Moraine:** Linear ridges of debris deposited parallel along the outer sides of a glacial valley wall.

- **Medial Moraine:** Formed in the middle of a larger valley glacier where two tributary glaciers converge and merge their inner lateral moraines.
- **Ground Moraine:** A widespread, irregular blanket of sediment till dropped directly across the entire valley floor as the glacier retreats.

CHAPTER 7: COMPOSITION AND STRUCTURE OF ATMOSPHERE

COMPOSITION OF THE ATMOSPHERE

The atmosphere is composed of three main components: Gases, Water Vapour, and Dust Particles. The proportion of these components changes significantly in the higher layers.

1. Gases

Altitude Limits: Oxygen becomes almost negligible in quantity at a height of 120 km. Carbon dioxide is found only up to 90 km from the earth's surface.

Carbon Dioxide : Meteorologically vital because it is transparent to incoming solar radiation but opaque to outgoing terrestrial radiation. It absorbs a part of terrestrial radiation, reflects some back to earth, and is largely responsible for the greenhouse effect. Its volume has been rising due to the burning of fossil fuels, increasing air temperatures.

Ozone : Found between 10 and 50 km above the earth's surface. It acts as a filter, absorbing harmful ultra-violet (UV) rays radiating from the sun.

2. Water Vapour

Distribution: A variable gas that decreases with altitude. It also decreases from the equator towards the poles.

Warm, wet tropics: Accounts for up to 4% of the air by volume.

Dry, cold deserts/polar regions: Less than 1% of the air by volume.

Blanket Effect: Absorbs parts of insolation and preserves the earth's radiated heat, preventing the planet from becoming too hot or too cold. It also contributes to air stability and instability.

3. Dust Particles

Sources: Includes sea salts, fine soil, smoke-soot, ash, pollen, and disintegrated particles of meteors.

Distribution: Generally concentrated in the lower layers, though convectional currents transport them to great heights. Dry winds cause higher concentrations in subtropical and temperate regions compared to equatorial and polar zones.

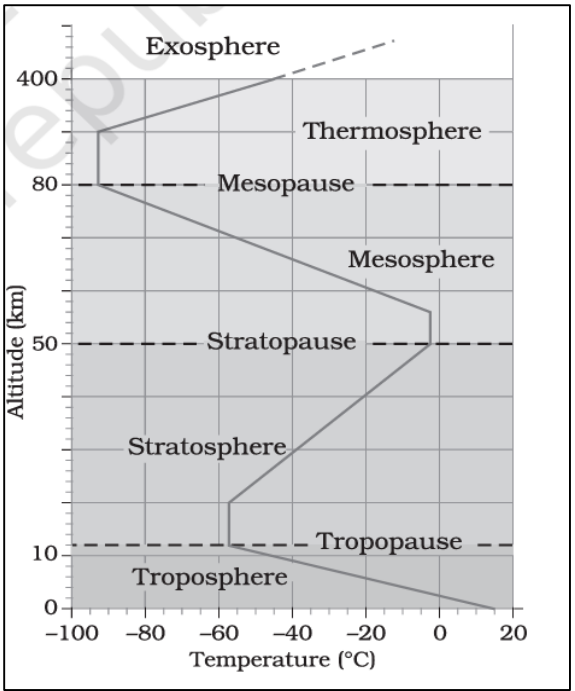
Significance: Dust and salt particles act as hygroscopic nuclei around which water vapour condenses to produce clouds.

STRUCTURE OF THE ATMOSPHERE

The atmosphere consists of different layers with varying density and temperature. Density is highest near the surface and decreases with altitude. The column is divided into five distinct layers based on temperature conditions.

The atmosphere has five layers based on temperature:

1. Troposphere,
2. Stratosphere,



3. Mesosphere,
4. Thermosphere,
5. Exosphere.

Density is highest near Earth's surface and decreases with height.

1. Troposphere

- Lowest layer;
- average height 13 km (8 km at poles, 18 km at equator).
- Contains dust particles and water vapour.
- All weather and climate changes occur here.
- Temperature decreases by 1°C per 165 m rise.
- Most important layer for life and biological activity.
- Upper boundary: Tropopause (temperature nearly constant).
- Temp: –80°C at equator, –45°C at poles.

2. Stratosphere

- Lies above tropopause,
- extends up to 50 km.
- Contains the ozone layer, which absorbs UV radiation and protects life.
- Temperature increases with height due to ozone absorption.
- Ideal for jet aircraft flight (stable air, no weather disturbances).

3. Mesosphere

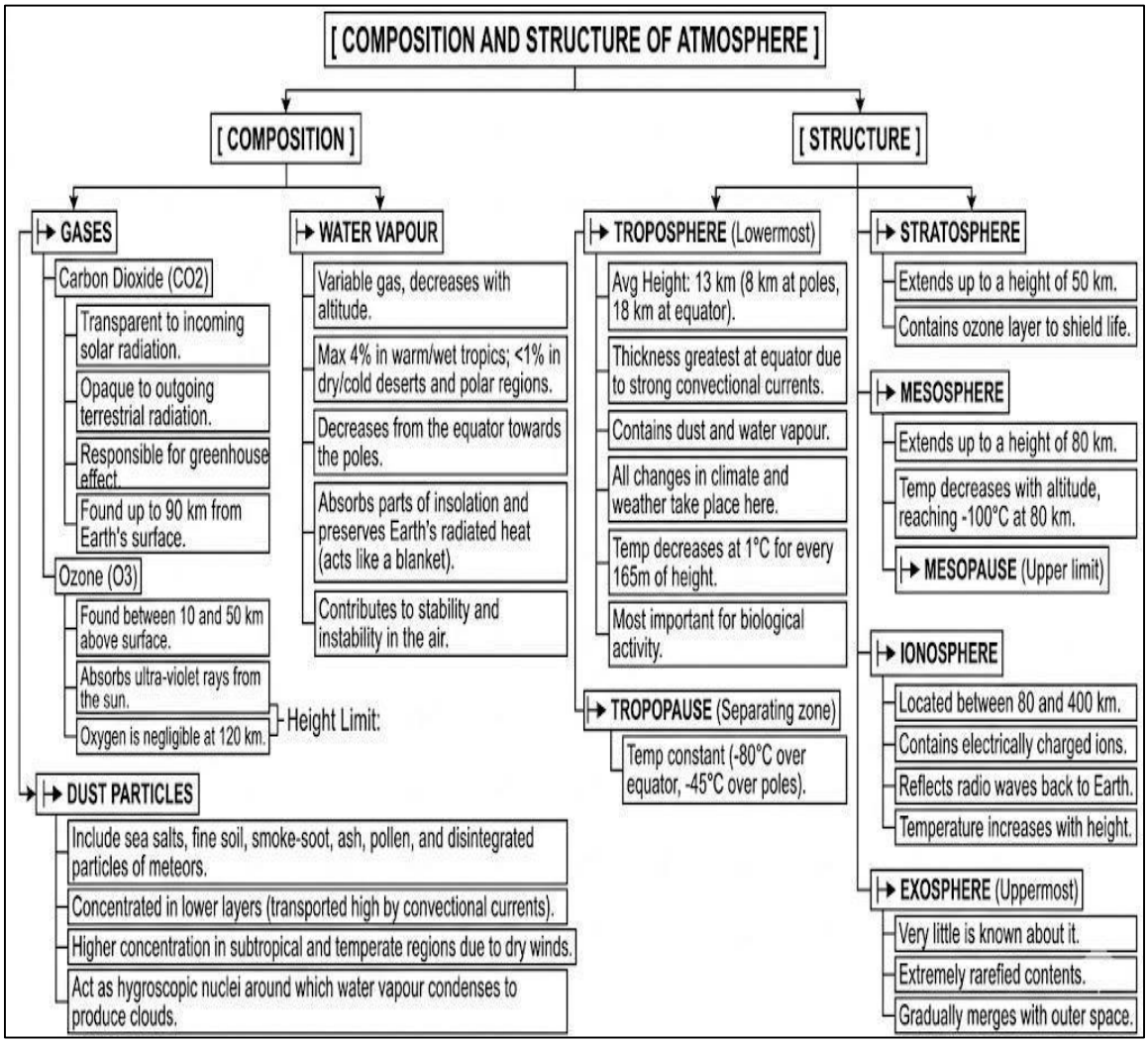
- Extends from 50 km to 80 km.
- Temperature decreases again with altitude, reaching –100°C at 80 km.
- Upper boundary: Mesopause.
- Meteors burn up in this layer due to friction.

4. Thermosphere (Ionosphere)

- Lies between 80–400 km.
- Contains ions (charged particles) → reflects radio waves back to Earth.
- Temperature increases with height.
- Important for radio communication and auroras.

5. Exosphere

- Outermost layer, merges gradually with outer space.
- Contains very rarefied gases (hydrogen, helium).
- Little is known; negligible influence on weather.



SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. **Approximately what percentage of the total mass of the atmosphere is confined within a height of 32 km from the earth's surface?**

A. 50% B. 75% C. 90% D. 99%

2. **At which height above the earth's surface does the quantity of oxygen become almost negligible?**

A. 50 km B. 90 km C. 120 km D. 400 km

3. **Which gas is transparent to incoming solar radiation but completely opaque to outgoing terrestrial radiation, making it primarily responsible for the greenhouse effect?**

A. Oxygen
B. Carbon dioxide
C. Nitrogen
D. Ozone

4. **Why is water vapour considered to act as a "blanket" around the Earth?**

A. It blocks all types of incoming solar rays.
B. It acts as a dynamic layer that generates strong convection currents.
C. It absorbs parts of insolation and preserves the earth's radiated heat.
D. It keeps the atmospheric density uniform throughout all layers.

5. Which layer of the atmosphere contains water vapour and dust particles, and is the exclusive zone where all weather and climate changes occur?

A. Stratosphere
B. Mesosphere
C. Thermosphere
D. Troposphere

6. Q6. What is the standard environmental lapse rate of temperature decrease with height in the troposphere?

A. 1°C per 110 m rise
B. 1°C per 165 m rise
C. 1°C per 320 m rise
D. 1°C per 500 m rise

7. Match the layers of the Atmosphere in Column-I with their corresponding Boundary/Phenomenon in Column-II using the options table:

Column-I (Atmospheric Layer)	Column-II (Key Identifier)
1. Troposphere	a. Upper boundary is the Mesopause where meteors burn up
2. Stratosphere	b. Boundary features the Tropopause where temperature is nearly constant
3. Mesosphere	c. Ideal zone for flying jet aircraft due to high stability

Options Table:

Option	1 (Troposphere)	2 (Stratosphere)	3 (Mesosphere)
A	b	c	a
B	c	b	a
C	a	c	b
D	b	a	c

8. Match the Atmospheric Layers in Column-I with their absolute Vertical Extents in Column-II:

Column-I (Layer)	Column-II (Vertical Height)
1. Stratosphere	a. Extends up to an average height of 13 km
2. Mesosphere	b. Extends from 50 km up to 80 km from earth's surface
3. Troposphere	c. Lies above the tropopause and extends up to 50 km

Options Table:

Option	1 (Stratosphere)	2 (Mesosphere)	3 (Troposphere)
A	a	b	c
B	c	b	a
C	b	a	c
D	c	a	b

9. Which layer contains electrically charged particles (ions) that reflect radio waves back to Earth to facilitate wireless communication?

A. Stratosphere
B. Ionosphere (Thermosphere)
C. Exosphere
D. Mesosphere

10. Which of the following is NOT considered a fundamental, constantly changing element of weather and climate?

A. Nitrogen gas percentage
B. Temperature and Pressure
C. Humidity and Precipitation
D. Clouds and Winds

SECTION - B (SOURCE BASED QUESTIONS)

11. Read the given text carefully and answer the questions that follow:

"Carbon dioxide is meteorologically a very important gas as it is transparent to the incoming solar radiation but opaque to the outgoing terrestrial radiation. It absorbs a part of terrestrial radiation and reflects back a part of it towards the earth's surface. It is largely responsible for the greenhouse effect. The volume of other gases is constant but the volume of carbon dioxide has been rising in the past few decades mainly because of the burning of fossil fuels. This has also increased the temperature of the air."

a. Why is Carbon dioxide considered meteorologically a vital gas for the earth's surface?
b. Explain how the greenhouse effect is created by this gas.
c. What primary human activity has disrupted the balance of carbon dioxide volume in recent decades, and what is its consequence?

SECTION - C (SHORT ANSWER QUESTIONS)

12. What is the composition of the atmosphere? Name the three primary components and mention how their proportion shifts in higher altitudes.

13. Explain the spatial distribution of water vapour in the atmosphere. Why does its presence vary between the warm wet tropics and cold polar regions?

14. "The Stratosphere provides ideal conditions for flying jet aircraft." Validate this statement by giving three structural reasons.

15. Describe the main characteristics and operational significance of the Thermosphere (Ionosphere) in human life.

ANSWER KEY & MARKING SCHEME

SECTION - A

1. **D. 99%** (The atmosphere is compressed near the surface by gravity; 99% of its mass is concentrated within 32 km height).
2. **C. 120 km** (While major gases like nitrogen and oxygen dominate the lower atmosphere, oxygen drops to near-negligible levels by 120 km).
3. **B. Carbon dioxide** (Its selective absorption allows shortwave solar rays through but traps longwave terrestrial energy).
4. **C. It absorbs parts of insolation and preserves the earth's radiated heat.** (By absorbing incoming heat and trapping outgoing thermal energy, it regulates extreme cold and heat).
5. **D. Troposphere** (This dense, turbulent lowest layer contains over 90% of the atmosphere's water vapour and dust particles).
6. **B. 1°C per 165 m rise**
7. **A. 1-b, 2-c, 3-a** (Troposphere ends at the tropopause; Stratosphere is stable for aviation; Mesosphere is capped by the mesopause).
8. **B. 1-c, 2-b, 3-a** (Stratosphere extends to 50 km; Mesosphere spans 50–80 km; Troposphere averages 13 km).
9. **B. Ionosphere (Thermosphere)** (Contains highly charged ions that act as a reflective mirror for long-range radio transmissions).

10. **A. Nitrogen gas percentage** (Nitrogen is a permanent, fixed structural gas; temperature, pressure, wind, and humidity are the variable weather components).

SECTION - B

11. **Source-Based Analysis:**

a. It acts as a primary thermal regulator. It allows shortwave solar energy to heat the Earth but prevents longwave heat from escaping directly into deep space.

b. It absorbs outgoing longwave terrestrial radiation and counter-radiates a significant portion back down to the surface, forming a heat-trapping cycle.

c. The **burning of fossil fuels** is the primary activity disrupting this balance. Its direct consequence is global warming (an ongoing increase in global air temperatures).

SECTION - C

12. **Composition of the Atmosphere:**
    - The atmosphere is a mixture of many gases, water vapour, and dust particles.
    - The three primary constituent categories are **Permanent Gases** (Nitrogen, Oxygen, Argon), **Variable Gases** (Carbon dioxide, Ozone, Water Vapour), and **Solid Particulates** (Aerosols/Dust).
    - Their proportions alter significantly with altitude: water vapour and dust are confined almost entirely within the lowest few kilometres, oxygen becomes negligible at 120 km, and carbon dioxide drops off significantly past 90 km.

13. **Spatial Distribution of Water Vapour:**
    - Water vapour decreases rapidly with altitude, with more than 90% confined below 5 km.
    - Spatially, it decreases from the equator toward the poles.
    - In the **warm, wet tropics**, high insolation and vast oceans drive extreme evaporation, allowing water vapour to account for up to 4% of the air by volume. In **cold, dry polar regions** and deserts, low temperatures limit evaporation and the air's moisture capacity, dropping its volume to less than 1%.

14. **Stratosphere and Jet Aviation:**
    - **Absence of Weather Phenomena:** It is nearly devoid of clouds, water vapour, and convective storms, ensuring clear, unobstructed flight paths.
    - **Horizontal Airflow:** Unlike the turbulent troposphere, air moves horizontally in the stratosphere without heavy vertical updrafts or downdrafts.
    - **High Visibility and Stability:** The dry, stable conditions above the tropopause provide excellent visibility and structural safety for high-speed commercial jet aircraft.

15. **Characteristics of the Thermosphere (Ionosphere):**
    - It is located above the mesosphere, extending between 80 km and 400 km, and experiences a rapid increase in temperature with altitude.
    - It contains electrically charged particles known as **ions**, created by the ionization of gas molecules by solar radiation.
    - **Operational Significance:** It reflects low-frequency radio waves transmitted from the ground back to Earth. This enables long-distance wireless communication, satellite signal propagation, and global telecommunication systems.

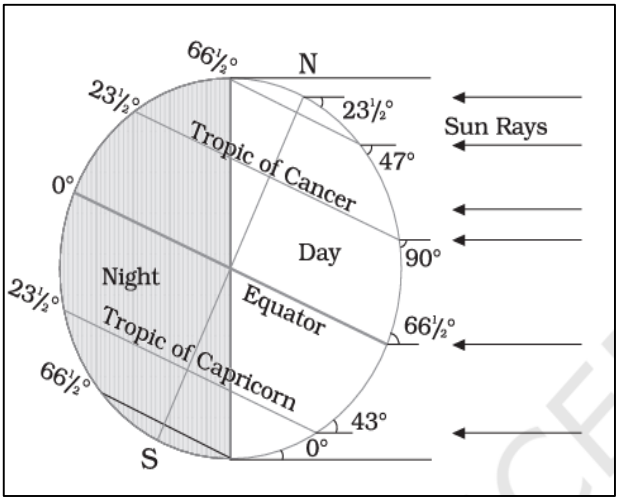
- **Atmosphere**: The Earth is surrounded by an envelope of air called the atmosphere.
- **Energy Source**: The Earth receives almost all of its energy from the Sun.
- **Radiation Balance**:
  - Earth absorbs solar energy.
  - Earth radiates this energy back into space.
  - Because of this balance, Earth neither keeps warming up nor cooling down over time.
- **Unequal Heating:**
  - Different parts of Earth receive different amounts of heat.
  - This causes pressure differences in the atmosphere.
  - Winds transfer heat from one region to another, maintaining balance.

SOLAR RADIATION & INSOLATION

- **Definition:** The energy received by the earth is known as incoming solar radiation, or **insolation**. The earth's surface receives most of its energy in **short wavelengths**.
- **Solar Constant:** On average, the earth intercepts a very small portion of the sun's energy, receiving **1.94 calories per sq. cm per minute** at the top of its atmosphere.
- **Aphelion & Perihelion:** The solar output varies slightly during the year due to the changing distance between the earth and the sun:
- **Aphelion (4th July):** The earth is farthest from the sun (**152 million km**).
- **Perihelion (3rd January):** The earth is nearest to the sun (**147 million km**), receiving slightly more insolation than in July.

Factors Causing Variations in Insolation:

1. The rotation of the earth on its axis.
2. The **angle of inclination of the sun's rays** (depends on latitude; higher latitudes receive slanted rays which spread energy over a larger area and pass through a greater atmospheric depth).
3. The length of the day.
4. The transparency of the atmosphere.
5. The configuration of land in terms of its aspect.
6. *(Note: The earth's axis makes an angle of*



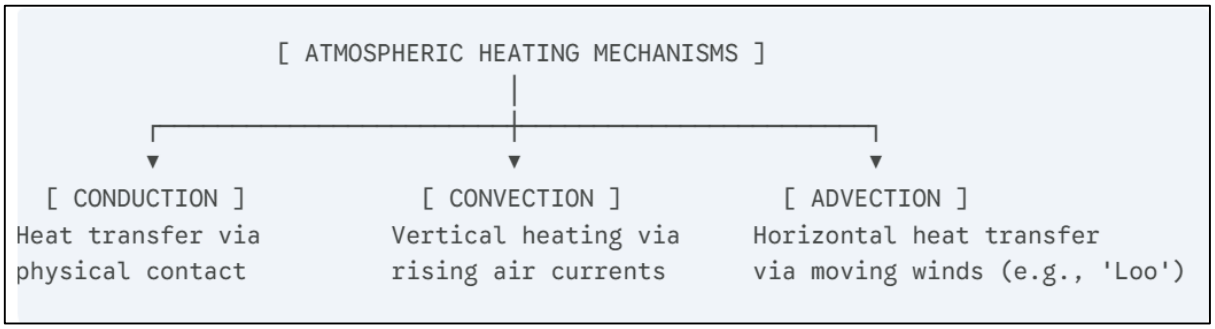
66½° with the plane of its orbit, greatly influencing the insolation received at different latitudes).

Passage of Solar Radiation & Spatial Distribution:

- **Scattering:** Small suspended particles in the troposphere scatter the visible spectrum, causing the **blue colour of the sky** and the **red colour of the rising and setting sun**.
- **Spatial Variations:** Insolation varies from **320 Watt/m²** in the tropics to **70 Watt/m²** at the poles. Maximum insolation is received over **subtropical deserts** (least cloudiness), while the equator receives comparatively less than the tropics. At the same latitude, insolation is greater over continents than over oceans.

HEATING AND COOLING OF THE ATMOSPHERE

There are four distinct primary ways through which the atmosphere is heated and cooled:



- **Conduction:** The transfer of heat when two bodies of unequal temperature are in direct contact; energy flows from the warmer to the cooler body until they reach the same temperature. It heats the lower layers of the atmosphere near the earth's surface.
- **Convection:** The air in contact with the earth rises vertically upon heating in the form of currents, transmitting heat upward. This convective transfer is **confined only to the troposphere**.
- **Advection:** The transfer of heat through the **horizontal movement of air**. Horizontal movement is relatively more important than vertical movement. In middle latitudes, most diurnal weather variations are caused by advection. In northern India during summer, local hot winds called **'loo'** are the outcome of advection.
- **Terrestrial Radiation:** The earth, after being heated by short-wave insolation, becomes a radiating body itself and releases energy back to the atmosphere in the form of **long waves**. This long-wave radiation is absorbed by atmospheric gases like carbon dioxide, heating the atmosphere indirectly from below.

Heat Budget of Earth

Definition:

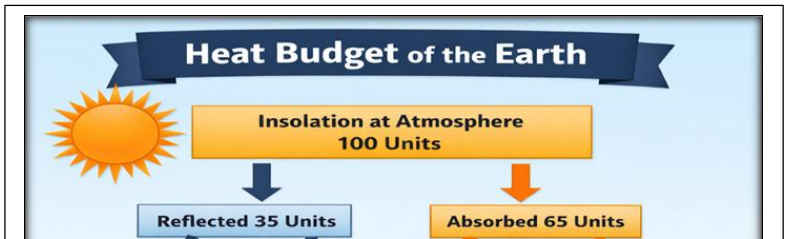
The heat budget (or heat balance) refers to the balance between incoming solar radiation (insolation) and outgoing terrestrial radiation.

Earth maintains a stable temperature because the amount received = the amount lost.

Insolation at top of atmosphere:

- 100 units received.

Reflection (Albedo):



- 35 units reflected back to space.
  - 27 units from clouds.
  - 2 units from snow/ice.
- This reflected radiation = **Earth's albedo**.

Absorption:

- 65 units absorbed.
  - 14 units absorbed by atmosphere.
  - 51 units absorbed by Earth's surface.

Terrestrial Radiation (Earth radiates back):

- 51 units radiated.
  - 17 units directly to space.
  - 34 units absorbed by atmosphere.
  - 6 units absorbed directly.
  - 9 units via convection/turbulence.
  - 19 units via latent heat of condensation.

Atmosphere Radiation:

- Atmosphere absorbs 48 units (14 from insolation + 34 from terrestrial).
- Atmosphere radiates 48 units back to space.

Final Balance:

- Outgoing radiation = 17 (direct) + 48 (atmosphere) = 65 units.
- Incoming radiation = 65 units.
- **Balanced system → Earth neither warms nor cools.**

Variation in Net Heat Budget

Unequal distribution of radiation:

Radiation received at Earth's surface varies by latitude.

Surplus regions:

- Between **40° North and 40° South**.
- These areas receive more incoming radiation than they lose.
- Tropics have a **positive radiation balance**.

Deficit regions:

- Near the poles.
- These areas lose more radiation than they receive.
- Polar regions have a negative radiation balance.

Redistribution of heat:

- Surplus heat from tropics is transferred poleward.
- Prevents tropics from overheating.
- Prevents poles from permanent freezing.
- Achieved through atmospheric circulation (winds) and ocean currents.

Result:

- Global climate stability.
- Maintains balance between tropical surplus and polar deficit.

TEMPERATURE & ITS GLOBAL DISTRIBUTION

While heat represents the molecular movement of particles, **temperature** is the measurement in degrees of how hot or cold a place is.

Factors Controlling Temperature Distribution:

1. **Latitude:** Dictates the amount of insolation received.
2. **Altitude:** The atmosphere is heated from below, so temperature decreases with height. The rate of decrease is called the **normal lapse rate**, which is **6.5°C per 1,000 m**.
3. **Distance from the sea:** Land heats up and cools down quickly, while the sea heats and cools slowly. Maritime locations experience a moderating influence from land and sea breezes.
4. **Air-mass and Ocean currents:** Warm air masses and warm ocean currents (like the Gulf Stream/North Atlantic Drift) raise coastal temperatures, while cold air masses and currents lower them.

Distribution of Temperature (January & July)

Isotherms: Lines joining places of equal temperature.

Latitude Effect: Isotherms generally parallel to latitude.

Northern Hemisphere (January):

- Strong deviations due to landmass & ocean currents.
- Isotherms bend **north over oceans** (warm currents like Gulf Stream, North Atlantic Drift).
- Isotherms bend **south over continents** (Europe, Siberia).
- Example: Along 60°E, temp = –20°C at both 80°N & 50°N.
- Range: Equatorial oceans ~27°C; tropics ~24°C; mid-latitudes ~0–2°C; Eurasian interior –18°C to –48°C.

Southern Hemisphere (January):

- Oceans dominate → isotherms nearly parallel to latitude.
- Gradual variation.
- Isotherms: 20°C ~35°S, 10°C ~45°S, 0°C ~60°S.

July:

- Isotherms mostly parallel to latitude.
- Equatorial oceans >27°C.
- Subtropical Asia (30°N) >30°C.
- 10°C isotherm runs along 40°N and 40°S.

Temperature Range (Jan–July):

- Highest (>60°C) in NE Eurasia → due to continentality.
- Lowest (~3°C) between 20°S and 15°N.

In one line: *Temperature distribution is latitude-controlled, modified by landmass and ocean currents; deviations stronger in January (NH), smoother in SH; range highest in Eurasia, lowest near equator.*

INVERSION OF TEMPERATURE

- **Definition:** A reversal of the normal trend where temperature **increases with increasing altitude** instead of decreasing.

- **Ideal Conditions:** Occurs over short durations during **long winter nights with clear skies and still air**. The day's heat is radiated off rapidly, making the ground and air next to it cooler than the air layers aloft.
- **Polar Regions:** Over polar areas, temperature inversion is a normal phenomenon throughout the entire year.

SECTION - A (MULTIPLE CHOICE QUESTIONS)

1. On an average, the earth intercepts a very small portion of the sun's energy. The solar constant received at the top of the atmosphere is approximately:

A. 1.00 calorie per sq. cm per minute
C. 2.50 calories per sq. cm per minute
B. 1.94 calories per sq. cm per minute
D. 3.00 calories per sq. cm per minute

2. The earth's surface receives most of its energy in short wavelengths. The energy received by the earth is known as:

A. Terrestrial Radiation
C. Insolation
B. Advection
D. Conduction

3. At which position does the earth reach its farthest point from the sun (152 million km) on the 4th of July every year?

A. Perihelion
C. Equinox
B. Aphelion
D. Winter Solstice

4. In middle latitudes, most of the diurnal (day and night) variations in daily weather are caused by which thermal mechanism?

A. Conduction
C. Advection
B. Convection
D. Terrestrial Radiation

5. The process by which the earth's surface transmits heat to the atmospheric layers in contact with it through molecular collisions is called:

A. Insolation
C. Conduction
B. Convection
D. Reflection

6. Out of 100 units of incoming solar radiation, how many total units are reflected back into space directly from the atmosphere, clouds, and snow covers before reaching the Earth's surface?

A. 14 units B. 35 units C. 51 units D. 65 units

7. Match the term in Column-I with its precise definition in Column-II using the options table:

Column-I (Term)	**Column-II (Definition)**
1. Albedo	a. The line joining places having equal temperatures
2. Isotherm	b. The structural difference between the highest and lowest temperatures
3. Range of Temperature	c. The percentage of solar radiation reflected back from a surface

Options Table:

Option	**1 (Albedo)**	**2 (Isotherm)**	**3 (Range of Temperature)**
A	a	b	c
B	c	a	b
C	c	b	a

D	b	a	c

8. Why do coastal areas experience moderate temperatures and a low annual range of temperature compared to continental interiors?

A. Due to high geothermal gradients near coasts.
B. Due to the high specific heat of water and the moderating impact of land and sea breezes.
C. Because coastal areas receive only long-wave terrestrial radiation.
D. Due to low albedo of mountain barriers near shores.

9. A phenomenon where the standard thermal rule is reversed and temperature increases with an increase in altitude is known as:

A. Green House Effect
B. Inversion of Temperature
C. Isothermal Plateau
D. Advectional Warming

10. Assertion (A): Inversion of temperature is a common phenomenon in deep mountain valleys during clear, calm winter nights.
Reason (R): Heavy, cold air produced by nocturnal radiation flows downslope under gravity to accumulate at the valley bottom, pushing warm air upward.
Options:

A. Both (A) and (R) are true, and (R) is the correct explanation of (A).
B. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).
C. (A) is true, but (R) is false.
D. (A) is false, but (R) is true.

11. Why do isotherms bend sharply equatorward when crossing ocean surfaces from a continental landmass during the month of January in the Northern Hemisphere?

A. Continents are warmer than oceans during winter.
B. Oceans are structurally colder than the adjacent land masses in winter.
C. Continents cool down rapidly, making oceans relatively warmer and forcing warm isotherms to bend poleward (northward) over water, while dropping equatorward (southward) over the cold land.
D. High solar reflection over continental snow sheets.

12. The local wind in northern plains of India that causes intense advectional heating during summer afternoons is called:

A. Mistral B. Chinook C. Loo D. Blizzard

SECTION - B (SOURCE BASED QUESTIONS)

13. Read the given text carefully and answer the questions that follow:

"The earth as a whole does not accumulate heat nor does it lose it. It maintains its temperature. This can happen only if the amount of heat received in the form of insolation equals the amount lost by the earth through terrestrial radiation. This equilibrium is called the heat budget of the earth. Suppose the incoming solar radiation at the top of the atmosphere is 100 units. While passing through the atmosphere some amount of energy is reflected, scattered and absorbed. Roughly 35 units are reflected back to space even before reaching the earth's surface. Of these, 27 units are reflected from the top of clouds, 2 units from snow and ice-covered areas, and 6 units from space itself. This reflected amount of radiation is called the albedo of the earth."

a. Define the concept of the Earth's "Heat Budget."
b. What is meant by the term "Albedo of the earth"?

c. Out of the 35 units of solar energy reflected directly back to space, specify the breakdown contributions of clouds, snow covers, and space reflection.

SECTION - C (SHORT ANSWER QUESTIONS)

14. Explain how the atmosphere is heated indirectly by terrestrial radiation rather than directly by incoming short-wave solar radiation.

15. "The latitude of a place directly conditions its temperature profile." Justify this statement with a geographical explanation. OR What is Inversion of Temperature? Explain any two conditions required for its occurrence.

SECTION - D (LONG ANSWER QUESTIONS)

16. Give a comprehensive, balanced account of the Earth's Heat Budget. Detail the distribution of the 100 units of incoming solar radiation through absorption and radiation stages.

17. Discuss the factors that control the global distribution of temperature. Focus your analysis on Latitude, Altitude, Distance from the Sea, and Air Masses.

18. Compare the mechanisms of Conduction, Convection, and Advection. Explain how they work sequentially to heat up the lower layers of our atmosphere.

ANSWER KEY & MARKING SCHEME

SECTION - A

1. **B. 1.94 calories per sq. cm per minute** (This value represents the solar constant received at the top of the atmosphere).
2. **C. Insolation** (Short for *Incoming Solar Radiation*).
3. **B. Aphelion** (Occurs around July 4th; Perihelion occurs around January 3rd when the earth is closest at 147 million km).
4. **C. Advection** (The horizontal transfer of heat via winds is highly dynamic in middle latitudes).
5. **C. Conduction** (The transfer of molecular kinetic energy through direct contact between the warmer surface and the cooler air layer).
6. **B. 35 units** (These 35 units constitute the total planetary albedo).
7. **B. 1-c, 2-a, 3-b** (Albedo = reflection %; Isotherm = equal temperature line; Range = max minus min temperature difference).
8. **B. Due to the high specific heat of water and the moderating impact of land and sea breezes.** (Water heats up and cools down much slower than land).
9. **B. Inversion of Temperature** (A reversal of the normal environmental lapse rate).
10. **A. Both (A) and (R) are true, and (R) is the correct explanation of (A).** (This describes the mechanism of air drainage/catabatic wind inversion).
11. **C. Continents cool down rapidly, making oceans relatively warmer and forcing warm isotherms to bend poleward over water.** (Since the land is colder, an isotherm of a specific value must loop southward/equatorward when moving from ocean to cold continent).
12. **C. Loo** (A dry, hot, dust-laden local wind blowing across northwestern India in May and June).

SECTION - B

13. **Source-Based Analysis:**

a. The Heat Budget is the net thermal equilibrium maintained by the Earth, where the total short-wave insolation intercepted equals the exact amount of long-wave energy radiated back into space.

b. Albedo is the total percentage/fraction of incoming solar radiation reflected back into space from various surfaces without heating the planet or its atmosphere.

c. The exact breakdown is: **27 units** from cloud tops, **2 units** from snow and ice-covered zones, and **6 units** scattered/reflected from space (scattering by air molecules).

SECTION - C

14. **Indirect Atmospheric Heating:**

- The atmosphere is largely transparent to incoming short-wave solar radiation (insolation).
- When this energy reaches the Earth's surface, it heats up the land and water bodies. The heated surface then transforms this energy into long-wave infrared thermal waves, radiating it upward as **terrestrial radiation**.
- Gases in the lower atmosphere (like carbon dioxide, water vapour) easily absorb these long wavelengths. Thus, the atmosphere is warmed from the bottom upward, making it an indirect heating process.

15. **Latitude vs. Temperature:**

- The earth is a geoid, causing the angle of incidence of the sun's rays to vary with latitude.
- At the equator, the sun's rays fall vertically, concentrating immense heat energy over a smaller surface area with less atmospheric obstruction.
- Moving toward the poles, the rays become increasingly oblique. Oblique rays spread across a much larger surface area and pass through a thicker layer of the atmosphere, causing more reflection and absorption, which drops the temperature profile significantly.
- **OR (Inversion Alternative):** Inversion of temperature is a meteorological condition where temperature increases with increasing altitude for a limited height, reversing the normal lapse rate.
- *Conditions required:* (1) **Long winter nights**, so that the loss of heat via nocturnal terrestrial radiation exceeds daytime solar gain. (2) **Clear skies**, which allow terrestrial heat waves to escape unimpeded into space. (3) **Calm, stable air**, preventing vertical mixing of warm and cold layers.

SECTION - D

16. **The Earth's Heat Budget Account:**

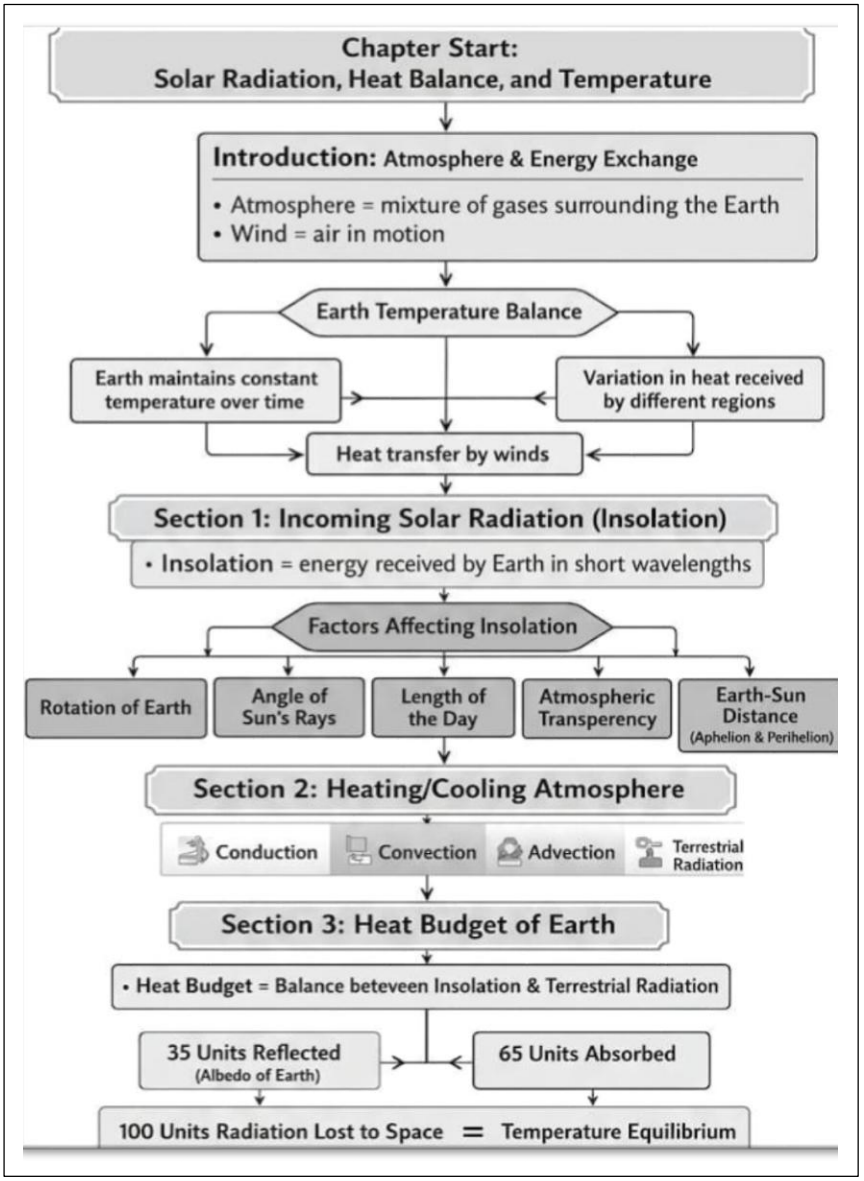
- Let total incoming solar radiation at the top of the atmosphere be **100 units**.
  Loss before reaching the surface (Albedo): 35 units are reflected back instantly (27 from clouds, 2 from ice sheets, 6 scattered by space).
- **Net Remaining Units: 65 units** enter the active balance system.
- **Atmospheric Absorption:** The atmosphere directly absorbs **14 units** out of the 65 within its clouds and gases.
- **Surface Absorption:** The Earth's surface absorbs the remaining **51 units** (via direct and scattered insolation).
- **Terrestrial Radiation (Returning the 51 units):** The Earth radiates back 51 units as long-wave energy: **17 units** escape directly into space, while **34 units** are absorbed by the atmosphere (9 units through conduction/convection, 19 units via latent heat of condensation, and 6 units through direct radiation).
- **Final Release:** The atmosphere eventually radiates its total accumulated **48 units** (14 units original + 34 units from the surface) back into space. Total outgoing units (35 units { albedo} + 17 units { surface} + 48 units { atmosphere} = 100 { units}), keeping the planet's thermal budget in perfect balance.

17. **Factors Controlling Global Temperature:**

- **Latitude:** Dictates the angle of the sun's rays. Low latitudes receive intense vertical insolation (warm), while high latitudes receive weaker oblique rays (cold).
- **Altitude:** The atmosphere is heated from below by terrestrial radiation. Therefore, places at lower elevations are denser and warmer, while places at higher elevations experience lower pressure and colder temperatures (decreasing at 1^0C per 165 meters).
- **Distance from the Sea:** Land heats up and cools down rapidly compared to water. Coastal zones enjoy a marine, moderate climate due to land and sea breezes, whereas continental interiors suffer from extreme seasonal shifts (high annual ranges of temperature).
- **Air Masses:** Warm air masses crossing an area raise its temperature, while cold air masses lower it. Similarly, warm ocean currents warm the coastal air of adjacent land masses, while cold currents induce cooling.

18. **Comparison of Heating Mechanisms:**

- **Conduction:** Occurs when two Bodies of unequal temperature are in direct contact. Heat flows from the warmer earth's surface to the lowermost layer of air resting over it via molecular collision until they match. It is highly local and limited to the immediate bottom-most layer.
- **Convection:** The air heated by conduction expands, becomes less dense, and rises vertically in columns or currents. The cooler, denser air above sinks down to take its place, getting heated in turn. This vertical circulation transfers heat through the troposphere.
- **Advection:** The horizontal Transfer Of heat through the movement of air masses (winds). While conduction and convection are vertical and local, advection spreads heat horizontally over vast distances. In middle latitudes, it is the primary driver of daily weather changes, such as the hot '*Loo*' winds in India during summer.



Chapter 9 ATMOSPHERIC CIRCULATION AND WEATHER SYSTEMS

1. Atmospheric Pressure and Vertical Variation

- **The Concept of Pressure**: Atmospheric pressure represents the total weight of a column of air extending from sea level to the top of the atmosphere. At sea level, the average atmospheric pressure is **1,013.25 mb**, measured using mercury or aneroid barometers.
- **Vertical Decline**: Gravity pulls air molecules closer to the surface, making air denser at sea level. As elevation increases, the air becomes thinned or rarefied. Pressure drops rapidly in the lower atmosphere at an average rate of **1 mb for every 10 meters** of elevation.
- **The Vertical Balance**: While the vertical pressure gradient force pulling air upward is much larger than horizontal gradients, it is perfectly countered by the downward force of gravity. This balance prevents strong, continuous upward vertical winds under normal conditions.

2. Horizontal Distribution and Wind Forces

- **Isobars and Pressure Systems**: Horizontal pressure patterns are mapped using isobars—lines connecting areas of equal atmospheric pressure. To make accurate comparisons across different regions, station pressure measurements are always mathematically reduced to sea level.
    - *Low-Pressure System (Cyclone)*: Enclosed by one or more circular isobars where pressure decreases toward the center.
    - *High-Pressure System (Anticyclone)*: Enclosed by isobars where the highest pressure readings are concentrated at the center.
    - *Elongated Features*: An elongated low-pressure area is termed a **trough**, while an elongated high-pressure region is called a **ridge**.
- **Forces Controlling Wind Velocity and Direction**:
    - **Pressure Gradient Force**: Generated by spatial differences in pressure. The force acts perpendicular to isobars. It is strong where isobars are tightly packed together and weak where they are spread far apart.
    - **Coriolis Force**: A deflective force caused by the Earth's rotation. It deflects moving air to the **right** in the Northern Hemisphere and to the **left** in the Southern Hemisphere. It is directly proportional to wind speed and latitude—reaching its maximum at the poles and becoming completely **absent (zero) at the equator**.
    - **Frictional Force**: Acts as a resistive drag against wind movement near the surface. Its influence extends from the ground up to an altitude of 1–3 km. Friction is minimal over smooth sea surfaces, allowing higher wind speeds.

3. Upper Atmospheric Winds and Circulation Models

- **Geostrophic Wind** In the upper atmosphere (2–3 km above the ground), winds are entirely free from surface friction. When isobars are straight, the **Pressure Gradient Force** pushing air towards lower pressure is perfectly balanced by the opposing **Coriolis Force**. This causes the resulting wind vector (V) to blow completely parallel to the isobars, a phenomenon known as geostrophic flow.
- **Vertical Wind Motion**: Surface wind systems are directly linked to upper-level atmospheric dynamics:

- Over a **Low-Pressure Area**, surface winds **converge** horizontally and are forced to **rise** vertically. This rising air cools, leading to condensation, cloud formation, and precipitation. At the top of the troposphere, this air **diverges**.
- Over a **High-Pressure Area**, air **subsides** (sinks) from the upper atmosphere, causing horizontal **divergence** at the Earth's surface, which generally brings clear, stable weather.

4. General Global Circulation of the Atmosphere

- **Global Pressure Belts** : The world distribution of sea level pressure is arranged in latitudinal zones, which shift southwards during Northern Hemisphere winter (January) and northwards during summer (July) following the sun's apparent path:
  - *Equatorial Low (ITCZ)*: Thermally driven low-pressure belt along the equator.
  - *Subtropical Highs*: Dynamically driven high-pressure belts located around 30° N and 30° S.
  - *Subpolar Lows*: Dynamic low-pressure belts situated along 60° N and 60° S.
  - *Polar Highs*: High-pressure zones centered over the icy poles.
- **The Three-Cell Global Model** : The general circulation of planetary winds relies on a series of continuous loops called atmospheric cells:
  - **Hadley Cell**: Intense solar heating at the **Inter Tropical Convergence Zone (ITCZ)** forces air to rise via convection up to 14 km. This air travels poleward aloft, cools, and sinks around 30° N and S to create the Subtropical Highs. At the surface, this sinking air flows back toward the equator as the **North East** and **South East Trade Winds**.
  - **Ferrel Cell**: In mid-latitudes, air flows poleward along the surface from the subtropical high-pressure zone. These surface winds are deflected to become the **Westerlies**. This warm air meets cold polar air and rises along the subpolar lows (60° N/S).
  - **Polar Cell**: Cold, dense air subsides over the polar highs and moves toward lower latitudes along the surface, forming the **Polar Easterlies**.

5. Localized and Seasonal Wind Systems

- **Land and Sea Breezes** : Driven by the differential heating capacities of land and water:
  - *Sea Breeze (Daytime)*: Land heats up faster than the ocean, creating a localized low-pressure zone over land. The pressure gradient forces cooler, high-pressure air from the sea to blow inland.
  - *Land Breeze (Nighttime)*: Land radiates heat rapidly and becomes colder than the sea, building high pressure over the coast. The wind reverses, blowing from the land out toward the warmer, low-pressure ocean.
- **Mountain and Valley Winds**:
  - During the day, mountain slopes heat rapidly, causing air to rise up the slopes as a **valley breeze**.
  - At night, slopes cool down quickly; the dense, chilled air sinks by gravity into the valley floor as a mountain wind, also known as a cold **katabatic wind**.

6. Air Masses, Frontogenesis, and Cyclones

- **Air Masses**: When air stays over a vast, homogenous surface (like large oceans or polar plains) for an extended time, it takes on that region's temperature and humidity characteristics. They are classified into five source regions: Maritime

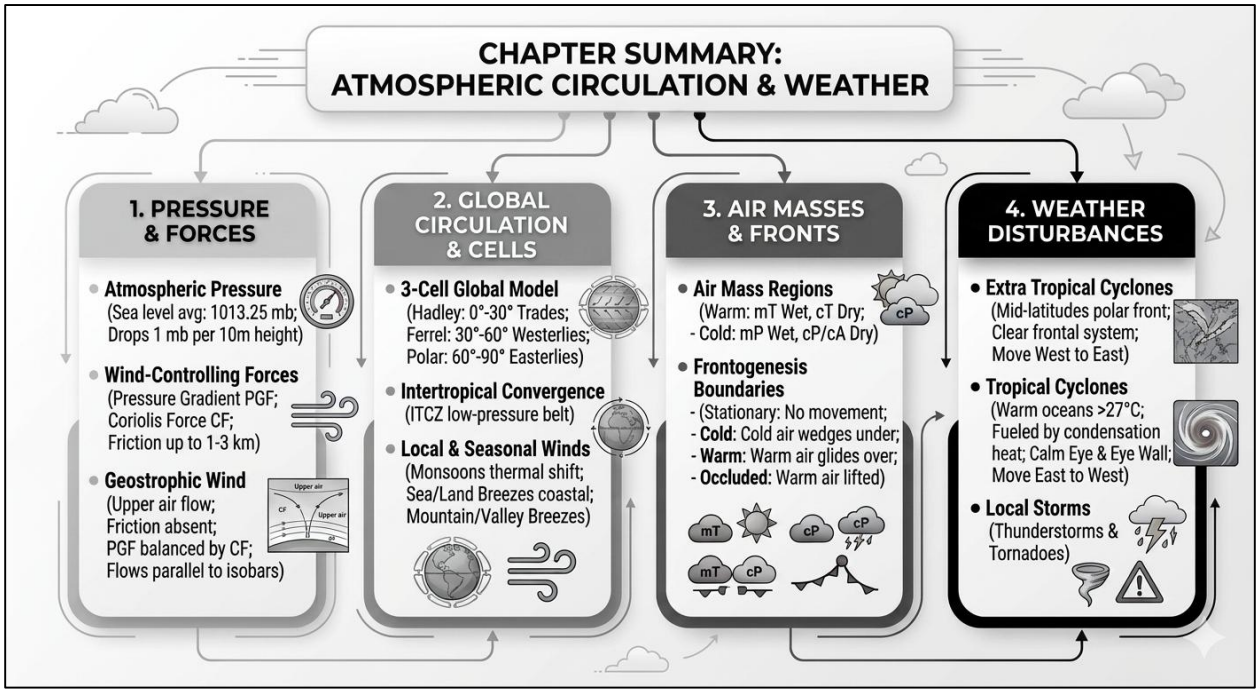
Tropical (mT), Continental Tropical (cT), Maritime Polar (mP), Continental Polar (cP), and Continental Arctic (cA).

- **Frontal Systems** : The boundary zone where two contrasting air masses collide is a front:
    - *Warm Front*: Warm, less dense air actively advances and glides gently up over a colder air mass.
    - *Cold Front*: Dense, cold air aggressively pushes forward, wedging underneath warm air and lifting it sharply.
    - *Occluded Front*: Occurs when a fast-moving cold front completely overtakes a warm front, lifting the warm air entirely off the ground.
- **Extra Tropical Cyclones** : Developing along mid-latitude polar fronts, these systems originate when warm southern air and cold northern air form an anticlockwise circulation around a dropping low-pressure center. A fully developed mid-latitude cyclone features a distinct warm sector wedged between advancing cold and warm fronts, generating systematic cloud bands and prolonged precipitation.
- **Mature Tropical Cyclones** : Violent, low-pressure storms fueled by latent heat from condensation over warm tropical oceans (sea temperatures >27* Celsius
    - *The Eye*: A calm, cloudless central core spanning 150–250 km characterized by gently subsiding warm air.
    - *The Eye Wall*: A ring of towering cumulonimbus clouds surrounding the eye. This is where the storm's most violent, spiraling ascent occurs, harboring torrential rain and maximum wind velocities up to 250 km/h.
    - *Landfall*: When a tropical cyclone crosses a coastline, its moisture fuel supply is cut off, causing the storm to dissipate rapidly.

7. Core Cyclonic Wind Patterns

The direction of wind rotation around pressure systems is strictly determined by the hemisphere due to Coriolis deflection:

Pressure System	**Center Condition**	**Northern Hemisphere Direction**	**Southern Hemisphere Direction**
Cyclone	Low Pressure	**Anticlockwise**	**Clockwise**
Anticyclone	High Pressure	**Clockwise**	**Anticlockwise**



MULTIPLE CHOICE QUESTIONS

1. If the surface air pressure is 1,000 mb, the air pressure at 1 km above the surface will be:

A. 700 mb B. 1,100 mb C. 900 mb D. 1,300 mb

2. Arrange the sequence of precipitation by thunderstorm.
   1) Intense updraft of rising warm air.
   2) Clouds grow bigger.
   3) Clouds rise to greater height.
   4) Precipitation occurs.
   Codes

A. 1,2,3,4 B. 3,2,4,1 C. 4,3,2,1 D. 2,3,4,1

3. The atmospheric pressure is expressed in which of the following units?
   1. Millibar 2. Pascals 3. Kilowatt 4. Kilopascal
   Codes

A. 1,2 and 3 C. 2,3 and 4
B. 1,2 and 4 D. All of these

4. Match the Following

Column (Air mass)	Column (Codes)
1. mP	A Maritime tropical
2. m	B Continental tropical
3. CT	C. Maritime polar
4 CP	D. Continental polar

Codes

	A	B	C	D
A.	1	2	3	4
B.	2	3	1	4
C.	3	2	1	4
D.	4	2	1	3

5. Which of the following is not a type of cell?

A. Hadley cell B. Ferrell cell C. Polar cell D. Deadly cell

Assertion and Reason

Directions (QNos. 6 and 7) In the questions given below are two statement labelled as Assertion (A) and other is labelled as Reason (F). In the context of two statements which one of the following is correct.

Codes

(a) Both A and I are true and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

6. **Assertion (A):** The pressure decreases with height.
   Reason (R): The air at the surface is denser and hence, has higher pressure.
7. **Assertion (A):** Wind moves from high pressure areas to low pressure areas.
   Reason (R): At any elevation pressure varies from place to place and its variation is the primary cause of air motion.

Answers –

1. Ans (c) 900 mb
2. Ans (a) 1,2,3,4
3. Ans (b) 1, 2 and 4
4. Ans (b)2 3 1 4
5. Ans (d) Deadly cell
6. Ans (a) Both A and R are true and R is the correct explanation of A
7. Ans (a) Both A and R are true and R is the correct explanation of A

SHORT QUESTION ANSWER (3 MARKS)

1. Why do you think Coriolis force affects directions of wind. Explain.

Ans. Due to rotation of the Earth, winds do not cross the isobars but are deflected from their path — This called Coriolis effect or Coriolis force.

- Coriolis force defects the wind to right direction in the northern hemisphere and left in the southern hemisphere.
- It is maximum at the poles and is absent at the equator.
- The Coriolis force is directly proportional to the angle of latitude.

2. Analyse the Difference between Cyclone and Anticyclone.

Ans. Cyclone—A cyclone is a low pressure area surrounded by high pressure areas from all sides. It is circular or elliptical in shape. Winds move from all sides to the central low. They assume anti clock wise direction in the Northern hemisphere and clockwise direction in the Southern hemisphere due to Coriolis effect.

Anti-cyclone—A anti cyclone is a high pressure area surrounded by low pressure ocean from all sides. Winds move to all sides from centre. They assume clock wise direction in the northern hemisphere and anticlock wise direction in the southern hemisphere due to Coriolis effect.

3. 'Tropical cyclones are common in equatorial region', why ?

Ans. (i) Large sea surface with temperature higher than 27°C.
(ii) Presence of the Coriolis force.
(iii) Small variations in the vertical wind speed.
(iv) A pre-existing weak low pressure area or low level cyclonic circulation.
(v) Upper divergence above the sea level.

LONG ANSWER QUESTIONS (5 MARKS)

1. Velocity and direction of winds vary according to the regions? Explain.

Ans. The air is set in motion due to the differences in atmospheric pressure. The horizontal winds near the earth surface respond to combined effects of three forces—
(i) Pressure Gradient—The rate of change of pressure with respect to distance is the pressure gradient. The pressure gradient is strong where the isobars are close to each other & is weak where the isobars are apart far away from each other.
(ii) Frictional Force—It is greatest at the surface and its influence generally, extends up to an elevation of 1 to 3 km. Over the sea surface the friction is minimum.
(iii) Coriolis Force—This force deflected the wind to the right direction in the northern hemisphere and to the left in the southern hemisphere. The Coriolis force is directly proportional to the angle of latitude. It is maximum at the poles and is absent at the equator.

2. The extra tropical cyclone differs from the tropical cyclone in number of ways. Analysis it.

Ans. (i) The extra tropical cyclones have a clear frontal system which is not present in the tropical cyclones.
(ii) They cover a larger area and can originate over the land and sea. Whereas the Tropical cyclones originate only over the seas and on reaching the land they dissipate.
(iii) The extra tropical cyclone affects a much larger area as compared to the tropical cyclone.
(iv) The wind velocity in a tropical cyclone is much higher and it is more destructive.
(v) The Extra tropical cyclones move from West to East but tropical cyclones, move from East to West.

CHAPTER NO 10: WATER IN ATMOSPHERE

Water in the Atmosphere

This summary covers the key concepts of atmospheric moisture, condensation forms, precipitation types, and global rainfall distribution.

1. Water in the Atmosphere and Humidity

- **Three States**: Water exists as gas, liquid, and solid in the air.
- **Continuous Cycle**: Water exchanges continuously between oceans, atmosphere, and land.
- **Humidity**: This refers to the water vapour present in the air.
- **Absolute Humidity**: The actual weight of water vapour per unit volume of air.
- **Relative Humidity**: The percentage of moisture present compared to the air's full capacity.
- **Saturated Air**: Air holding moisture to its full capacity at a given temperature.
- **Dew Point**: The exact temperature at which air saturation occurs.

2. Evaporation and Condensation

- **Evaporation**: The process converting liquid water into a gaseous state.
- **Latent Heat**: The heat energy required to change liquid into vapour without changing temperature.
- **Condensation**: The transformation of water vapour back into liquid water.
- **Cooling Requirement**: Condensation is primarily caused by a loss of heat.
- **Condensation Nuclei**: Tiny particles like dust, smoke, and salt that absorb water.

3. Forms of Condensation

- **Dew**: Moisture deposited as water droplets on cool solid surfaces like grass.
- **Frost**: Ice crystals formed on cold surfaces when the dew point is below freezing.
- **Fog**: A low-altitude cloud with its base at or near the ground.
- **Mist**: Similar to fog but contains more moisture and offers slightly better visibility.
- **Smog**: A dense atmospheric combination of fog mixed with smoke.
- **Clouds**: Mass of tiny water droplets or ice crystals formed at higher elevations.

4. Major Cloud Types

- **Cirrus**: High-altitude, thin, detached white clouds with a feathery appearance.
- **Cumulus**: Cotton-wool-like patches formed at medium heights with a flat base.
- **Stratus**: Layered clouds covering large portions of the sky due to heat loss.
- **Nimbus**: Black or dark gray, extremely dense clouds that bring precipitation.

5. Precipitation and Its Forms

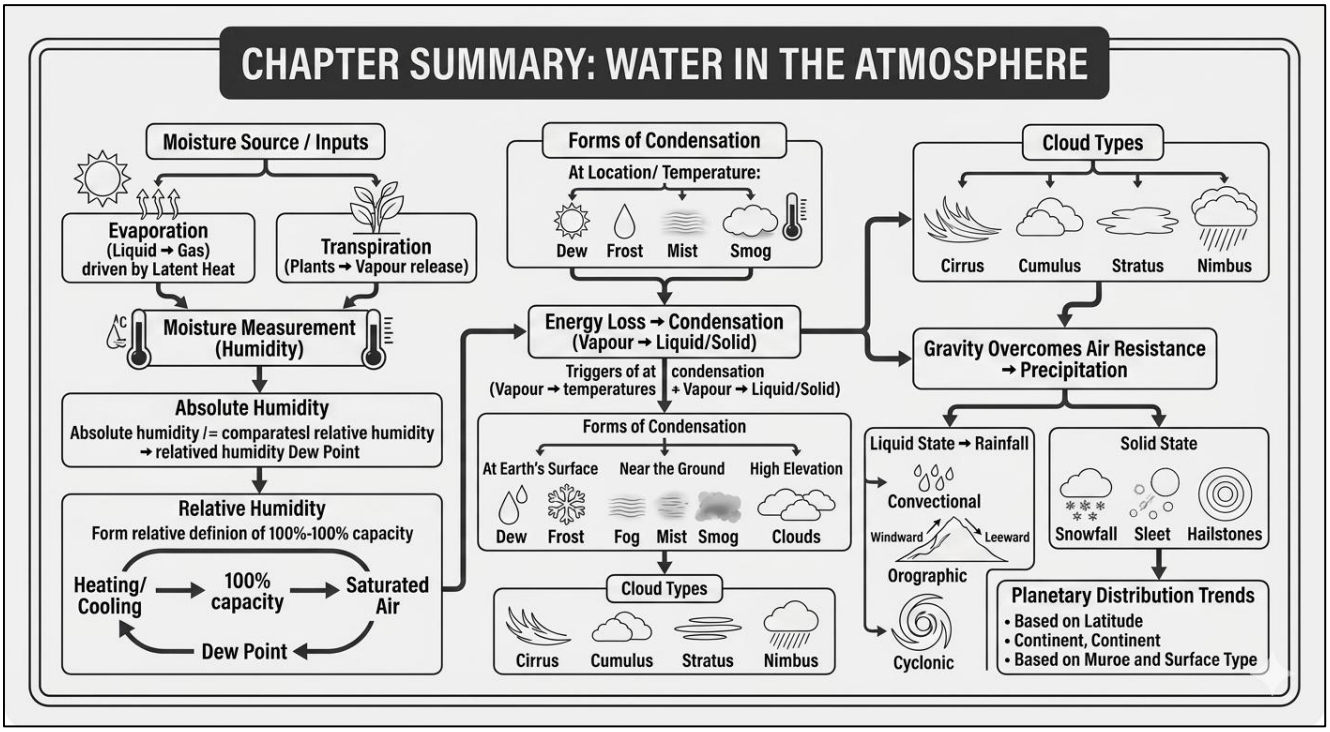
- **Precipitation**: The release of condensed moisture due to gravity.
- **Rainfall**: Precipitation that falls on the ground in liquid form.
- **Snowfall**: Hexagonal ice crystals falling as fine flakes when temperatures are below freezing.
- **Sleet**: Frozen raindrops or refrozen melted snow falling as small ice pellets.
- **Hail**: Rainwater turning into large, concentric layers of solid rounded ice.

6. Types of Rainfall

- **Convectional Rain**: Caused by heated air rising up in convection currents.
- **Orographic Rain**: Caused when saturated air is forced to ascend a mountain slope.
- **Rain-Shadow Area**: The dry leeward side of a mountain receiving minimal rainfall.
- **Cyclonic Rain**: Precipitation associated with the movement of cyclonic systems.

7. World Distribution of Rainfall

- **Latitudinal Trend**: Rainfall generally decreases from the equator toward the poles.
- **Coast vs. Interior**: Coastal zones receive much more rainfall than continental interiors.
- **Heavy Rainfall Belts**: Equatorial regions and windward mountain slopes receive over 200 cm annually.
- **Low Rainfall Belts**: Rain-shadow regions and high latitudes receive less than 50 cm annually.



MULTIPLE CHOICE QUESTIONS

Directions (Q Nos. 1 and 3) In the questions given below are two statement labelled as Assertion (A) and other is labelled as Reason (R). In the context of two statements which one of the following is correct.

codes

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true, but R is not the correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

1. **Assertion:** The amount of water in atmosphere added or withdrawn.
Reasoning: Evaporation and condensation are responsible for this change.

Ans (a) Both A and R are true and R is the correct explanation of A

2. **Reason (R):** The evaporated water is transformed into water.
Reason (R): It is due to the process of condensation.

Ans (a) Both A and R are true and R is the correct explanation of A

3. **Reason (R):** Dew forms on cooler surfaces of solid objects when conditions include clear skies , calm air and high relative humidity .
Reason (R): Dew forms when the dew point is below the freezing point.

Ans (a) Both A and R are true and R is the correct explanation of A

SHORT ANSWER QUESTION (3 MARKS)

1. The formation of clouds needs some favorable conditions in the atmosphere, how?

Ans. Clouds are formed by the condensation of water vapour around nuclei minute dust particles in the air. In most cases, clouds consist of tiny droplets of water, but they may also consist of ice particles if the temperature is below freezing point.

2. 'Evaporation is a main process of water cycle ' Explain the factors affecting Evaporation?

Ans. Evaporation is a process by which water is transformed from liquid to gaseous state. Approximately 600 calories of energy is required to convert one gram of water into water vapour without any change in the temperature. Heat stored in the water vapor is known as latent heat. Temperature. Dryness of air, size of water, area & movement of air affects evaporation.

3. During rainy season we feel more sticky or unfavorable conditions, why? Explain with the types of humidity?

Ans. The amount of water vapour present in the air is called humidity. It is measured in cubic meter/gm. At any specific temperature, the quantity of moisture that can be held by the air has a definite limit. This limit is known as saturation point. Types of humidity are—

(i) Absolute humidity—The weight of actual amount of water vapour present in a unit volume of air is called the absolute humidity. It is usually expressed as grams per cubic metre of air.

(ii) Relative humidity—It is the ratio of water vapour present in the air a particular temperature to the amount of water vapour required to saturate the same air at the same temperature. It is always expressed in percentages. It is important for the weather forecast.

4. 'Earth's surface is heated during day time and it cools down at night.'? Explain the favourable conditions for the formation of Dew.

Ans. Earth's surface is heated during day time and it cools down at night. Sometimes the cooling is so much that the temperature of the air touching earth's surface falls below dew points. Water vapor present in the air condenses and is deposited in the form of droplets on cooler surface of solid objects such as stones, grass blades and plant leaves. This is known as Dew.

Following are the conditions for dew formation—

(i) Long nights—Long nights helps in falling of temperature. So, dew forms.

(ii) Clear sky—Clear sky permits sufficient heating and large scale evaporation during day. Condensation is caused by cooling at night and dew is formed.

(iii) Clam Air—If the air is calm, it will remain in contact with the earth's surface for a long time and cool down to dew point and dew will be formed.

(iv) High relative humidity.

(v) Dew point should be higher than freezing point.

LONG ANSWER QUESTIONS (3 MARKS)

1. Rainfall is the part of precipitation? How rainfall occurs? Explain the types of rainfall?

Ans. When the humid air rises up, it cools and condensation of water vapour takes place. The water vapor is deposited on hygroscopic particles and turned into water particles. These are known as cloud particles. The cloud particles float in the air and clouds are formed. If these particles come close to one another, they may coalesce into bigger particles. When their size becomes so large that their weight is more than the up thrust of air, the particles will fall down in the form of rain.

Types of Rainfall

(i) Convectional Rainfall—When the earth's surface is heated up, the air touching it is also heated. On being heated, it expands and become lighter. Consequently, it rises to

great heights and convection currents are formed. When the moist air cools at sufficient height, condensation of the water vapor takes place and convectional rainfall occurs. It occurs almost daily in the equatorial region.
(ii) Orographic Rainfall—When humid air is forced to rise along the slope of a mountain or a plateau, cooling is caused and its gets saturated. Clouds are formed due to condensation and rainfall occurs. This is called orographic rainfall.
(iii) Cyclonic Rainfall—Rainfall associated with a cyclone is known as cyclonic rainfall.

2. We find different types of clouds; classify the clouds according to their height, density and transparency?

Ans. (i) Cirrus—They formed at high altitudes (8000 – 1200 m). They are thin and detached clouds having a feathery appearance. They are always white in colour.
(ii) Cumulus—Cumulus clouds looks like cotton wool. They are generally formed a height of 4000 – 7000 meter. They exist in patches and can be seen scattered here & there.
(iii) Stratus—These are layered clouds covering large portions of the sky. There clouds are generally formed either due to loss of heat.
(iv)Nimbus—Nimbus clouds are black or dark grey, they form at middle levels or very near to the surface of the earth. These are extremely dense & opaque to the rays of the sun known as cyclonic or frontal rainfall.

3. "Different places on the earth's surface receive different amount of rainfall in a year." Analyse the statement.

Ans. (i) As proceeding from the equator towards the poles, rainfall goes on decreasing steadily. (ii) The coastal areas of the world receive greater amounts of rainfall than the interior of the continents. (iii) The rainfall is more over the oceans than on the land masses of the world because of being great sources of water. (iv) Between the latitudes 35° & 40°N & South of the equator, the rain is heavier on the eastern coasts and goes on decreasing towards the west. (v) Between 45° and 65° N and S of equator, due to the westerlies, the rainfall is first received on the western margins of the continents and it goes on decreasing towards the east.

CHAPTER NO 11. WORLD CLIMATE AND CLIMATE CHANGE

(To be tested through internal assessments in the form of project and presentation)

CHAPTER NO 12. WATER (OCEAN)

KEY POINTS OF CHAPTER

Life is not possible without water; water is an essential component for all living organisms on earth. Therefore, it is said that water is life, oceans extend over 71% of the earth. Therefore, oceans are the largest source of water on earth. Due to this excess of water on the earth, the earth is also called a blue planet.
In this chapter, we will study the reliefs of the ocean floor, causes and effects of ocean temperature and the horizontal and vertical distribution of salinity.
The Hydrological cycle describes the movement of water on, in and above the earth.
Characteristics of oceans such as troughs, oceanic plains and tectonic activities, Volcanoes are formed by actions and deposition actions.

Hydrological Cycle

- The hydrological cycle describes the movement of water on, in, and above the earth.

- The water cycle has been working for billions of years and all the life on earth depends on it.
- The hydrological cycle is the circulation of water within the earth's hydrosphere in different forms, i.e., the liquid, solid, and gaseous phases.
- It also refers to the continuous exchange of water between the oceans, atmosphere, land surface and subsurface, and the organisms.
- About 71% of the planetary water is found in the oceans.
- Nearly 59% of the water that falls on land returns to the atmosphere through evaporation from over the oceans as well as from other places. This leads to water crisis in different parts of the world – spatially and temporally.

Relief of the Ocean Floor

- The oceans are confined to the great depressions of the earth's outer layer.
- The oceans, unlike the continents, merge so naturally into one another that it is hard to demarcate them. A major portion of the ocean floor is found between 3–6 km below the sea level.

Divisions of the Ocean Floors

The ocean floors can be divided into four major divisions:

(i) Continental Shelf

- The continental shelf is the extended margin of each continent occupied by relatively shallow seas and gulfs.
- The width of the continental shelves vary from one ocean to another
- On the contrary, the Siberian shelf in the Arctic Ocean, the largest in the world, stretches to 1,500 km in width. The depth of the shelves also varies.

(ii) Continental Slope

- The continental slope connects the continental shelf and the ocean basins.
- It begins where the bottom of the continental shelf sharply drops off into a steep slope.
- The gradient of the slope region varies between 2°- 5°.
- The depth of the slope region varies between 200 and 3,000 m.

(iii) Deep Sea Plain

- Deep sea plains are gently sloping areas of the ocean basins.
- These are the flattest and smoothest regions of the world.
- The depths vary between 3,000 and 6,000 m.

(iv) Oceanic Deeps or Trenches

- These areas are the deepest parts of the oceans.
- The trenches are relatively steep sided, narrow basins.
- They are some 3-5 km deeper than the surrounding ocean floor.

(v) Mid-Oceanic Ridges

- A mid-oceanic ridge is composed of two chains of mountains separated by a large depression.

- The mountain ranges can have peaks as high as 2,500 m and some even reach above the ocean' surface.
  Example: Iceland.

(vi) Seamount

- It is a mountain with rounded tops that rises from the ocean's floor but does not touch the water's surface.
- Volcanoes are the cause of seamounts.
- They may be 3,000–4,500 m high.

(vii) Submarine Canyons

- These are deep valleys, some of which are equivalent to the Colorado River's Grand Canyon
- The Hudson Canyon is the world's most well-known undersea canyon.

(viii) Guyots

- It has a seamount with a flat top.
- They exhibit signs of slow sinking over a number of stages to become mountains with flat tops that are submerged.
- More than 10,000 seamounts and guyots are thought to be present in the Pacific Ocean alone.

(ix) Atoll

- These tiny coral reef-encircled islands, which can be found in tropical seas, are low islands.
- These could be a body of fresh, brackish, or extremely saline water, or sea (lagoon).

Temperature Of Ocean Waters

- Ocean waters get heated up by the solar energy just as land.
- The process of heating and cooling of the oceanic water is slower than land.

Factors Affecting Temperature Distribution

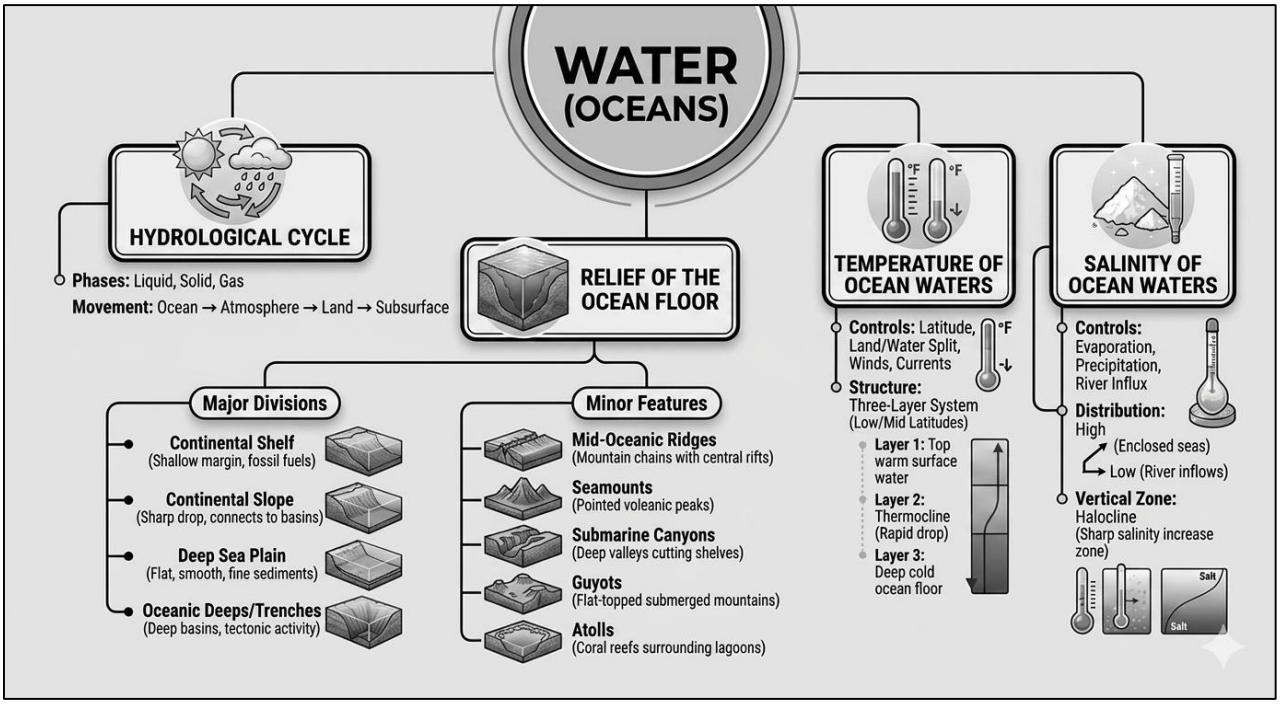
- **Latitude:** The temperature of surface water decreases from the equator towards the poles because the amount of insolation decreases poleward.
- **Unequal distribution of land and water:** The oceans in the northern hemisphere receive more heat due to their contact with larger extent of land than the oceans in the southern hemisphere.
- **Prevailing wind:** The upwelling of cold water from below is caused by warm surface water being driven away from the coast by winds flowing from the land towards the oceans. The temperature changes longitudinally as a result. In contrast, the onshore breezes cause warm water to collect close to the coast, which raises the temperature.
- **Ocean currents:** While cold ocean currents lower the temperature in warm ocean areas, warm ocean currents boost the temperature in cold areas. The Labrador current (cold current) cools the area near the north-east coast of North America while the Gulf stream (warm current) elevates the temperature close to the east coast of North America and the west coast of Europe.

Horizontal and Vertical Distribution of Temperature

- The ocean water's temperature-depth profile demonstrates how the temperature drops as depth increases.
- A location where the ocean's surface waters and deeper layers divide may be seen in the profile.
- The boundary often starts between 100 and 400 m below the surface of the water and descends several hundred metres.
- The thermocline is the name given to this boundary zone where temperatures rapidly drop.
- In the deep ocean, beneath the thermocline, there is about 90% of the total amount of water.
- Temperatures here are close to 0°C. The temperature structure of oceans over middle and low latitudes can be described as a three-layer system from surface to the bottom.
- The first layer indicates the top 500 m of warm ocean water, which has a temperature between20°C and25°C. In the tropical zone, this layer is present all year long, whereas in mid-latitudes, it only forms in the summer.
- The second layer also referred to as the thermocline layer, is marked by a rapid drop in temperature with depth. The thermocline has a thickness of 500–1,000 m.
- The third layer is extremely cold and reaches the deep ocean floor. The temperature difference with depth is quite small in the Arctic and Antarctic circles because the surface water is near to 0°C. Only one layer of cold water is present here, and it stretches from the surface to the deep ocean floor.

Salinity of Ocean Waters

- Salinity is the term used to define the total content of dissolved salts in sea water.
- It is calculated as the amount of salt (in g) dissolved in 1,000 g (1 kg) of seawater.
- It is usually expressed as parts per thousand (0 / 00) or ppt.
- Salinity is an important property of sea water.
- Salinity of 24.7ppt has been considered as the upper limit to demarcate ‘brackish water’.



MULTIPLE CHOICE QUESTIONS

1. Hydrological cycle is the circulation of water within the earth's hydrosphere in different forms such as

A. Solid B. Liquid C. Gaseous D. All of these

2. The component 'water storage in oceans' is associated with which of the following processes of the water cycle?

A. Evaporation C. Sublimation

B. Evapotranspiration D. All of these

3. Hydrological cycle is the continuous exchange of water between the
1) Oceans 2) Atmosphere 3) Land surface 4) Organisms Codes

A. Both 1 and 2 C. 1 and 4

B. 2 and 3 D. All of these

4. Arrange the following water bodies as per their salinity from highest to lowest.
1)Lake Van 2)Great Salt lake 3) Dead sea 4)Red sea
Codes

A. 1,2,3,4 B. 1,3,2,4 C. 3,2,1,4 D. 4,3,2,1

Directions (Q. Nos. 5 to 7) In the questions given below are two statements labelled as Assertion (A) and other is labelled as Reason (R). In the context of two statements which one of the following is correct?

Codes

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

5. **Assertion (A):** Salinity at depth is very much fixed.
Reason (R): There is no way that water is 'lost' or the salt is added at depth.

6. **Assertion (A):** In temperate latitudes salinity is lower.
Reason (R): In temperate latitudes, evaporation is less and rains are more abundant.

7. **Assertion (A):** There is huge water crisis in different parts of the world.
Reason (R): The renewable water on the earth is constant while the demand is increasing tremendously.

Answers -

1. Ans (d) All of these
2. Ans (d) All of these
3. Ans (d) All of these
4. Ans (b) 1,3,2,4
5. Ans (a) Both A and R are true and R is the correct explanation of A
6. Ans (a) Both A and R are true and R is the correct explanation of A
7. Ans (a) Both A and R are true and R is the correct explanation of A

SHORT ANSWER QUESTION (3 MARKS)

1. Highlight the features of Continental shelf

Ans. • The continental shelf is the extended margin of each continent occupied by relatively shallow seas and gulfs.
• It is the shallowest part of the ocean showing an average gradient of one degree or even less.
• It's depth varies from 30m to 600m
• The shelf typically ends at a very steep slope, called the shelf break.
• The width of the continental shelves vary from one ocean to another. The average width is about 80 km.
• It is the source of fossil fuels

2. Continental slope had many main features , Explain?

Ans. • The continental slope connects the continental shelf and the ocean basins.
• The gradient of the slope region varies between 2-5 degrees.
• The depth of the slope region varies between 200 and 3,000 m.
• The slope boundary indicates the end of the continents.
• Canyons and trenches are observed in this region.

3. The salinity of ocean water is differ in different regions of oceans. describe the horizontal distribution of salinity?

Ans. Different amounts of salinity are found at different places. Factors affecting it are:-
1. Water supply: Low salinity in cold water compared to hot water it occurs. Salinity is reduced at the estuaries of rivers.
2. The amount of evaporation: less at the poles and higher latitudes, while more evaporation occurs at Cancer and Capricorn circles. Where evaporation is high salinity will be high.
3. Ocean currents: Salinity is less in cold streams and more in hot streams.

4. Explain the factors affecting the temperature distribution of oceans?

Ans. Like all other objects on the earth, ocean water receives heat from the sun. Sea water is heated by receiving heat from solar radiation which increases its temperature. The temperature of seawater is not always the same. It varies according to time and place. The following factors affect the temperature:

1. Latitude
2. Prevailing Winds
3. Ocean Currents
4. Effect of Adjacent Land Masses
5. Salinity
6. Ice Flows and Icebergs

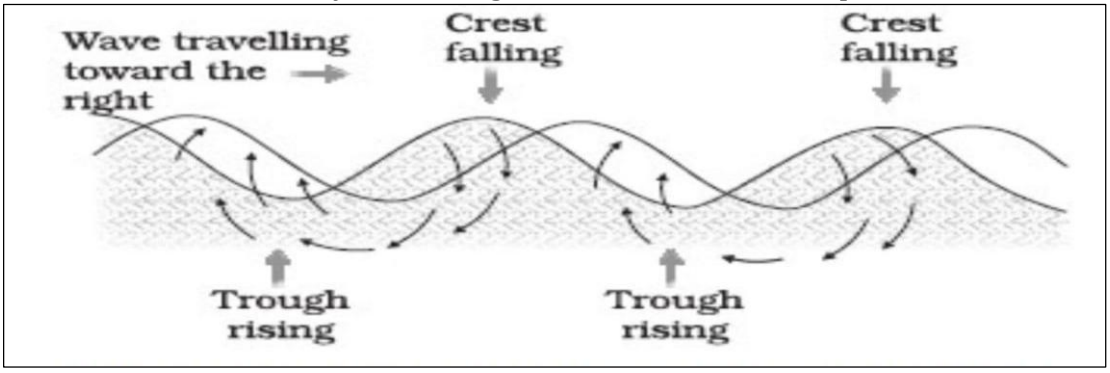
CHAPTER 13: MOVEMENTS OF OCEAN WATER

Overview of Ocean Water Movements

- Ocean water is dynamic and experiences continuous horizontal and vertical motions influenced by temperature, salinity, density, winds, and astronomical forces.
- Horizontal motion refers to ocean currents and waves, while vertical motion refers primarily to tides, upwelling, and the sinking of surface water.
- In ocean currents, water physically shifts from one place to another, whereas in waves, only energy moves forward while the water particles travel in small circular paths.

Ocean Waves

- Waves are moving energy driven across the surface of the ocean, generated primarily by wind friction.
- As a wave approaches the shoreline, friction with the sea floor slows it down, causing it to break when the water depth becomes less than half of the wave's wavelength.
- Wave size and shape indicate origin; steep waves are young and formed by local winds, while slow, steady waves originate from distant hemispheres.



- Key wave characteristics include:
  - **Crest and Trough**: The highest and lowest points of a wave, respectively.
  - **Wave Height**: The vertical distance from the bottom of a trough to the top of a crest.
  - **Wave Amplitude**: Exactly one-half of the total wave height.
  - **Wave Period**: The time interval required for two successive crests or troughs to pass a fixed point.
  - **Wavelength**: The horizontal distance separating two successive crests.

- **Wave Speed**: The rate of a wave's movement through water, measured in knots.
- **Wave Frequency**: The number of waves passing a specific point during a one-second interval.

Ocean Tides

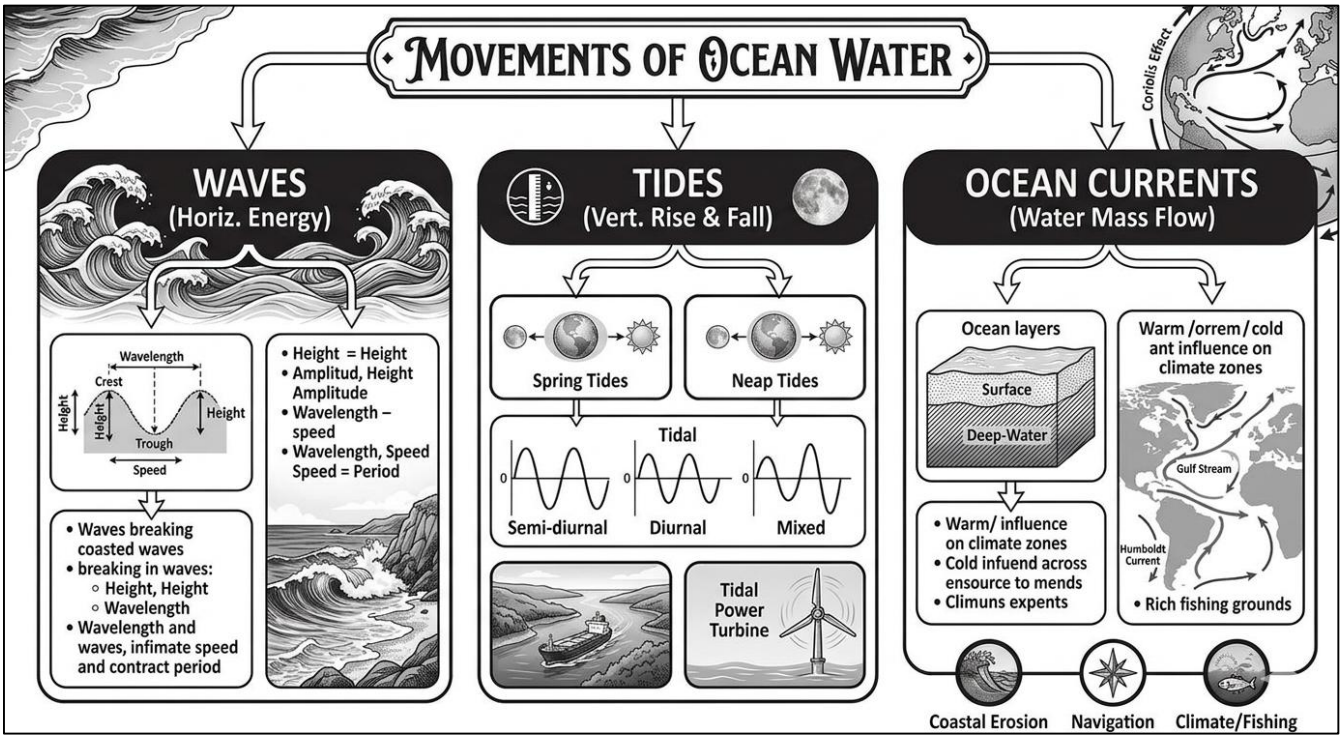
- Tides are the periodic rise and fall of global sea levels, occurring once or twice a day, primarily caused by the gravitational forces of the moon and sun.
- Non-regular sea level movements caused by meteorological events like winds and atmospheric pressure changes are called surges.
- Two major tidal bulges are created on Earth: one on the side facing the moon due to direct gravitational pull, and another on the opposite side due to counterbalancing centrifugal force.
- Tides categorized by frequency of occurrence include:
  - **Semi-diurnal Tide**: The most common pattern, featuring two high tides and two low tides each day of approximately equal height.
  - **Diurnal Tide**: Features only one high tide and one low tide during a 24-hour cycle.
  - **Mixed Tide**: Tides that exhibit wide variations in height, common along the western coast of North America and Pacific islands.
- Tides categorized by astronomical positions include:
  - **Spring Tides**: Higher-than-average tides occurring twice a month (during full and new moons) when the sun, moon, and Earth align in a straight line.
  - **Neap Tides**: Lower-than-average tides occurring when the sun and moon form a right angle relative to the Earth, counteracting each other's gravitational pulls.
- Key astronomical and operational terms include:
  - **Perigee and Apogee**: Unusually high and low tides occur when the moon is closest to Earth (perigee), while tidal ranges shrink when the moon is farthest (apogee).
  - **Perihelion and Aphelion**: Tidal ranges maximize when Earth is closest to the sun in January (perihelion) and minimize when farthest away in July (aphelion).
  - **Ebb and Flood**: Ebb refers to the falling water level between high and low tide, while flood (or flow) is the rising water level between low and high tide.
  - **Importance**: Tidal consistency allows for advanced prediction, helping fishermen and navigators guide ships through shallow harbors, desilt estuaries, and generate clean electrical power.

Ocean Currents

- Ocean currents function like rivers within the sea, representing large, regular volumes of water moving along definite paths and directions.
- **Primary Forces**: Factors that initiate water movement include solar heating (which expands water near the equator to create a subtle downhill slope), wind friction, gravity, and the Coriolis force (which deflects water to the right in the Northern

Hemisphere and to the left in the Southern Hemisphere, forming circular systems called Gyres).

- **Secondary Forces**: Variations in water density influence vertical movement. High-salinity and cold waters are denser and sink near the poles, moving toward the equator, while lighter, warm surface waters flow toward the poles.
- Currents categorized by depth include:
    - **Surface Currents**: Make up the upper 400 meters of the ocean and account for roughly a tenth of total ocean water volume.
    - **Deep Water Currents**: Driven by density and gravity variations at high latitudes, accounting for the remaining majority of ocean water.
- Currents categorized by temperature include:
    - **Cold Currents**: Carry polar water toward lower latitudes, typically bordering the west coasts of continents in low-to-middle latitudes and the east coasts in high northern latitudes.
    - **Warm Currents**: Carry equatorial water toward higher latitudes, typically bordering the east coasts of continents in low-to-middle latitudes and the west coasts in high northern latitudes.
- **Global Impacts**: Ocean currents act as a major planetary heat transfer system. Cold currents lead to arid coastal landmasses with frequent fog, whereas warm currents bring humid, mild marine climates. Additionally, mixing zones where cold and warm currents converge replenish oxygen and foster plankton growth, creating the world's richest commercial fishing grounds.



MULTIPLE CHOICE QUESTIONS

1. Upward and downward movement of ocean water is known as the:

A. Tide B. Wave

C. Current D. None of these

2. Spring tides are caused:
A. As result of the Moon and the Sun pulling the Earth gravitationally in the same direction.
B. As result of the Moon and the Sun pulling the Earth gravitationally.
C. Indention in the coastline.
D. None of the above

3. The distance between the Earth and the Moon is minimum when the Moon is in:
A. Aphelion B. Perihelion C. Perigee D. Apogee

4. The attraction force caused by the sun and the water to move up down moon forces ocean:
A. Once in a day C. Thrice a day
B. Twice a day D. None of these

5. The other forms of vertical movement of oceanwater are
A. Upwelling of cold Water C. Tides
B. Sinking of surface water D. Both (a) and (b)

6. The maximum wave height is determined by the strength of the
A. Evaporation C. Temperature conditions
B. Wind D. Precipitation

7. The crests of waves move in which direction due to gravity?
A. Forward C. Upward
B. Downward D. None of these

8. Periodically rise and fall of the sea level, once in a day due to the attraction of the sun and the moon is called a
A. Current B. Waves C. Tide D. All of these

Assertion and Reason

Directions (Q. Nos. 9 and 10) In the questions given below are two statements labelled as Assertion (A) and other is labelled as Reason (R). In the context of two statements which one of the following is correct.

Codes

(a) Both A and B are true and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

9. **Assertion (A):** At higher latitudes, the density of water increases.
Reason (R): At higher latitudes, the temperature is low.

10. **Assertion (A):** Deep bottom water remains stagnant.

Reason (R): The horizontal movement of surface water is continued to top surface layer of ocean water.

Answers –

1. Ans (a) Tide
2. Ans (a) As result of the Moon and the Sun pulling the Earth gravitationally in the same direction.
3. Ans (c) Perigee
4. Ans (b) twice a day
5. Ans (d) Both (a) and (b)
6. Ans (b) Wind
7. Ans (b) Downward
8. Ans (c) tide
9. Ans (a) Both A and R are true and R is the correct explanation of A
10. Ans (a) Both A and R are true and R is the correct explanation of A

SHORT ANSWER QUESTION (3 MARKS)

1. 'Tides are very common phenomena in a coastal area.' Describe the major types of Tides and its importance.

Ans. The periodical rise and fall of the sea level, once or twice a day, mainly due to the attraction of the sun and the moon, is called a tide.

Types of Tides

(a) Tides based on Frequency

1. Semi-diurnal tide 2. Diurnal tide 3. Mixed tide

(b) Tides based on heights

1. Spring Tides 2. Neap Tides

Importance of the Tides

1. Tides helps the ships and boats to enter into harbours situated near rivers and estuaries having shallow bars at the entrance.

2. Tides are also helpful in desilting the sediments and in removing polluted water from river estuaries.

3. Tides are used to generate electrical power.

4. Tides help, the navigators and fisherman to plan their activities.

5. Due to tides seawater remains dynamic in result water does not freeze in the colder areas.

2. 'Life of flora and fauna is affected by ocean currents? Explain its effects.

Ans. Ocean currents have the following effects:

1. The currents affect the temperature and narrows down the Diurnal and annual range of temperature of the visiting and surrounding area. Warm currents increase the temperature of colder areas and vice versa.

2. Ocean currents can also cause other climate changes, such as increased fog humidity etc.

3. The mixing of warm and cold currents help to replenish the oxygen and favour the growth of planktons, the primary food for fish population, the best fishing Grounds of the world exist mainly in the mixing zones.

CHAPTER 14 BIODIVERSITY AND CONSERVATION

(To be tested through internal assessments in the form of project and presentation)

BOOK: INDIA: PHYSICAL ENVIRONMENT
CHAPTER 1:
INDIA LOCATION

Location:

1. India is located in South Asia, entirely in the Northern Hemisphere.
2. It lies between latitudes 8°4' N and 37°6'N and longitudes 68°7' E and 97°25'E.
3. Bounded by the Himalayas in the north, it tapers southward to the Indian Ocean, dividing into the Bay of Bengal to the east and the Arabian Sea to the west.
4. India extends from Kashmir in the north to Kanyakumari in the south and Arunachal Pradesh in the east to Gujarat in the west.
5. India's territorial limit further extends towards the sea up to 12 nautical miles (about 21.9 km) from the coast.

Size:

1. India covers an area of about 3.287 million square kilometres, making it the seventh-largest country in the world by land area.
2. It has a land frontier of about 15,200 kilometres and a coastline of about 7,516 kilometres, including the mainland, Lakshadweep Islands, and the Andaman and Nicobar Islands.

- **Note-**The official length of India's coastline has been recalculated to **11,098.81 kilometres**, marking a **47.7% increase** from the 7,516.60-kilometre figure used since the 1970s.

- This comprehensive update was conducted by the Survey of India (SoI) and the National Hydrographic Office (NHO).

- The dramatic change reflects **no actual physical expansion** or land acquisition. It is entirely a result of advanced mapping precision, higher resolution tracking data, and the standardisation of island boundaries.

3. The actual distance measured from north to south extremity is 3,214 km and that from East to West is only 2,933 km.

India and Its Neighbours-

1. Pakistan: To the northwest, with a border length of about 3,323 kilometres.
2. China: To the north and northeast, with a border length of about 3,488 kilometres.
3. Nepal: To the north, with a border length of about 1,751 kilometres.
4. Bhutan: To the northeast, with a border length of about 699 kilometres.
5. Bangladesh: To the east, with a border length of about 4,096 kilometres. (Longest land frontier)
6. Myanmar: To the east, with a border length of about 1,643 kilometres.

Additionally, India shares maritime borders with-

1. Sri Lanka: Separated by the narrow Palk Strait.
2. Maldives: Situated to the southwest in the Indian Ocean.

Indian Standard Time (IST) and Its Implications-

- IST is the time observed throughout India and Sri Lanka.

- It is 5 hours and 30 minutes ahead of Coordinated Universal Time (UTC+5:30).
- The reference point for IST is the 82.5°E longitude, passing through Mirzapur near Allahabad (Prayagraj) in Uttar Pradesh.

Implications of India's Location-

India's strategic location in the Indian Ocean has significant implications across various dimensions, including economic, geopolitical, cultural, and environmental aspects-

1. **Economic Implications:** Trade and Commerce, Energy Security, Fisheries and Marine Resources
2. **Geopolitical Implications:** Strategic Military Presence, Influence and Diplomacy, Regional Stability and Security.
3. **Cultural and Historical Implications:** Cultural Exchange, Diaspora and Migration
4. **Environmental Implications:** Marine Ecosystems, Climate and Weather Patterns.

MULTIPLE CHOICE QUESTIONS

Assertion Reasoning based Questions: -

A. Both A and R are correct and R explain A completely
B. Both A and R incorrect
C. A is correct and R is not correct explain
D. A is incorrect and R is correct

1. **Assertion (A):** Northern part of India is located in subtropical part and southern part of India is located in tropical zone
   Reasoning (R): Tropic of Cancer passes through centre of India.

2. **Assertion (A):** From Gujarat to Arunachal Pradesh there is a time lag of 2 hours
   Reasoning (R): Eastern and western ends have 30-degree longitude difference

3. **Assertion (A):** All watches in Kolkata, Delhi, Mumbai & Chennai show the same time**.**
   Reasoning (R): All these places are located on standard meridian of India.

4. **Arrange the following countries correctly in the terms of their rank in area in the world?**

A. Russia Canada China Brazil
B. Russia India Brazil China
C. Canada Brazil China Russia
D. Brazil India China Russia

5. **Match the following latitudes/longitudes with their geographical significance:**

Latitudes/Longitudes	**Geographical significance**
1. 1.82°30'E	a. Standard meridian of India
2. 2.23°30' N	b. Tropic of Cancer
3. 3.8°4'N	c. Southern most point of India's mainland
4. 4.37°6'N	d. Northernmost latitude of India

Options:

A. 1-a, 2-b, 3-c, 4-d
B. 1-b, 2-a, 3-d, 4-c

C. 1-d, 2-c, 3-a, 4-b D. 1-a, 2-c, 3-b, 4-d

Answers –

1. Ans: A. Both A and R are correct and R explain A completely
2. Ans: A. Both A and R are correct and R explain A completely
3. Ans: C. A is correct and R is not correct explain
4. Ans: A. Russia Canada China Brazil
5. Ans: A. 1-a, 2-b, 3-c, 4-d

SHORT ANSWER QUESTIONS

1. Does India need to have more than one standard time? If yes, why do you think so?

Ans: Yes, I think India needs to have more than one standard time.

• There is time variation of 2 hours between the Easternmost and the westernmost parts of our country. The sun rises two hours earlier in Arunachal Pradesh as compared to Gujarat.

• This is because the earth is tilted and also it rotates in east to west direction. So while rotation, the Eastern parts of the world experiences the sun rays earlier as compared to the western parts of the world.

• Many countries like USA, Canada and Russia have more than one standard time because their longitudinal extent is large. India's longitudinal extent is also 30° approximately.

2. "Latitudinal spread of India advantageous to India" justify the statement?

Ans: There are three major advantages of latitudinal extent-

1. Tropic of cancer (23 ½°.) – It divides India into two parts. Southern part is in the tropical zone while northern part is in the temperate zone. Therefore biodiversity in India is exceptional.
2. It also brings climatic diversity in India which has many advantages.
3. As we move from Kanyakumari to Jammu and Kashmir duration of day and night decreases by more than 4 hours 30 minutes.
4. We have places of all climates. It makes India a subcontinent.

3. "India is often referred to as a subcontinent". Justify the statement with reference to its location and size.

Ans: India is called a subcontinent because-

- It is a distinct landmass, separated from the rest of Asia by natural features like the Himalayas.
- It is the seventh-largest country in the world with a vast area of 3.28 million sq km. Its location between 8°4'N and 37°6'N latitudes and 68°7'E and 97°25'E longitudes gives it diverse climates and geography, distinguishing it from other Asian countries.
- The **cultural and ethnic diversity** that matches its continental scale

LONG ANSWER QUESTION

1. While the sun rises earlier in the east, say Nagaland and also sets earlier, how do the watches at Kohima and New Delhi show the same time? Elaborate.

Ans: While the sun rises earlier in the east, say Nagaland and also sets earlier but the watches at Kohima and New Delhi show the same time because-

- India follows one standard time all over its land. It is time shown at standard meridian of India.

- There is a general understanding among the countries of the world to select the Standard Meridian in multiples of 7° 30′ of longitude. Hence, 82°30′ E is chosen as the Standard Meridian of India and the time along the Standard Meridian of India passing through Mirzapur is taken as the Standard Time for the whole country.
- Watches do not track local solar time (the position of the sun overhead).
- Instead, devices connect to network time protocols synced to the Mirzapur standard.
- The Council of Scientific and Industrial Research (CSIR-NPL) maintains this national time.
- This administrative choice ensures uniform schedules for railways, aviation, and banking.

CHAPTER 2: STRUCTURE AND PHYSIOGRAPHY

Geological Divisions of India

- **Three Major Regions**: Based on structural variations, India is divided into the Peninsular Block, the Himalayas (with other Peninsular mountains), and the Indo-Ganga-Brahmaputra Plain.
- **The Peninsular Block**:
  - Represents one of the oldest, most rigid, and highly stable landmasses of India.
  - Composed primarily of ancient gneisses and granites.
  - Characterized by rift valleys (Narmada, Tapi, Mahanadi) and relict mountains (Aravali, Nallamala, Javadi, Mahendragiri).
  - Features shallow river valleys with low gradients.
- **The Himalayas and Peninsular Mountains**:
  - Geologically young, weak, flexible, and tectonic in origin.
  - Actively shaped by ongoing endogenic (internal) and exogenic (external) forces.
  - Dissected by fast-flowing, youthful rivers forming gorges, V-shaped valleys, rapids, and waterfalls.
- **Indo-Ganga-Brahmaputra Plain:**
  - Originally a massive geo-synclinal depression formed during the Himalayan mountain-building phase.
  - Filled gradually by rich alluvial sediments brought down by Himalayan and Peninsular rivers.
  - Contains alluvial deposits ranging between depths of 1,000 to 2,000 meters.

Physiographic Divisions of India

1. The Northern and North-eastern Mountains
2. The Northern Plain
3. The Peninsular Plateau
4. The Indian Desert (Marusthali)
5. The Coastal Plains
6. The Islands

1. The Northern and North-eastern Mountains-

- **Structure**: Consists of parallel mountain ranges including the Great Himalayas and the Shiwalik (p. 5).

- **Dimensions**: Extends approximately 2,500 km from east to west, with a width varying between 160–400 km (p. 5).
- **Function**: Acts as a massive physical, climatic, drainage, and cultural barrier between the Indian subcontinent and East/Central Asia.

2. The Northern Plain-

- **Origin**: Formed by the alluvial deposits of three mighty river systems: Indus, Ganga, and Brahmaputra.
- **Core Geomorphological Zones**:
  - **Bhabar**: A narrow, 8–10 km belt parallel to the Shiwalik foothills where heavy boulders accumulate and streams often disappear underground.
  - **Tarai**: A 10–20 km wide marshy, swampy zone south of Bhabar where underground streams re-emerge, hosting dense vegetation and wildlife.
  - **Bhangar**: Older, mature alluvial plains located further south.
  - **Khadar**: Newer, highly fertile alluvial deposits prone to periodic flooding.

3. The Peninsular Plateau-

Elevation: An irregular triangular tableland rising from 150 meters to an elevation of 600–900 meters.

(A)Deccan Plateau:

- Bordered by the Western Ghats (continuous, higher elevation) and Eastern Ghats (discontinuous, highly eroded) (pp. 6-7).
- **Highest Peak**: Anaimudi (2,695 m) located on the Anaimalai hills of the Western Ghats.

(B)Central Highlands: Bounded by the Aravali range, sloping north and northeastward with prominent relict mountains and metamorphic rocks.

(C)Northeastern Plateau: An extension detached by the Malda fault, housing the Garo, Khasi, and Jaintia hills which are highly rich in mineral reserves.

4. The Indian Desert (Marusthali)-

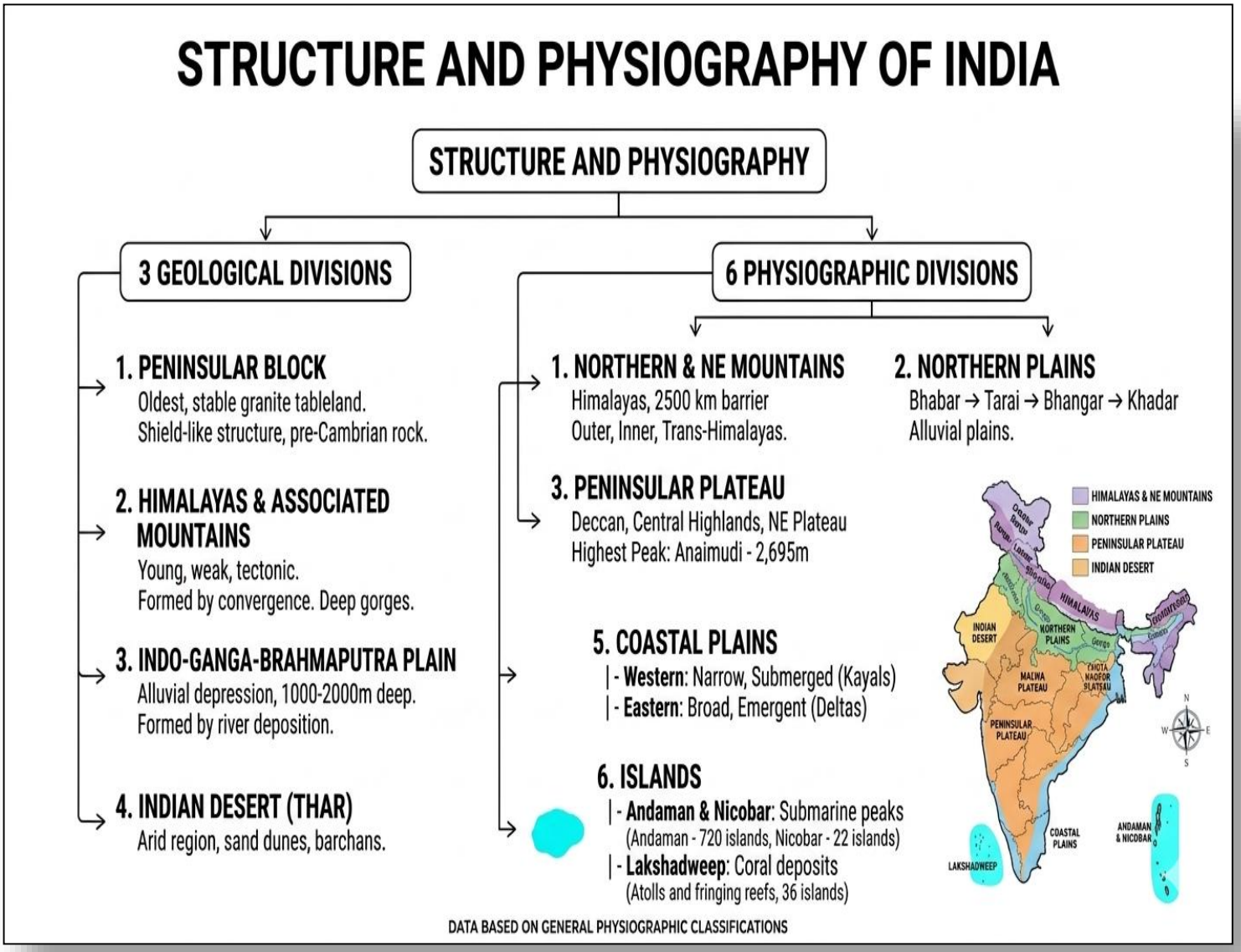
- **Climate**: Arid climate receiving low rainfall (below 150 mm per year) with scarce vegetation cover.
- **Topography**: Characterized by undulating terrain, shifting longitudinal sand dunes, crescent-shaped *barchans*, and mushroom rocks.
- **Drainage**: Rivers are ephemeral (temporary); features inland drainage where streams disappear into brackish lakes or *playas* used for salt extraction.

5. The Coastal Plains-

- **Western Coastal Plain**:
  - A narrow, submerged coast that provides ideal natural conditions for deep-water ports (e.g., Kandla, Mumbai, Cochin).
  - Rivers flowing here do not form deltas.
  - Characterized by *Kayals* (backwaters) used for fishing, transport, and tourism (like the famous Nehru Trophy boat race).
- **Eastern Coastal Plain**:
  - A broader, emergent coast with well-developed river deltas (Mahanadi, Godavari, Krishna, Kaveri).
  - Features a wide continental shelf extending up to 500 km, making it less suitable for natural ports.

6. The Islands-

- **Bay of Bengal Group:**
  - Contains about 572 islands split into Andaman (North) and Nicobar (South), separated by the Ten Degree Channel.
  - Conceived as elevated submarine mountains; includes Barren Island, India's only active volcano.
- **Arabian Sea Group:**
  - Comprises the Lakshadweep and Minicoy islands, built entirely from coral deposits.
  - Divided broadly by the Nine Degree Channel.



MULTIPLE CHOICE QUESTIONS

Assertion and Reasoning Questions

A. Both A and R are true, and R is the correct explanation of A.
B. Both A and R are true, but R is not the correct explanation of A.
C. A is true but R is false.
D. A is false but R is true.

1. **Assertion (A):** The Himalayas are considered young fold mountains.

Reason (R): They were formed due to the collision of the Indian plate with the Eurasian plate.

Ans: A. Both A and R are true, and R is the correct explanation of A.

2. **Assertion (A):** The Peninsular Plateau is more stable than the Himalayan region.
Reason (R): The Peninsular Plateau is made up of hard, crystalline igneous and metamorphic rocks.

Ans: A. Both A and R are true, and R is the correct explanation of A.

3. **Assertion (A):** The Northern Plains are highly fertile and agriculturally productive.
Reason (R): These plains are formed by the deposition of alluvium brought by rivers originating in the Himalayas and the Peninsular Plateau.

Ans: A. Both A and R are true, and R is the correct explanation of A.

4. **Assertion (A):** The Western Ghats receive more rainfall than the Eastern Ghats.
Reason (R): The Western Ghats are parallel to the monsoon winds.

Ans: C. A is true but R is false.

5. **Assertion (A):** The Indo-Gangetic plain has a low relief and gentle slope.
Reason (R): It is a tectonically active region formed due to recent upliftment.

Ans: C. A is true but R is false.

SHORT ANSWER QUESTION

1. Island groups of the Bay of Bengal and the Arabian Sea are different in many ways. Explain.

Ans - Difference between the island groups of the Bay of Bengal and the Arabian Sea-

- **Lakshadweep:**
  Lakshadweep Islands group is lying close to the Malabar Coast of Kerala. - This group is composed of small coral Islands. It covers small area of 32 sq. km. Kavaratti is the capital of Lakshadweep.
- **Andaman and Nicobar:**
  These islands are close to equator and have thick forest cover. They are bigger in size and more in number. There is a great diversity of flora and fauna. It is believed that these Islands are elevated portion of submarine mountains.

2. India has the potential of Coastal Tourism and Port Development for Economic Growth. Comment.

Ans- India, with a coastline of over 7,500 km, has immense potential in coastal tourism and port development, both of which can significantly contribute to the nation's economic growth.

1. Coastal Tourism-

- Coastal areas are rich in natural beauty, cultural heritage, and biodiversity, attracting both domestic and international tourists.
- Economic Benefits: Employment generation: Jobs in hospitality, transport, water sports, and local crafts.
- Foreign exchange earnings: Increase in international tourist arrivals.
- Development of local economies: Growth in small businesses and services.

- Popular Destinations: Goa, Kerala, Andaman & Nicobar Islands, Puducherry, Odisha's beaches.
- Sustainable Potential: Promotes eco-tourism, cultural tourism, and marine conservation.

2. Port Development-

- Ports are gateways for international trade and are vital for import and export activities.
- Boost to trade and commerce: Efficient ports reduce logistics cost and time.
- Industrial growth: Development of port-based industries and Special Economic Zones (SEZs).
- Employment: Jobs in shipping, warehousing, logistics, and construction.

LONG ANSWER QUESTIONS

1. The formations of Himalayan Mountain ranges have evolved in several phases. Discuss.

Ans- Himalayas, one of the most prominent mountain ranges in the world, were formed as a result of the collision between the Indian Plate and the Eurasian Plate.

- This collision led to the upliftment of the Himalayas, creating a series of parallel mountain ranges with varying orientations in different regions of India.
- The Great Himalayas, also known as the central axial range, span approximately 2,500 km from east to west and have a width ranging from 160-400 km from north to south.
- The Himalayas act as a natural barrier between the Indian subcontinent and Central and East Asian countries, influencing the climate and biodiversity of the region. The range is characterized by diverse ecosystems, including alpine meadows, temperate forests, and snow-capped peaks, making it a hotspot for biodiversity and a crucial source of freshwater for the Indian subcontinent.

2. The Peninsular Plateau in India is the oldest landmass of the Indian subcontinent. Explain.

Ans- The Peninsular Plateau in India is a vast elevated region characterized by its irregular triangular shape and relatively stable landmass.

- Rising from approximately 150 m above the river plains to elevations of 600-900 m, the plateau is bordered by prominent features such as the Delhi Ridge, Rajmahal Hills, Gir Range, and Cardamom Hills.
- This plateau is home to a series of patland plateaus, including the Hazaribagh Plateau, Palamu Plateau, Ranchi Plateau, Malwa Plateau, Coimbatore Plateau, and Karnataka Plateau.
- The Peninsular Plateau is one of the oldest landmasses in India and plays acrucial role in influencing the drainage patterns of the region. The general eastward slope of the plateau is reflected in the flow of rivers, which support fertile alluvial soils and sustain agricultural activities, contributing significantly to the economy and livelihoods of the local population.

CHAPTER- 3
DRAINAGE SYSTEM

GIST OF THE LESSON

1. DRAINAGE: The flow of water through well-defined channels.
2. DRAINAGE SYSTEM: The network of well-defined channels.
3. Catchment area: A river drains the water collected from a specific area.
4. Drainage basin: An area drained by a river and its tributaries.
5. Watershed: The boundary line separating one drainage basin from the other.
6. River basins: The catchments of large rivers.
7. **Important Drainage Patterns:** A) Dendritic B) Radial C) Trellis D) Centripetal.
8. On the basis of discharge of water (orientations to the sea), it may be grouped into: The Arabian Sea drainage; and (ii) The Bay of Bengal drainage.
9. On the basis of the size of the watershed:
   i) Major rivers ii) Medium rivers iii) Minor rivers.
10. On the basis of the mode of origin, nature and characteristics, the Indian drainage may also be classified into:
    i) the Himalayan drainage and ii) the peninsular drainage.

DRAINAGE SYSTEMS OF INDIA:

I. THE HIMALAYAN DRAINAGE:

- It mainly includes

A. the Ganga,
B. the Indus and the
C. Brahmaputra river basins.

- Characteristics: Fed by melting snow, precipitation, perennial, form V- shaped valley, rapids, waterfalls.
- **Indo– Brahma River** was dismembered into three main drainage systems:

(i) The Indus and its five tributaries in the western part;
(ii) The Ganga and its Himalayan tributaries in the central part; and
(iii) The stretch of the Brahmaputra in Assam and its Himalayan tributaries in the eastern part.

THE RIVER SYSTEMS OF THE HIMALAYAN DRAINAGE:

1. The Indus System;
2. The Ganga System;
3. The Brahmaputra System.

II. THE PENINSULAR DRAINAGE SYSTEM:

- Older River system; shallow valleys; Western Ghats act as water divide; Most of the major Peninsular rivers except Narmada and Tapi flow from west to east.

The Evolution of Peninsular Drainage System:

- Three major geological events in the distant past have shaped the present drainage systems of Peninsular India:

(i) Subsidence of the western flank of the Peninsula;
(ii) Upheaval of the Himalayas;
(iii) Slight tilting of the Peninsular block from northwest to the southeastern.
(iv) River Systems of the Peninsular Drainage: Mahanadi; Godavari; Krishna; Kaveri; Narmada and Tapi river systems.

EXTENT OF USABILITY OF RIVER WATER:

Carry huge volumes of water per year; perennial rivers; During the rainy season, much of the water is wasted in floods and flows down to the sea. Similarly, when

there is a flood in one part of the country, the other area suffers from drought. These problems be solved or minimized by transferring the surplus water from one basin to the water deficit basins.

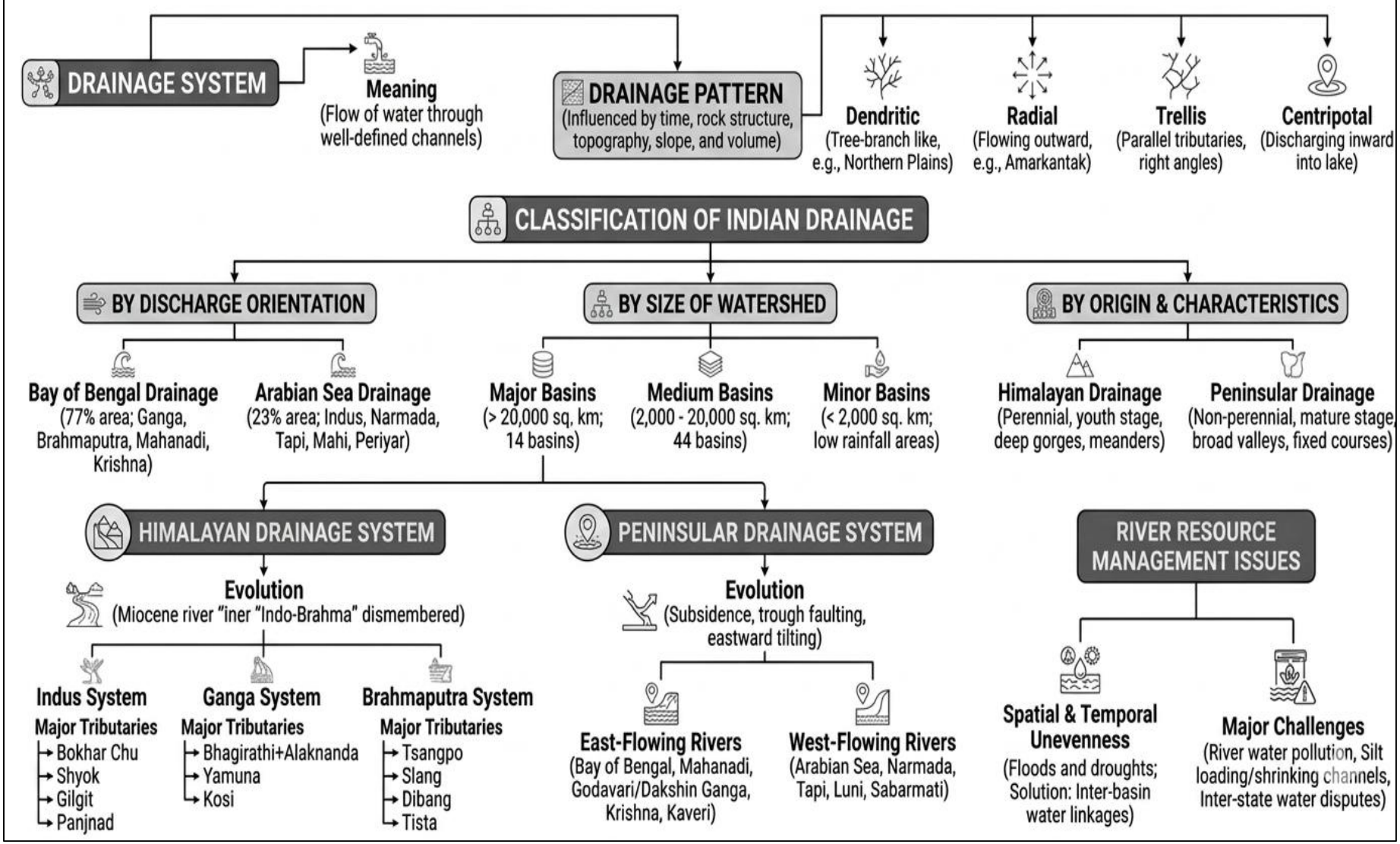
Namami Gange Programme-

It is an Integrated Conservation Mission, approved as "Flagship Programme" by the Union Government in June 2014 with the twin objectives of effective abatement of pollution, conservation and rejuvenation of the National River Ganga.

Main pillars of the Namami Gange Programme are:

1. Sewerage Treatment Infrastructure
2. River-Front Development
3. River-Surface Cleaning
   a. Bio-Diversity
   b. Afforestation
4. Public Awareness
5. Industrial Effluent Monitoring
6. Ganga Gram

CHAPTER 3: DRAINAGE SYSTEM



MULTIPLE CHOICE TYPE QUESTIONS

Assertion and Reasoning Questions-

A. Both A and R are true, and R is the correct explanation of A.
B. Both A and R are true, but R is not the correct explanation of A.
C. A is true, but R is false.
D. A is false, but Ris true.

1. **Assertion (A):** The Ganga River system is the largest river system in India.
   Reason (R): The Ganga River has the maximum number of tributaries among alluvial rivers.

ANS- A. Both A and R are true, and R is the correct explanation of A.

2. **Assertion (A):** The Himalayan rivers are perennial in nature.
   Reason (R): The Himalayan rivers are fed by both rain and melting snow from the glaciers.

ANS- A. Both A and R are true, and R is the correct explanation of A.

3. Statement I: The Ganga River basin is the largest river basin in India.
   Statement II: The Ganga River is primarily fed by monsoonal rainfall.

ANS- B) Both A and R are true, but R is not the correct explanation of A.

4. Match Column I with Column II and choose the correct option:

COLUMN I (NAME OF THE RIVER)	COLUMN II (PLACE OF ORIGIN)
I. Godavari	1. Amarkantak plateau
II. Krishna	2. Brahmagiri hills
III. Kaveri	3. Mahabaleshwar in Sahyadri
IV. Narmada	4. Nasik district of Maharashtra

Options:

A. III – 1, IV – 2, II – 3, I – 4
B. III – 1, I – 2, II – 3, IV – 4
C. II – 2, III – 1, IV – 4, I – 3
D. IV – 1, III – 2, I – 4, II – 3

Ans D) IV – 1, III – 2, I – 4, II – 3

5. Which of the following is not a characteristic of Indian Peninsular rivers?
A. Rivers Originates from central highland and Western Ghats.
B. Peninsular rivers have fixed course with well-adjusted valleys.
C. Rivers are at youthful stage.
D. Peninsular rivers are seasonal in nature and are dependent on Monsoon rainfall.

Ans- C) Rivers are at youthful stage

SHORT ANSWER TYPES

1. East-flowing and West-flowing rivers of Peninsular India have different physiographic pattern. Comment.

Ans The east-flowing and west-flowing rivers of Peninsular India have distinct characteristics:

1. Direction of Flow: East flowing rivers, such as Godavari, Krishna and Kaveri flow towards the Bay of Bengal, whereas west flowing rivers, like the Narmada and Tapi, flow towards the Arabian Sea.
2. Delta Formation: East-flowing rivers generally form large deltas at their mouths due to the deposition of sediments, whereas west-flowing rivers form estuaries.
3. Length and Basin Size: East-flowing rivers tend to be longer with larger basins compared to west flowing rivers, which have shorter courses and smaller basins.

LONG ANSWER TYPE QUESTIONS

1. The significance of interlinking of rivers in India is very important. Discuss its potential benefits and challenges.

Ans River interlinking in India aims to transfer water from surplus regions to deficit areas, enhancing water availability.

BENEFITS:

1. WATER DISTRIBUTION: Balances water availability across region, aiding agriculture and drinking water supply.
2. FLOOD CONTROL: Reduces flood risks in surplus areas.
3. IRRIGATION: Increases irrigated land, boosting agricultural productivity.
4. HYDROELECTRIC POWER: Potential for hydroelectric power generation.

CHALLENGES:

1. ENVIRONMENTAL IMPACT: Alters ecosystems and affects biodiversity.
2. DISPLACEMENT: Displaces communities due to construction of reservoirs and canals.
3. COST: High financial burden on the government.
4. INTER STATE DISPUTES: Potential for conflicts between states over water sharing.

2. "The Ganga is the most important river of India both from the point of view of its basin and cultural significance." Justify the statement with suitable arguments.

Ans The Ganga River system, originating from the Gangotri Glaciers in the Himalayas, is one of the most significant river systems in India.

Characteristics:

1. PERENNIAL RIVER: Receives water from both rain and glaciers.
2. EXTENSIVE BASIN: Covers a large area including northern India.
3. MAJOR TRIBUTARIES: Includes rivers like Yamuna, Ghaghara and Son.
4. ALLUVIAL PLAINS: Forms fertile plains, beneficial for agriculture.

IMPORTANCE:

1. AGRICULTURE: Supports irrigation, aiding food production.
2. CULTURAL SIGNIFICANCE: Sacred to Hindus, with numerous pilgrimage sites.
3. ECONOMIC ACTIVITY: Facilities fishing, transport and trade.
4. BIODIVERSITY: Supports diverse flora and fauna including endangered species like the Ganga River dolphin.

3. River pollution in India is a major concern. Suggest measures to control it.

Ans **CAUSES:**

1. INDUSTRIAL DISCHARGE: Release of untreated industrial waste into rivers.
2. SEWAGE DISPOSAL: Dumping of untreated sewage from urban areas.
3. AGRICULTURAL RUNOFF: Runoff of pesticides and fertilizers from farmlands.
4. RELIGIOUS ACTIVITIES: Disposal of religious offerings and ashes.

EFFECTS:

1. HEALTH HAZARDS: Contaminated water leads to diseases like cholera and dysentery.

2. ECOSYSTEM DAMAGE: Affects aquatic life, reducing biodiversity.
3. WATER SCARCITY: Polluted water becomes unusable for drinking and irrigation.
4. ECONOMIC LOSS: Affects fisheries and tourism.

MEASURES:

1. TREATMENT PLANTS: Establishment of sewage and industrial effluents treatment plants.
2. REGULATIONS: Strict enforcement of pollution control laws.
3. PUBLIC AWARENESS: Educating the public on the impact of river pollution.
4. SUSTAINABLE PRACTICES: Promoting organic farming and proper waste disposal.

CHAPTER 4
CLIMATE

Definition of Weather and Climate-

- **Weather**: The momentary state of the atmosphere that changes quickly, often within a single day or week. Its primary elements include temperature, pressure, wind, humidity, and precipitation.
- **Climate**: The average of weather conditions recorded over a much longer period, typically noticeable only after 50 years or more.

Unity and Regional Diversity-

- **Broad Unity**: India features a hot monsoonal cli
- mate characterized by a seasonal reversal of wind directions, a feature shared widely across South and Southeast Asia.
- **Temperature Variations**: Summer temperatures can reach 55°C in western Rajasthan while winter temperatures drop to minus 45°C in Leh and Drass. Diurnal temperature ranges vary drastically, from a minor 7–8°C difference in Kerala to a 30–35°C swing in the Thar Desert.
- **Precipitation Variations:** Cherrapunji and Mawsynram in Meghalaya receive over 1,080 cm of annual rainfall, whereas Jaisalmer in Rajasthan rarely exceeds 9 cm. Furthermore, snowfall is strictly confined to the Himalayan region.

Factors Influencing India's Climate

- **Latitude:** The Tropic of Cancer divides the country. The southern tropical zone enjoys high temperatures with low annual ranges, while the northern sub-tropical zone experiences extreme seasonal variations.
- **The Himalayan Mountains:** Act as a formidable climatic barrier that blocks chilly Arctic winds from entering the subcontinent and traps rain-bearing monsoon winds.
- Land and Water Distribution: Differential heating rates of the landmass and the surrounding Indian Ocean create distinct seasonal pressure zones that drive wind reversals.
- **Distance from the Sea:** Coastal areas benefit from an equable maritime climate, whereas landlocked interiors (like Delhi and Amritsar) suffer from continental extremes.
- **Altitude and Relief:** Temperatures decrease with height (e.g., January in Agra is 16°C vs. 4°C in mountainous Darjeeling). Physical relief also dictates rainfall distribution, creating heavy rainfall on windward slopes and dry rain-shadow zones on leeward sides.

Mechanism of the Indian Monsoon

- **Onset**: Intense summer heating over northern India forms a deep thermal low-pressure zone that attracts the southeast trade winds from the Southern Hemisphere. Crossing the equator deflects these into southwest winds due to the Coriolis force.
- **Inter Tropical Convergence Zone (ITCZ)**: In July, this equatorial low-pressure convergence zone shifts north over the Gangetic Plain (becoming the monsoon trough), drawing in moisture-laden winds.
- **Jet Streams**: The seasonal shifting and sudden withdrawal of the westerly jet stream from the northern plains, followed by the positioning of the easterly jet stream along 15°N latitude, triggers the rapid "burst" of the monsoon.
- **El-Nino**: A periodic warm ocean current off the coast of Peru that disrupts global atmospheric circulation, often delaying or weakening the Indian monsoon.
- **Break in the Monsoon**: Temporary dry spells during the rainy season where rain fails for a week or more, caused either by a lack of frequent storms along the trough or winds blowing parallel to the coastline.

Branches of the Southwest Monsoon

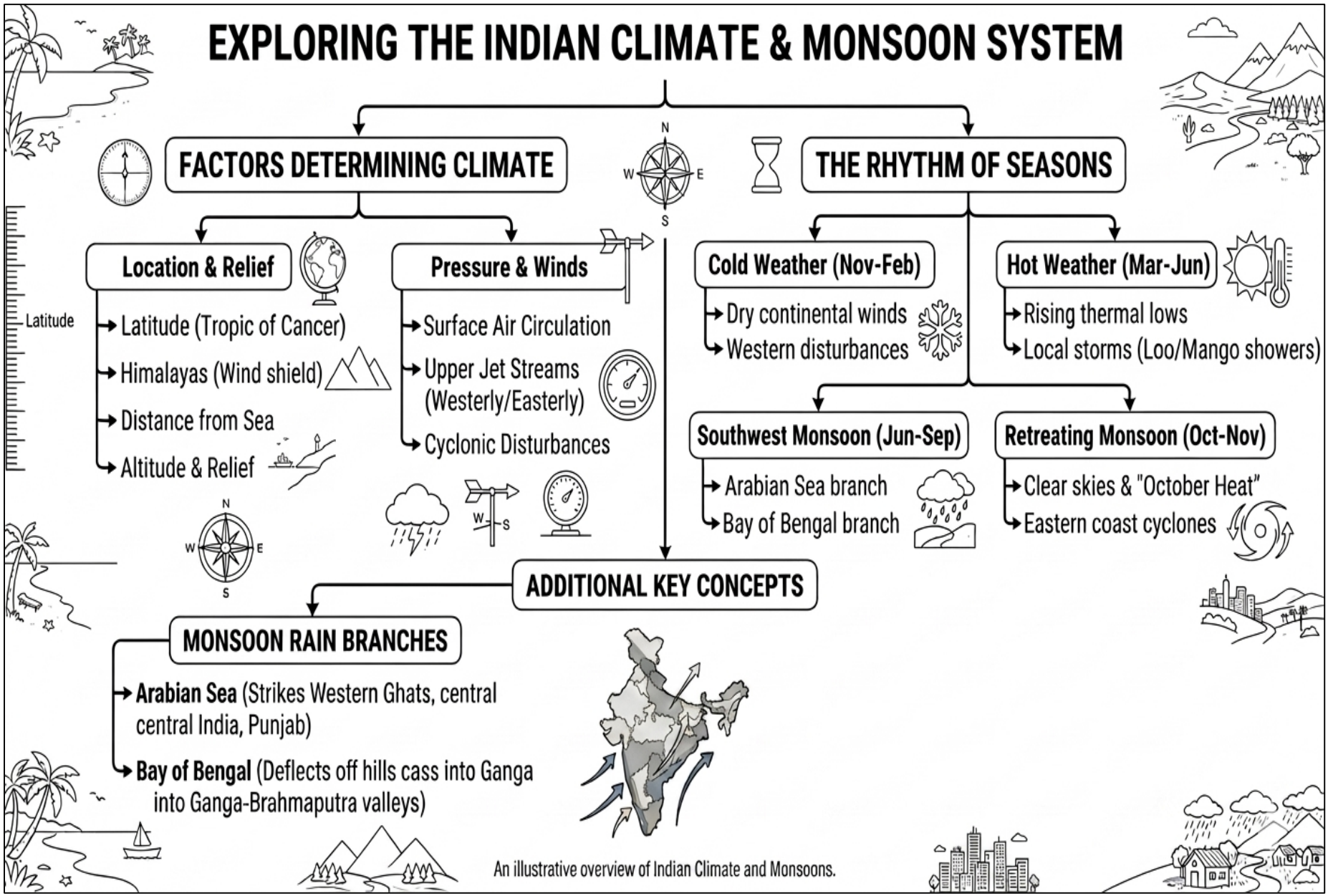
- **Arabian Sea Branch**: Splits into three streams: one hit by the Western Ghats causing heavy windward rain; a second moving along the Narmada and Tapi valleys into central India; and a third moving across Saurashtra and the Aravalis into Punjab.
- **Bay of Bengal Branch**: Enters through West Bengal and Bangladesh, deflected by the Arakan Hills. One sub-stream moves up the Brahmaputra Valley, while the main stream travels westward along the Ganga Plains.
- *Note*: The Tamil Nadu coast remains dry during summer because it runs parallel to the Bay of Bengal branch and lies in the rain-shadow region of the Arabian Sea branch.

The Four Core Seasons-

- **Cold Weather Season (Mid-November to February)**: Characterized by clear skies, low temperatures (below 21°C in the north), and high pressure. Weak temperate cyclones (Western Disturbances) originating from the Mediterranean bring crucial winter rain to northern rabi crops.
- **Hot Weather Season (March to June)**: Marked by rapidly rising temperatures (up to 48°C in the northwest) and falling air pressure. It features local storms like the hot, dry **Loo** winds, **Kalbaisakhi** (Nor'westers) in Bengal, and pre-monsoon **Mango Showers** in Kerala/Karnataka.
- **Southwest Monsoon Season (June to September)**: The primary rainy season across India, initiated by a sudden reduction in temperature and violent thunder/lightning during the monsoon burst.
- **Retreating Monsoon Season (October to November)**: A transition period where the monsoon winds withdraw southward. It causes a brief spell of clear but oppressive, humid weather in northern India known as **October Heat**. Concurrently, severe tropical cyclones crossing the Bay of Bengal bring torrential rains to the eastern Coromandel coast.

Socio-Economic Impact and Global Warming-

- **Economic Axis**: Around 64% of India's population relies directly on agriculture, tying the entire national economic cycle to the timely arrival and distribution of the southwest monsoon.
- **Global Warming Issues**: Anthropogenic emissions of greenhouse gases (CO_2, methane, CFCs, nitrous oxide) are raising temperatures. This accelerates glacial melting, threatens to raise sea levels, alters agricultural patterns, and increases the frequency of extreme flooding and insect-borne diseases.



An illustrative overview of Indian Climate and Monsoons.

MULTIPLE CHOICE QUESTIONS

1. The phenomenon of El Niño is associated with:

A. Changes in wind patterns in the Atlantic Ocean
B. Changes in the temperature of ocean currents in the Pacific Ocean
C. Changes in precipitation patterns in Europe
D. Changes in atmospheric pressure in the Indian Ocean

Ans- B) Changes in the temperature of ocean currents in the Pacific Ocean

2. A farmer notices that the monsoon season is delayed and the rainfall is less than usual. Which of the following actions would be the most effective in addressing the situation?

A. Planting the same crops as usual.
B. Switching to drought-resistant crops.
C. Increasing the use of chemical fertilizers.
D. Irrigating fields using the same methods as in previous years.

Ans- B) Switching to drought-resistant crops.

3. If a region experiences a sudden increase in temperature and a decrease in rainfall over a few years, which of the following impacts is most likely to occur?

A. Expansion of forest cover.
B. Increased agricultural yields.
C. Desertification of the area.
D. Increase in water bodies.

Ans - C) Desertification of the area.

Assertion and Reasoning Questions

A. Both A and R are true, and R is the correct explanation of A.
B. Both A and R are true, but R is not the correct explanation of A.
C. A is true, but R is false
D. A is false, but R is true.

4. **Assertion (A):** The Indian subcontinent experiences a monsoon type of climate.
Reason (R): The monsoon climate in India is influenced by the differential heating of land and water.

Ans- A) Both A and R are true, and R is the correct explanation of A.

5. **Assertion (A):** The Western Ghats receive heavy rainfall during the monsoon season.
Reason (R): The Western Ghats obstruct the moisture-laden winds coming from the Arabian Sea, causing orographic rainfall.

Ans- A) Both A and R are true, and R is the correct explanation of A

6. **Assertion (A):** The coastal areas of India have a moderate climate.
Reason (R): The coastal areas are influenced by the moderating effect of the sea, which reduces temperature extremes.

Ans- A) Both A and R are true, and R is the correct explanation of A.

SHORT ANSWER QUESTION

1. The main features of cold weather season is cold wave in northern India. Explain.

Ans- Winter starts around mid-November and lasts till February.

- December and January are the coldest months in northern India.
- Temperature decreases from south to north.
- Days are warm, while nights are cold with clear skies, low humidity, and variable winds.
- This season is crucial for cultivating "rabi" crops.

2. El Niño affect the Indian monsoon? How?

Ans- El Niño affects the Indian monsoon in the following ways:

1. **Reduction in Monsoon Rainfall:** During El Niño years, the sea surface temperatures in the Pacific Ocean rise significantly, altering global weather patterns. This change often results in a weakening of the Indian monsoon. Regions across India experience below- average rainfall, which can lead to drought conditions in some parts of the country.
2. **Impact on Agricultural Output:** The reduced monsoon rainfall influenced by El Niño can have severe implications for agriculture in India. Crops dependent on timely and sufficient rainfall may suffer, leading to lower agricultural yields. This affects the livelihoods of millions of farmers and can contribute to food insecurity and economic challenges.
3. **Temperature Variations:** El Niño can also lead to variations in temperature across different parts of India. Some regions may experience higher temperatures than usual, exacerbating the effects of reduced rainfall on crops and water resources. This temperature variability can further complicate agricultural planning and management during the monsoon season.

3. Write the salient features of Advancing Monsoon (The Rainy Season).

Ans- The southwest monsoon originates from southeast trade winds over warm subtropical areas,crossing the equator and entering India as the southwest monsoon.

- The monsoon covers the country for about a month, with regions like Mawsynram in the Khasi Hills receiving the highest average rainfall globally.
- The monsoon is characterized by breaks in rainfall, influenced by the movement of the monsoon trough and the frequency and intensity of tropical depressions.

LONG ANSWER QUESTION

1. There are many distinct seasons are found in India as per the Indian Meteorological Department? Discuss the weather conditions associated with any one season in detail.

Ans. In India, as per the Indian Meteorological Department, there are four distinct seasons:

a. Winter Season (from December to February)
b. Summer Season (from March to May)
c. Southwest monsoon season (from June to September)
d. Retreating Monsoon (from October to November).

Retreating/Post Monsoons (The Transition Season):

- October-November marks the transition from the hot rainy season to dry winter conditions.
- The retreat of the monsoon brings clear skies and rising temperatures.

- Day temperatures are high, while nights are cool and pleasant.
- Towards the end of October, temperatures start to decrease rapidly in northern India.

2. So many factors determine the climate of India. Discus.

Ans. Factors determine the climate of India

- **Latitude:** India stretches across different latitudes, resulting in varied climates. The southern parts near the equator are tropical with consistently high temperatures, while the northern regions have sub-tropical and temperate climates with more temperature variations.
- **Himalayan Mountains:** The Himalayas act as a barrier that blocks cold northern winds and influences the path of monsoon winds. They cause these winds to release moisture over India, affecting rainfall patterns.
- **Land and Water Distribution:** India's positioning with the Indian Ocean on three sides affects its climate. Coastal areas have milder climates due to the ocean's moderating influence, while inland regions experience more extreme weather variations.
- **Altitude:** Temperature decreases as altitude increases. Mountainous regions like Darjeeling, at higher altitudes, are cooler than plains areas like Agra, even if they are at similar latitudes.
- **Relief:** Geographical features such as mountains and plateaus affect India's climate. Regions like the windward side of the Western Ghats receive heavy rainfall during monsoons, while the leeward side remains dry due to sheltering from rain-bearing winds.

CHAPTER 5: NATURAL VEGETATION

GIST OF THE LESSON

- Natural vegetation refers to a plant community that has been left undisturbed over a long time, so as to allow its individual species to adjust themselves to climate and soil conditions as fully as possible.
- Himalayan heights are marked with the different types of vegetation according to altitude.
- The Western and Eastern Ghats and the Andaman Nicobar Islands have tropical rain forests while the deltaic regions have tidal forests (mangroves). The desert and semi-desert areas of Rajasthan are known for cactii, a wide variety of bushes and thorny vegetation.
- Depending upon the variations in the climate and the soil, the vegetation of India changes from one region to another.
- On the basis of certain common features such as predominant vegetation type and climatic regions, Indian forests can be divided into various groups.

Types of Forests-

A. Tropical Evergreen and Semi Evergreen forests

B. Tropical Deciduous forests

C. Tropical Thorn forests
D. Montane forests
E. Littoral and Swamp forests

The Tropical Evergreen and Semi Evergreen forests-

A. **The Tropical Evergreen forests-**

- These forests are found in the western slope of the Western Ghats, Eastern slopes of eastern Ghats, hills of the northeastern states and the Andaman and Nicobar Islands.
- They are found in warm and humid areas with an annual precipitation of over 200 cm and mean annual temperature above 22° C.
- Tropical evergreen forests are well stratified, with layers closer to the ground and are covered with shrubs and creepers, with short structured trees followed by tall variety of trees.
- Trees reach great heights up to 60 m or above.
- There is no definite time for trees to shed their leaves, flowering and fruition. As such these forests appear green all the year round.
- Species found in these forests include rosewood, mahogany, aini, ebony, etc.

B. **Semi Evergreen Forest-**

- The semi evergreen forests are found in the less rainy parts of these regions.
- Such forests have a mixture of evergreen and moist deciduous trees.
- The under growing climbers provide an evergreen character to these forests.
- Main species are white cedar, hollock and kail.
- The oak forests in Garhwal and Kumaon were replaced by pine (chirs) which was needed to lay railway lines.
- Forests were also cleared for introducing plantations of tea, rubber and coffee.

C. **Tropical Deciduous Forests-**

- These are the most widespread forests in India.
- They are also called the monsoon forests.
- They spread over regions which receive rainfall between 70-200 cm.
- On the basis of the availability of water, these forests are further divided into moist and dry deciduous.

Moist deciduous forests

- They are mostly found in the regions which record rainfall between 100-200 cm. These forests are found in the northeastern states along the foothills of the Himalayas, eastern slopes of the Western Ghats and Odisha.
- Teak, sal, shisham, mahua, amla, semul, kusum, and sandalwood etc. are the main species of these forests.

Dry deciduous forests

- Covers vast areas of the country.
- Rainfall ranges between 70 -100 cm.
- On the wetter margins, it has a transition to the moist deciduous, while on the drier margins to thorn forests.
- These forests are found in rainier areas of the Peninsula and the plains of Uttar Pradesh and Bihar.
- Parklands are found In the higher rainfall regions of the Peninsular plateau and the northern Indian plain.
- As the dry season begins, the trees shed their leaves completely and the forest appears like a vast grassland with naked trees all around.
- Tendu, palas, amaltas, bel, khair, axlewood, etc. are the common trees of these forests. In the western and southern part of Rajasthan, vegetation cover is very scanty due to low rainfall and overgrazing.

D. **Tropical Thorn Forests**

- Tropical thorn forests occur in the areas which receive rainfall less than 50 cm.
- These consist of a variety of grasses and shrubs.
- It includes semi-arid areas of south-west Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh.
- In these forests, plants remain leafless for the most part of the year and give an expression of scrub vegetation.
- Important species found are babool, ber, and wild date palm, khair, neem, khejri, palas, etc.
- Tussocky grass grows upto a height of 2 m as the under growth.

E. Montane Forests.

- In mountainous areas, the decrease in temperature with increasing altitude leads to a corresponding change in natural vegetation.
- Mountain forests can be classified into two types, the northern mountain forests and the southern mountain forests.
- The Himalayan ranges show a succession of vegetation from the tropical to the tundra, which changes in with the altitude.
- Deciduous forests are found in the foothills of the Himalayas.
- It is succeeded by the wet temperate type of forests between an altitude of 1,000-2,000 m.

F. Littoral And Swamp Forests

India's wetlands have been grouped into eight categories:

1. The Reservoirs of the Deccan plateau in the south together with the lagoons and other wetlands of southern west coast.
2. The vast saline expenses of Rajasthan Gujarat and the Gulf of Kachchhh.
3. Freshwater lakes and reservoirs from Gujarat eastward through Rajasthan (Keoladev National park) and Madya Pradesh.

4. The delta wetlands and lagoons of India's east coast (Chilika Lake).
5. The freshwater marshes of the Gangetic Plain.
6. The floodplains of the Brahmaputra, the marshes and swamps in the hills of northeast India and the Himalayan foothills.
7. The lakes and rivers of the montane region of Kashmir and Ladakh.
8. The mangrove forest and other wetlands of the island arcs of Andaman and Nikobar Islands.

In India, the mangrove forests spread over 6,740 sq. km which is 7 percent of the world's mangrove forests. They are developed in Andaman and Nicobar Islands, Sunderbans of West Bengal, the Mahanadi, the Godavari and the Krishna deltas.

Forest Conservation

India has implemented several measures to conserve its forests:

1. Forest Conservation Act, 1980: Restricts deforestation and the use of forest land for non- forest purposes without central government approval.
2. National Afforestation Programme: Promotes afforestation and reforestation activities.
3. Joint Forest Management: Involves local communities in the protection and management of forests.

Social Forestry

Social forestry aims to involve the local population in forest management and afforestation projects to meet the needs of rural and urban people. It includes:

1. Agro forestry: Combining agricultural crops with tree planting.
2. Community Forestry: Community involvement in raising and protecting trees.
3. Urban Forestry: Planting trees in urban areas to improve the environment.

Farm Forestry

Farm forestry involves farmers growing trees on their own land. This practice helps in meeting the demand for timber, fuel, fodder, and other forest products, reducing the pressure on natural forests.

Wildlife in India

India is home to diverse wildlife, including mammals, birds, reptiles, and amphibians. Notable species include the Bengal tiger, Indian elephant, Indian rhinoceros, and various species of deer and antelope.

It’s estimated that around 4-5% of all known plant and animal species on Earth are found in India, owing to its diverse ecosystems preserved over ages. However, human activities have disturbed their habitats, leading to a significant decline in their numbers. Some species are on the verge of extinction.

Several factors contribute to the decline of wildlife:

1. Industrial and technological advancements have led to increased exploitation of forest resources.
2. Expansion of agriculture, human settlements, roads, mining, and reservoirs has resulted in habitat loss.
3. Local communities cut trees for fodder and fuel wood, affecting wildlife and their habitat.
4. Hunting, once a sport for the elite, has now turned into commercial poaching.
5. Forest fires also pose a threat to wildlife and their habitats.

Recognizing the importance of wildlife conservation for national and global heritage, as well as the promotion of ecotourism, the government has taken steps in this direction.

Wildlife Conservation in India

Efforts for wildlife conservation include:

1. Wildlife Protection Act, 1972: Provides legal protection to wildlife and establishes protected areas.
2. Project Tiger: Launched in 1973 to conserve the Bengal tiger.
3. Project Elephant: Launched in 1992 to protect elephants and their habitats.
4. Protected Areas: Includes national parks, wildlife sanctuaries, and conservation reserves.

Biosphere Reserves

Biosphere reserves are areas designated to promote the conservation of biodiversity, research, and sustainable development. India has several biosphere reserves, including:

1. Nilgiri Biosphere Reserve: Encompasses parts of Tamil Nadu, Kerala, and Karnataka.
2. Sundarbans Biosphere Reserve: Famous for its mangrove forests and Royal Bengal tigers.
3. Gulf of Mannar Biosphere Reserve: Known for its marine biodiversity.
4. Nanda Devi Biosphere Reserve: Located in the Himalayan region, it supports a wide range of flora and fauna.

GIST OF THE LESSON: NATURAL VEGETATION AND WILDLIFE IN INDIA

MEANING:
Natural vegetation refers to plant life (forests, grasslands, shrubs) that grows naturally in an area without human intervention.

TYPES OF FOREST IN INDIA

Tropical Evergreen & Semi-Evergreen

Tropical Evergreen & Semi-Evergreen
Locations:
Western Ghats, A&N Islands, North-East.
Dense, multi-layered.

Tropical Deciduous (Monsoon Forests)

Tropical Deciduous (Monsoon Forests)
Locations:
Central, Northern India.
Shed leaves in dry season.

Tropical Thorn Forests

Tropical Thorn Forests
Locations:
Rajasthan, Gujarat, Haryana.
Low rainfall, thorny, thick bark.

Montane Forests

Montane Forests
Locations:
Himalayas.
Varies with altitude.

Littoral & Swamp (Mangrove Forests)

Littoral & Swamp (Mangrove Forests)
Locations:
Coastal, Estuaries.
Stilt roots in salty water.

FACTS:
4-5% of global plant & animal species.
Declining numbers.

WILDLIFE IN INDIA

Bengal Tiger | Elephant | Rhino | Deer

Causes of Wildlife Decline

Industrial exploitation | Agriculture expansion | Fuelwood cutting | Poaching | Forest Fires

Wildlife Conservation Efforts

Wildlife Protection Act, 1972 | **Project Tiger** (1973) | **Project Elephant** (1992) | **Protected Areas** (National Parks, Sanctuaries)

Forest Cover: ~21.71%

Very Dense (≥70%) | **Moderately Dense** (40-70%) | **Open** (10-40%)

Very Dense (≥70%) | **Moderately Dense** (40-70%) | **Open** (10-40%)

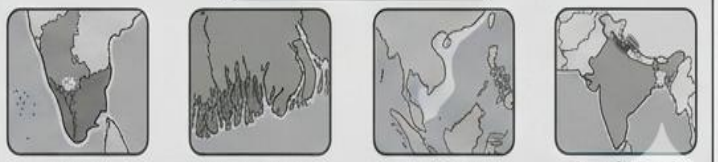
Forest Conservation Measures

Forest Conservation Act, 1980 | **National Afforestation Programme** | **Joint Forest Management**

Social & Farm Forestry

Agro-forestry | **Community** | **Urban** | **Farm Forestry**

BIOSPHERE RESERVES



Nilgiri (TN, KL, KA) | **Sundarbans** (Mangroves & Tigers) | **Gulf of Mannar** (Marine Biodiversity) | **Nanda Devi** (Himalayan Flora & Fauna)

MULTIPLE CHOICE QUESTIONS

Assertion and Reasoning

A. Both A and R are true and R is the correct explanation of A.
B. Both A and R are true but R is not the correct explanation of A.
C. A is true but R is false.
D. A is false but R is true.

1. **Assertion (A):** The dry deciduous forests are found in areas having rainfall between 100 -200 cm.
   Reason (R): These forests are found in rainier areas of the peninsular and the plains of Bihar and Uttar Pradesh.

Ans- D) A is false but R is true.

2. **Assertion (A):** The mangrove tidal forests are found in the areas of coasts influenced by tides.
   Reason (R): At higher elevations, temperate grasslands are common.

Ans- B) Both A and Rare true but R is not the correct explanation of A.

3. **Assertion (A):** Thorn Forests and shrubs receive less than 50 cm of rainfall.
   Reason (R): This type of vegetation is found in the north-eastern part of the India.

Ans- C) A is true but R is false.

4. **Assertion (A):** In India almost the entire rainfall in brought in by the advancing southwest monsoon.
   Reason (R): Areas of heavy rainfall have more dense vegetation as compared to other areas of heavy rainfall.

Ans- D) A is false but R is true.

SHORT ANSWER QUESTIONS

1. India has different types natural vegetation. Under what climatic conditions do tropical evergreen forests develop?

Ans: Natural vegetation refers to a plant community that has been left undisturbed over a long time, so as to allow its individual species to adjust themselves to climate and soil conditions as fully as possible.
India is a land of great variety of natural vegetation.

- Tropical Evergreen forests are found in the western slope of the Western Ghats, hills of the north eastern region and the Andaman and Nicobar Islands.

- They are found in warm and humid areas with an annual precipitation of over 200 cm and mean annual temperature above 22°C.

2. Social forestry is a part of rural area in India. Comment

Ans: Social forestry means the management and protection of forests and afforestation on barren lands with the purpose of helping in the environmental, social and rural development.
The National Commission on Agriculture (1976) has classified social forestry into three categories. These are-
1. Urban forestry, 2. Rural forestry and 3. Farm forestry.

3. Biosphere reserves conserve diversity flora and fauna in India. Justify

Ans: A Biosphere Reserve is a unique and representative ecosystem of terrestrial and coastal areas which are internationally recognised within the framework of UNESCO's Man and Biosphere (MAB) Programme. The Biosphere Reserve aims at achieving the three objectives:

- Conservation of biodiversity and ecosystem
- Association of environment with development;
- Providing international network in research and monitoring.

4. What measures can be taken to conserve and protect natural vegetation in India's rapidly urbanizing areas?

Ans: Conservation measures include enforcing strict regulations on land use, promoting afforestation and reforestation programs, creating urban green spaces, protecting existing natural reserves, and raising public awareness about the importance of preserving natural vegetation in urban areas. Additionally, integrating green infrastructure into urban planning can help mitigate the impact of urbanization on natural vegetation.

5. How do the climatic conditions of the Western Ghats contribute to the diversity of vegetation found there?

Ans: The Western Ghats receive heavy rainfall due to their proximity to the monsoon winds. The varied altitude and temperature in this region create a range of microclimates, supporting diverse types of vegetation such as tropical evergreen forests, deciduous forests, and montane forests.

LONG ANSWER QUESTIONS

1. What are the main objectives of National forest policy of India?

Ans: **Objectives of new forest policy are:**

- Bringing 33% of the geographical areas under forest cover.
- Maintaining environmental stability and to restore forests where ecological balance was disturbed.
- Conserving the natural heritage of the country.
- Its biological diversity and gentle pool.
- Checks soil erosion extension of the deserts land and reduction of floods and droughts.
- Increasing the forest cover through social forestry and afforestation on degraded lands.
- Increasing the productivity of forest to make timber, fuel, fodder and food available to rural population dependent on forests and encourage the substitution of wood.
- Creating massive people's movement involving women to encourage planting of trees, stop felling of trees and thus, reduce pressure on the existing forest.

2. Wildlife in India is in danger. Comment.

Ans: Important reasons for the decline of Wildlife in India are-

- Industrial and technological advancement brought about a rapid increase in the exploitation of forest resources.

- More and more lands were closed for agriculture, human settlement, roads, mining, resources, etc.
- Pressure on forests maintained due to looping for fodder and fuel, wood and removal of small timber by the local people.
- Grazing by domestic cattle caused an adverse effect on wildlife and its habitat.
- Hunting was taken up as a sport by the elite and hundreds of wild animals were killed in a single hunt.
- Now commercial poaching is rampant.
- Incidence of forest fire.

3. Examine the conservation strategies implemented to protect natural vegetation in India.

Ans: India has implemented a range of conservation strategies to protect its natural vegetation, focusing on safeguarding biodiversity, restoring degraded ecosystems, and promoting sustainable resource use.

National Parks and Wildlife Sanctuaries are the cornerstone of India's conservation efforts. These protected areas, such as Ranthambore National Park and Periyar Wildlife Sanctuary, are critical for the conservation of endangered species and their habitats. They serve as refuges for wildlife, protecting them from hunting, habitat destruction, and other human disturbances. However, the management of these areas faces challenges, including human-wildlife conflicts, inadequate funding, and encroachment by local communities.

Biosphere Reserves, such as the Nilgiri and Sundarbans Biosphere Reserves, represent a holistic approach to conservation. These reserves include core zones with strict protection, buffer zones with limited human activity, and transition zones where sustainable development practices are encouraged. This zoning helps balance conservation with the needs of local communities, promoting the sustainable use of natural resources while protecting biodiversity. Biosphere reserves also serve as sites for research and education, helping to raise awareness about the importance of conservation.

Afforestation and Reforestation programs are crucial for restoring degraded ecosystems and increasing forest cover. Initiatives like the Green India Mission aim to enhance carbon sequestration, improve biodiversity, and support rural livelihoods through the planting of native species. These programs are particularly important in regions where deforestation has led to soil erosion, loss of biodiversity, and reduced agricultural productivity.

Legal frameworks, such as the Forest Conservation Act of 1980 and the Wildlife Protection Act of 1972, provide the legal basis for protecting forests and wildlife in India. These laws regulate land use, restrict deforestation, and establish penalties for illegal activities. However, effective enforcement remains a challenge, particularly in remote and conflict-prone areas.

Despite these efforts, challenges persist, including illegal logging, poaching, and the pressures of development. To overcome these challenges, there is a need for stronger enforcement of laws, greater community involvement, and the integration of conservation with sustainable development goals.

Chapter 6 : Natural Hazards and Disasters

(To be tested through internal assessments in the form of project and presentation)

<table>
<tr><td colspan="2">Map Work
Book- Fundamentals of Physical Geography
(Map items for locating and labelling only on the outline political world map)</td></tr>
<tr><td>Chapter</td><td>Map item (Map present on official website of Govt. of India should be used)</td></tr>
<tr><td>Chapter 4
Distribution of oceans and continents</td><td>● Political Map of all Continents of the world.
● Major Oceans of the world: Indian Ocean, Pacific Ocean, Atlantic Ocean, Arctic Ocean, Southern Ocean • Major lithospheric plates and Minor lithospheric plates, Ring of fire (Pacific Ocean), Mid-
Atlantic Ridge.</td></tr>
<tr><td>Chapter 9
Atmospheric Circulations and
Weather Systems</td><td>Major Hot Deserts of the world:
● Mojave Desert- Nevada, US
● Patagonian Desert- Argentina
● Sahara- Africa
● Gobi Desert- Mongolia, Asia
● Thar desert- India
● Great Victoria Desert- Australia</td></tr>
<tr><td>Chapter 12
Water (Oceans)</td><td>● Major Seas
● Black sea
● Baltic sea
● Caspian Sea
● Mediterranean Sea
● North Sea
● Red sea
● Bay of Fundy (Canada)-Famous for the highest tides in the world</td></tr>
<tr><td>Chapter 13
Movements of Ocean Water</td><td>Ocean Currents
<table>
<tr><th>Cold currents</th><th>Warm currents</th></tr>
<tr><td>● Humboldt c.
● California c.
● Falkland c.
● Canaries c.
● West Australian c.
● Oyashio c.
● Labrador c</td><td>● Alaska c.
● Brazilian c.
● Agulhas c.
● Kuroshio c.
● Gulf stream c.</td></tr>
</table></td></tr>
</table>

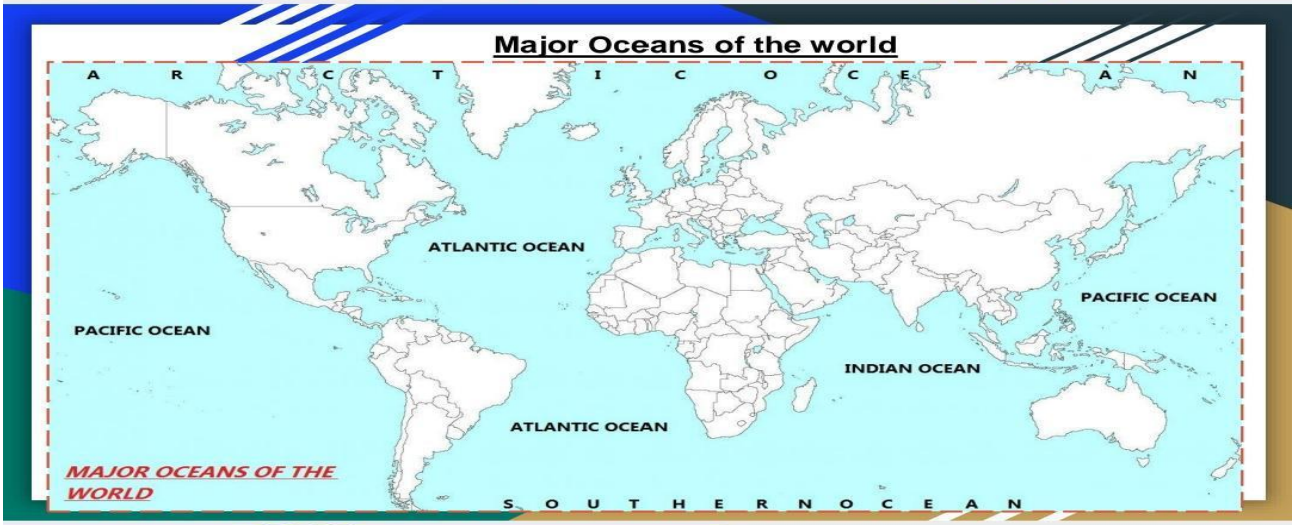
Chapter 14 Biodiversity and Conservation	**Ecological hotspots** ● Eastern Himalaya, India ● Western ghats, India ● Indonesia, Asia ● Eastern Madagascar, Africa ● Upper Guinean forests, Africa ● Atlantic forest, Brazil ● Tropical Andes

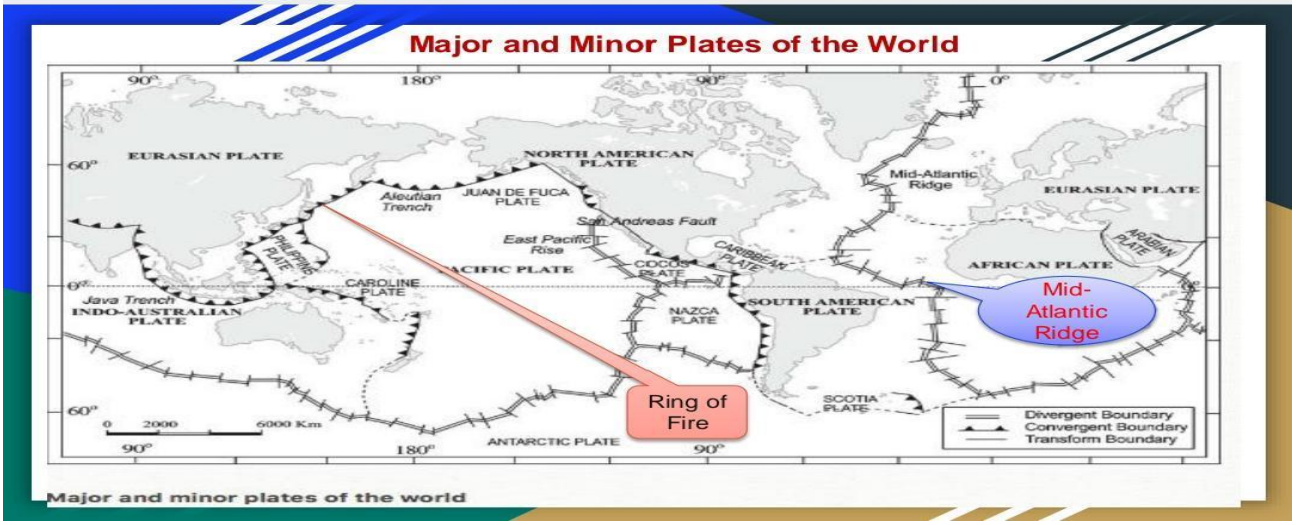
Map Work **Book- India Physical Environment** **(Map items for locating and labelling only on the outline political map of India)**	
Chapter	**Map item (Map present on official website of Govt. of India should be used)**
Chapter-1 India- Location	● Latitudinal extent of India ● Longitudinal extent of India ● Standard Meridian of India ● Important latitude passing through India (Tropic of Cancer) ● Southern Most Point of mainland of India (Kanya Kumari)
Chapter-2 Structure and Physiography	● Mountains: Karakoram Range, Garo- Khasi- Jaintia hills, Aravalli Range, Vindhyan Range, Satpura Range, Western ghats & Eastern ghats ● Peaks: K2, Kanchenjunga, Nandadevi, Nanga Parvat, Namcha Barwa and Anaimudi ● Passes: Shipkila, Nathula, Palghat, Bhor ghat and Thal ghat ● Plateaus: Malwa, Chhotnagpur, Meghalaya and Deccan Plateau. ● Coastal Plains: Saurashtra, Konkan, North and South Kanara, Malabar, Coromandel and Northern Circars ● Islands: Andaman & Nicobar Islands and Lakshadweep Islands
Chapter-3 Drainage System	● Rivers: Brahmaputra, Indus, Satluj, Ganga, Yamuna, Chambal, Damodar, Mahanadi, Krishna, Kaveri,Godavari, Narmada, Tapti and Luni ● Lakes: (Identification)Wular, Sambhar, Chilika, Kolleru, Pulicat & Vembanad ● Straits, Bays , Gulfs: Palk Strait, Rann of Kachchh, Gulf of Kachchh, Gulf of Mannar & Gulf of Khambat

Chapter-4 Climate	● Area with highest temperature in India ● Area with lowest temperature in India ● Area with highest rainfall in India ● Area with lowest rainfall in India
Chapter-5 Natural Vegetation	(Identification on an outline map of India) Tropical evergreen, Tropical deciduous, Tropical thorn, Montane and Littoral/ Swamp forests. Wildlife reserves: (locating and labeling) ● National Parks: Corbett, Kaziranga, Ranthambore. Shivpuri, Simlipal ● Bird Sanctuaries: Keoladeo Ghana and Ranganathittu Wild life Sanctuaries: Periyar, Rajaji, Mudumalai, Dachigam,

MAP WORK

Book 1 World map
Chapter 4 Distribution of Oceans and continents





CHAPTER 9 ATMOSPHERIC CIRCULATION AND WEATHER SYSTEM

Major Hot Desert of The World

1. Mojave Desert- Nevada, US
2. Patagonian Desert- Argentina
3. Sahara- Africa
4. Gobi Desert- Mongolia, Asia
5. Thar desert- India
6. Great Victoria desert- Australia

1. Locate and Label following major seas on the physical map of the World.

1. Black sea
2. Baltic sea
3. Caspian Sea
4. Mediterranean Sea
5. North Sea
6. Red sea
7. Bay of Fundy (Canada)-Famous for the highest tides in the world

CHAPTER 13 MOVEMENTS OF OCEAN WATER

1. Locate and Label following ocean currents on the physical map of the World.

A. Cold Currents–

1. Humboldt Current
2. California Current
3. Falkland Current
4. Canaries Current
5. West Australian Current
6. Oyashio Current
7. Labrador Current

B. Warm Currents–

1. Alaska Current
2. Brazilian Current
3. Aughlas Current
4. Kuroshio Current
5. Gulf stream Current

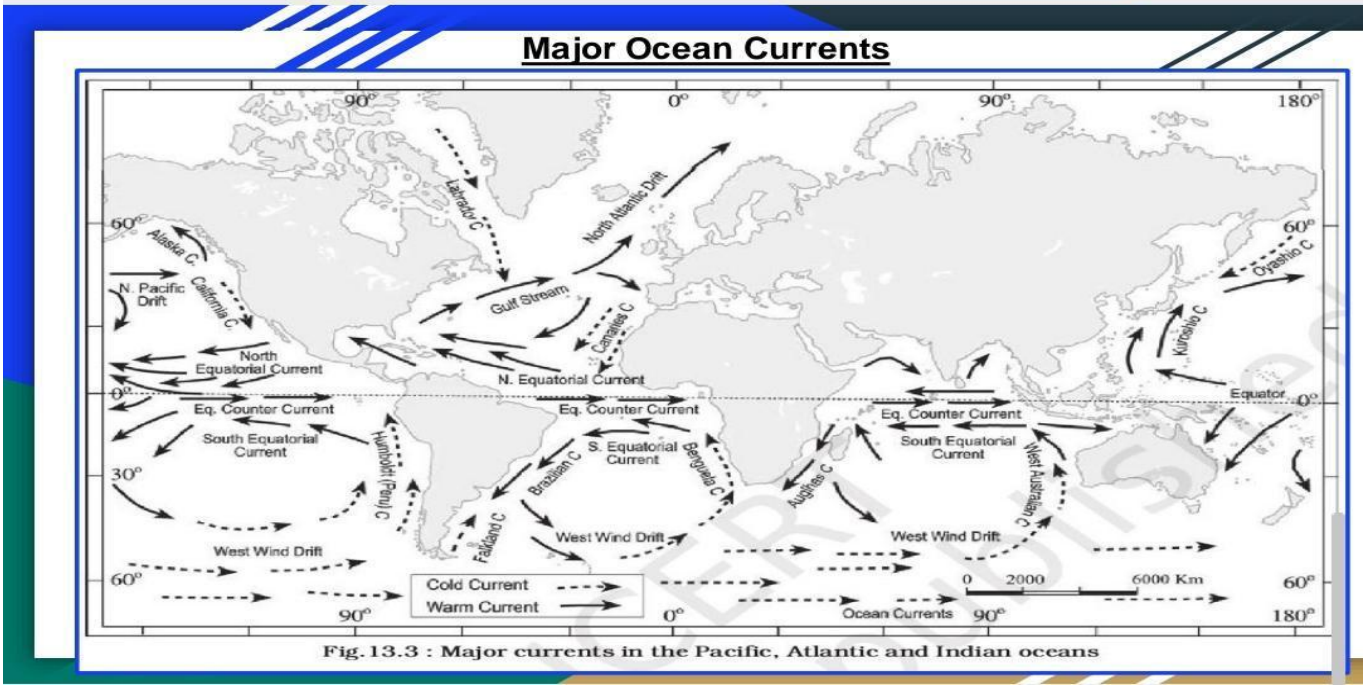
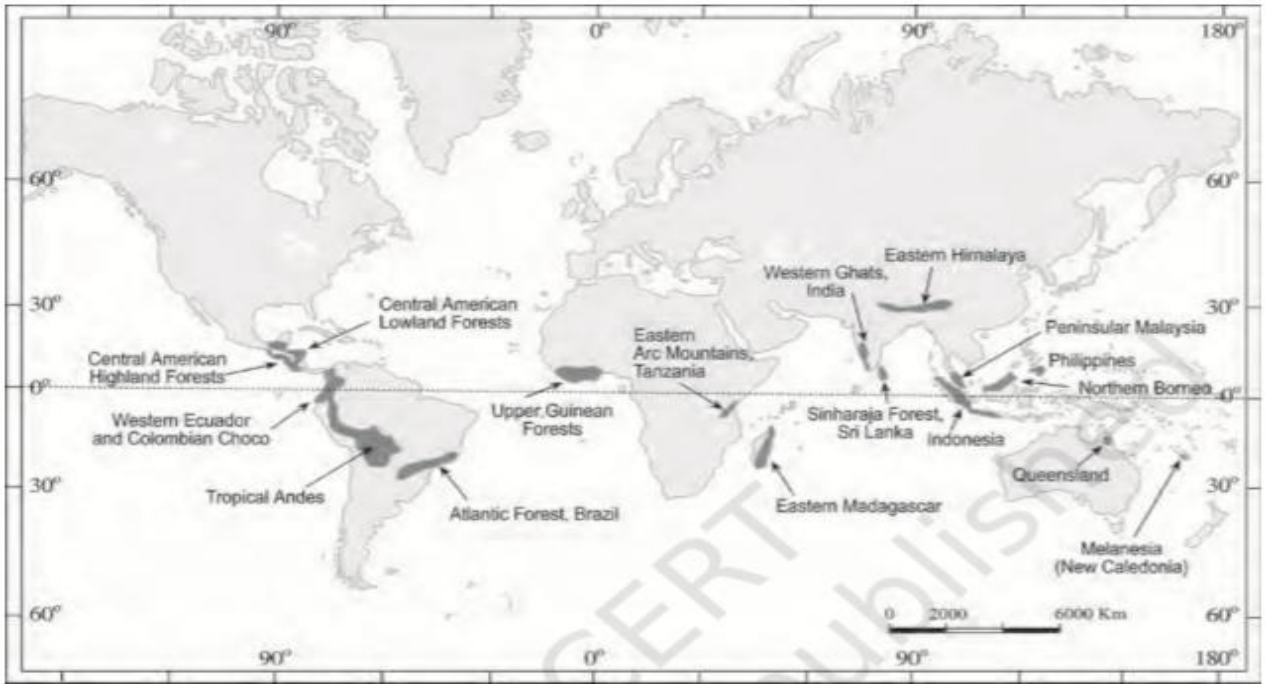


Fig. 13.3 : Major currents in the Pacific, Atlantic and Indian oceans

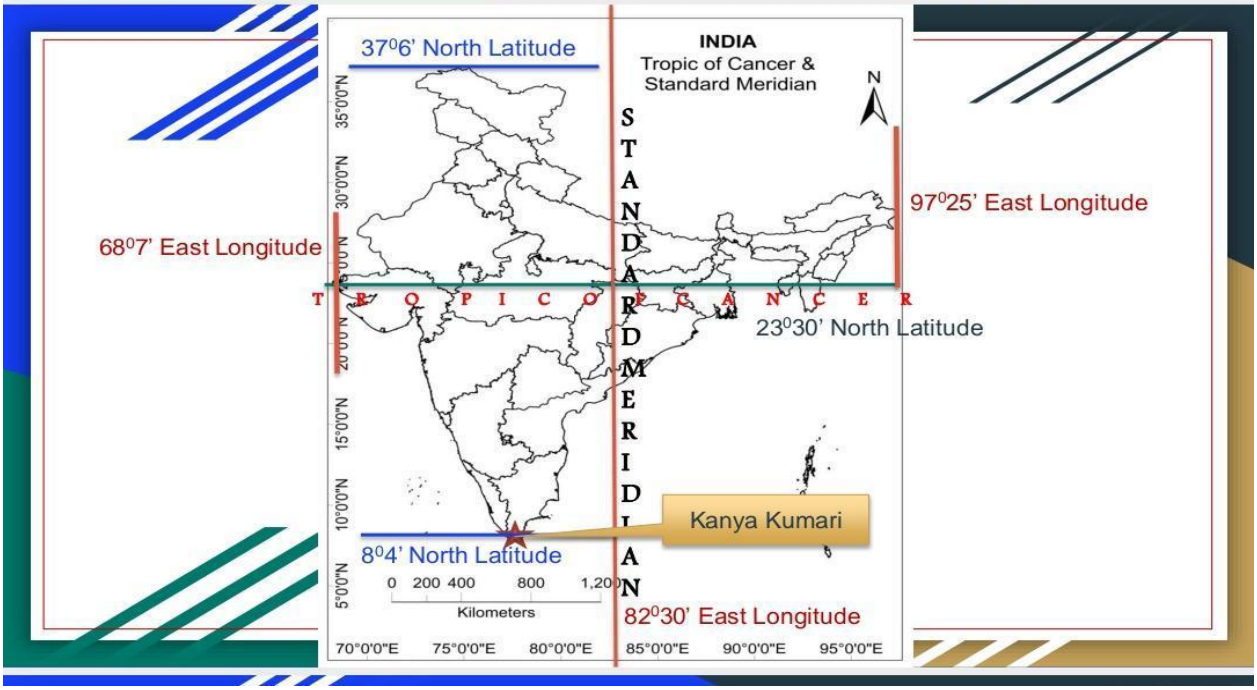


BOOK 2 INDIA MAP
CHAPTER 1 INDIA LOCATION

CHAPTER: 1- INDIA- LOCATION

Q1. Locate and label following features on political map of India.

1. Latitudinal extent of India.
2. Longitudinal extent of India.
3. Standard Meridian of India.
4. Important latitude passing through India (Tropic of Cancer).
5. Southern Most Point of main land of India (Kanya Kumari).

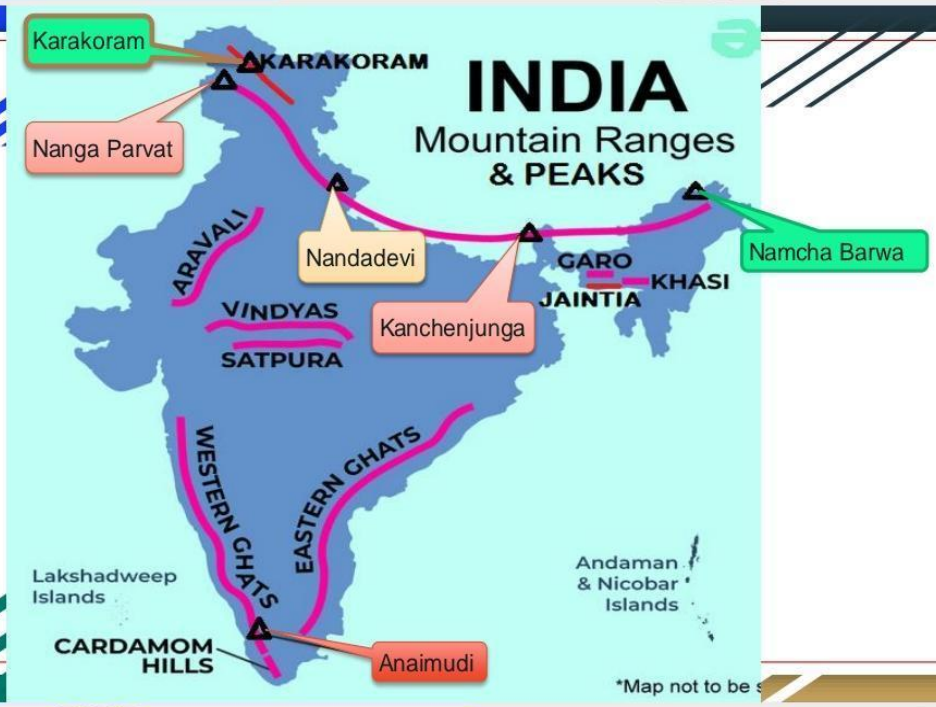


CHAPTER: 2- STRUCTURE AND PHYSIOGRAPHY

Q1. Locate and label following features on political map of India.

A. Mountains: Karakoram Range, Garo- Khasi- Jaintia hills, Aravalli Range, Vindhyan Range, Satpura Range, Western ghats & Eastern ghats.

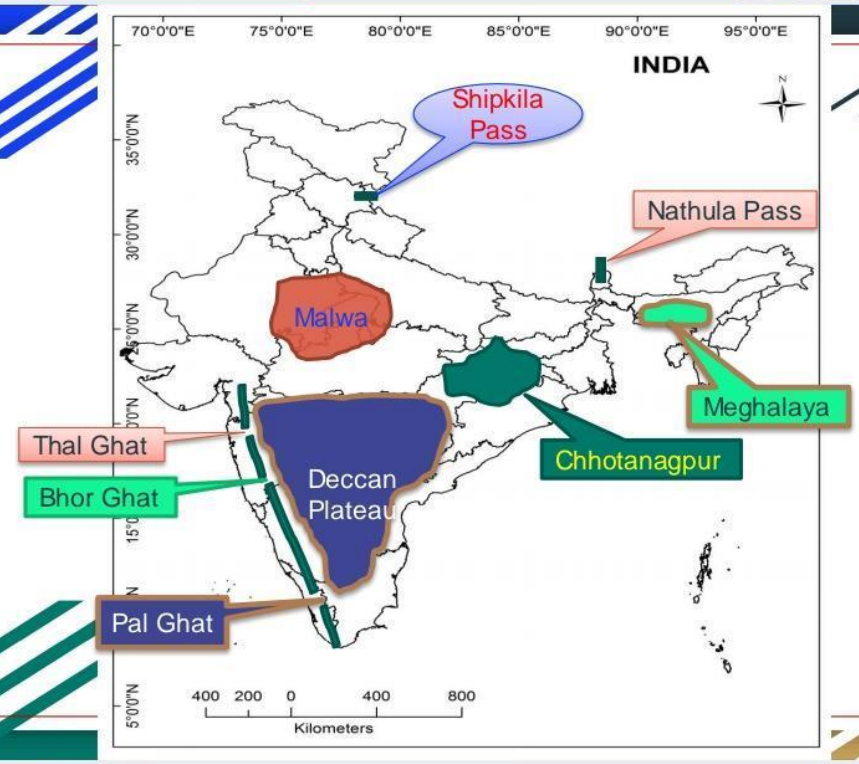
B. Peaks: K2, Kanchenjunga, Nandadevi, Nanga Parvat, Namcha Barwa and Anaimudi.



Q2. Locate and label following features on political map of India.

C. Plateaus: Malwa, Chhotanagpur, Meghalaya and Deccan Plateau.

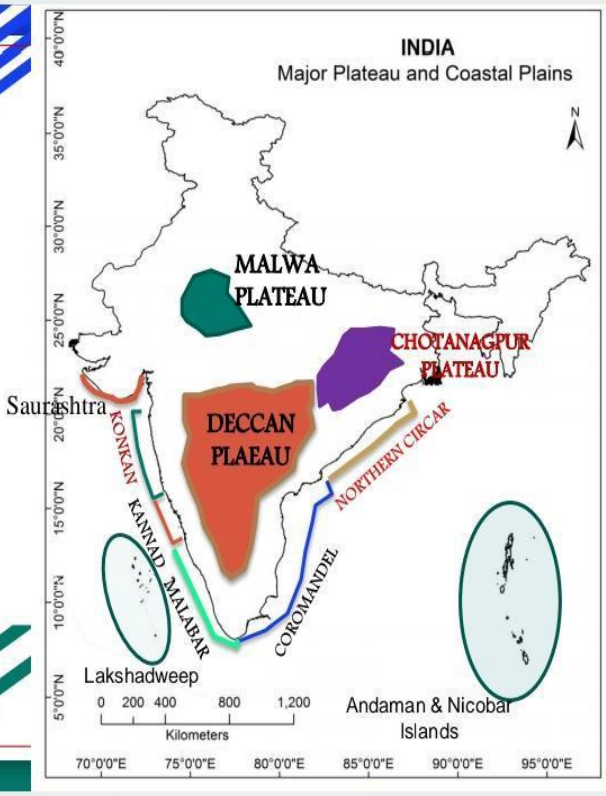
D. Passes: Shipkila, Nathula, Palghat, Bhor ghat and Thal ghat.



Q3. Locate and label following features on political map of India.

E. Coastal Plains: Saurashtra, Konkan, North and South Kanara, Malabar, Coromandel and Northern Circar.

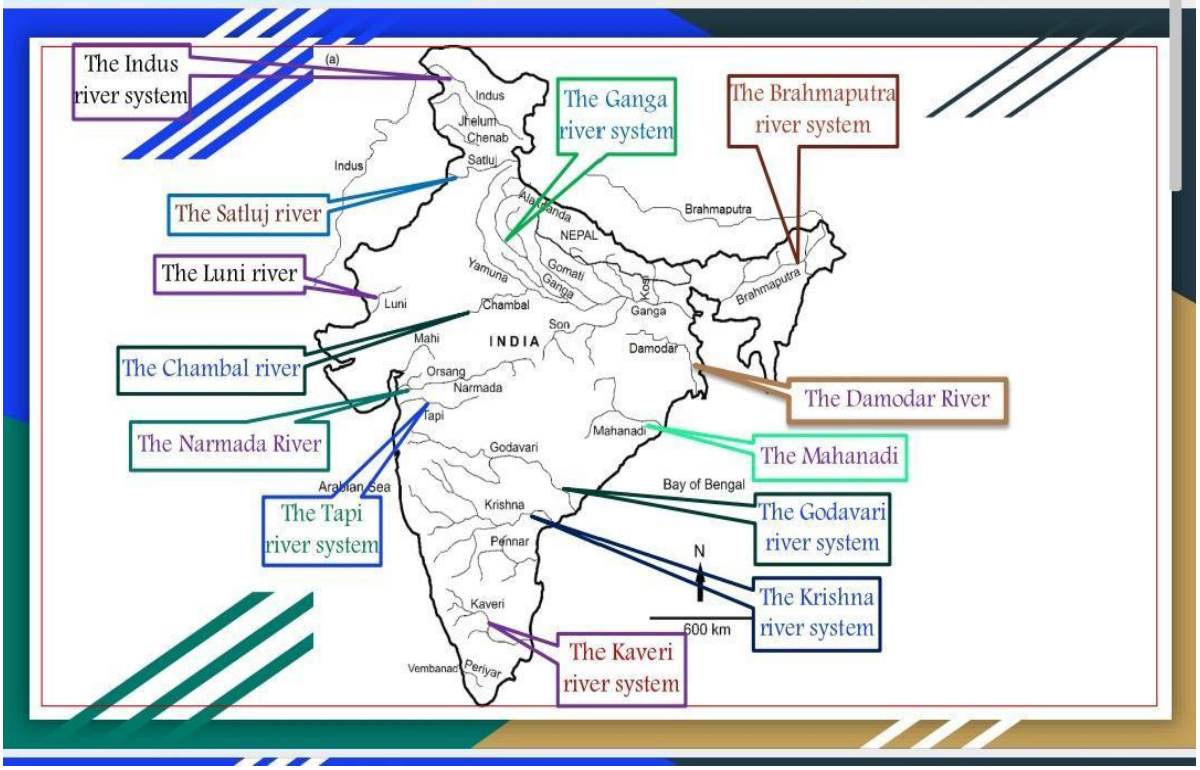
F. Islands: Andaman & Nicobar Islands and Lakshadweep Islands.



CHAPTER: 3- DRAINAGE SYSTEM

Q1. Locate and label following features on political map of India.

A. Rivers: Brahmaputra, Indus, Satluj, Ganga, Yamuna, Chambal, Damodar Mahanadi, Krishna, Kaveri, Godavari, Narmada, Tapti and Luni.



Q2. Locate and label following features on political map of India.

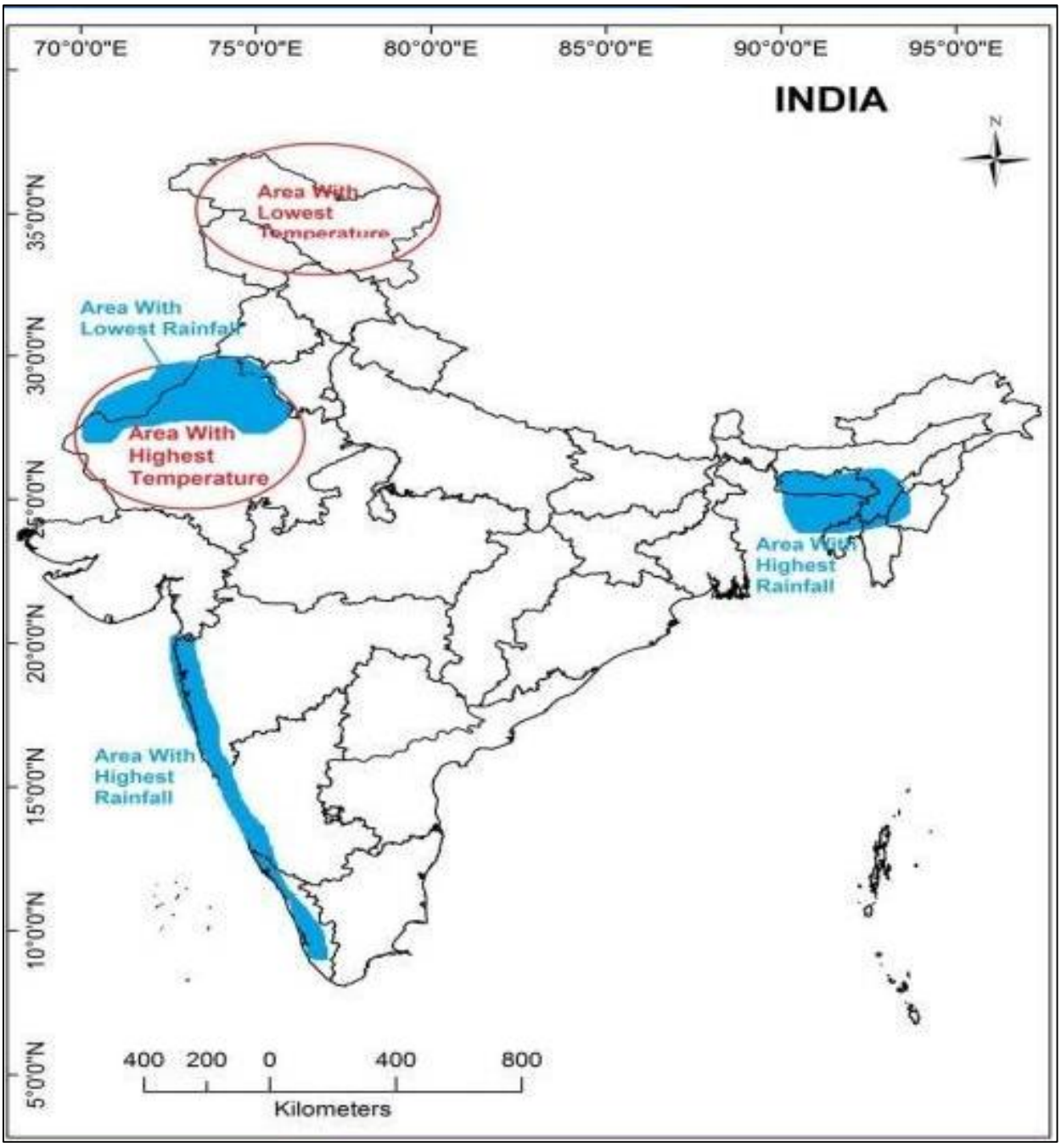
B. Lakes: (Identification) Wular, Sambhar, Chilika, Kolleru, Pulicat & Vembanad.

C. Straits, Bays, Gulfs: Palk Strait, Rann of Kachchh, Gulf of Kachchh, Gulf of Mannar & Gulf of Khambat.

CHAPTER: 4- CLIMATE

Q1. Locate and label following features on political map of India.

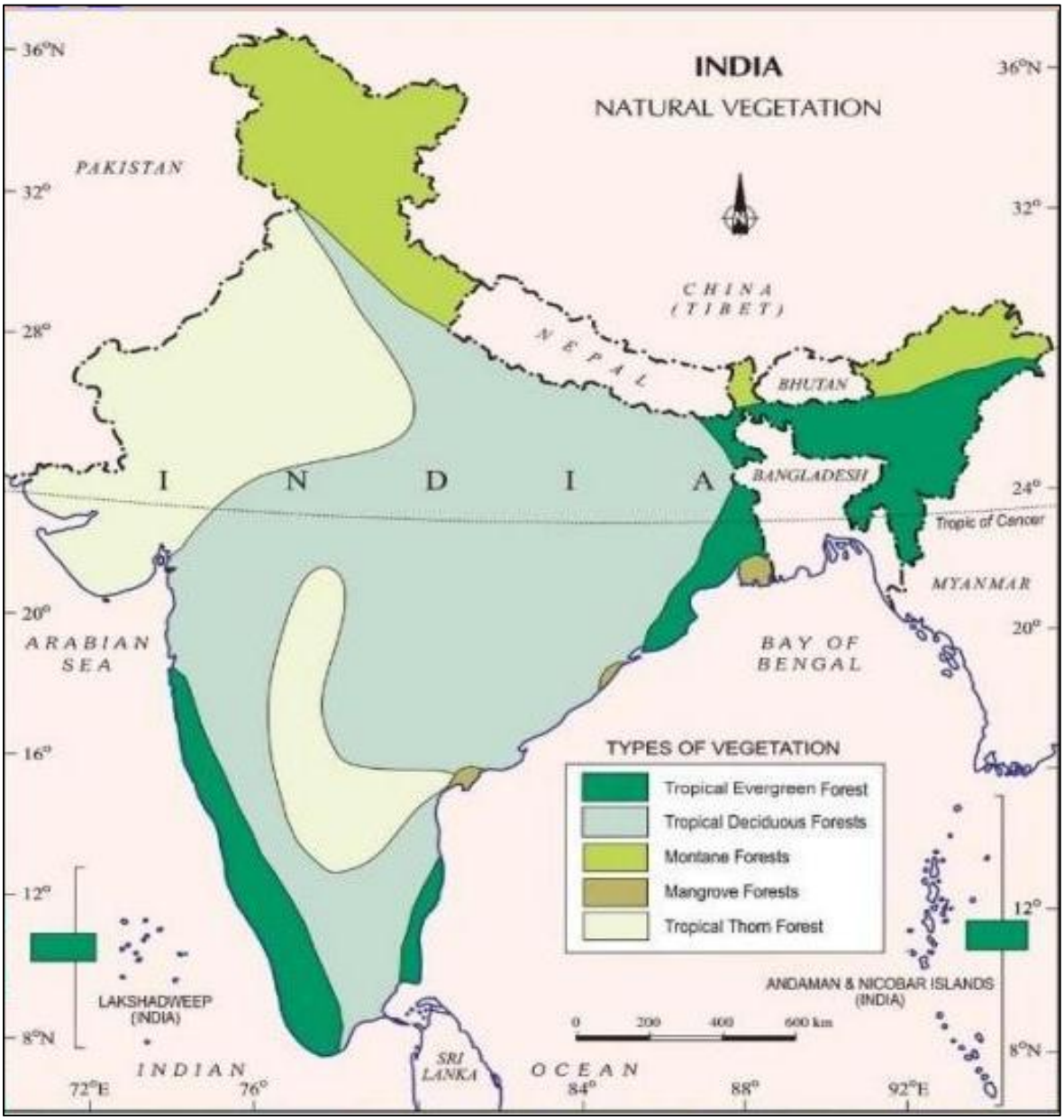
- Area with highest temperature in India
- Area with lowest temperature in India
- Area with highest rainfall in India
- Area with lowest rainfall in India



CHAPTER: 5- NATURAL VEGETATION

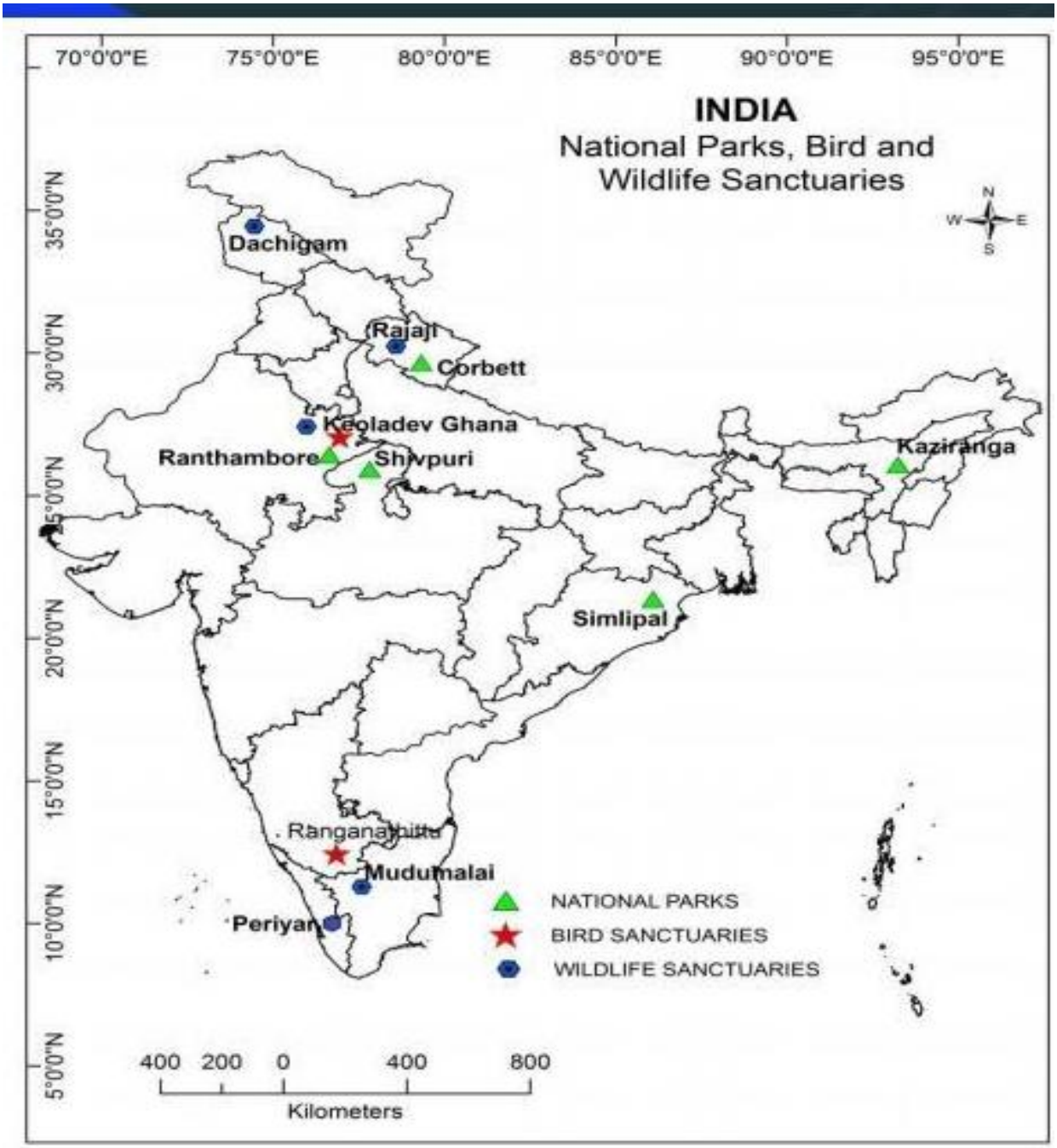
Q1. Locate and label following features on physical map of India.

✓ Tropical evergreen, Tropical deciduous, Tropical thorn, Montane and Littoral/Swamp forests.



Q2. Locate and label following features on physical map of India.

- ✓ **National Parks:** Corbett, Kaziranga, Ranthambore. Shivpuri, Simlipal
- ✓ **Bird Sanctuaries:** Keoladev Ghana and Ranganathittu
- ✓ **Wild life Sanctuaries:** Periyar, Rajaji, Mudumalai, Dachigam,



SAMPLE PAPER 1 (SOLVED PAPER)
KENDRIYA VIDYALAYA SANGATHAN
Session Ending Examination
GEOGRAPHY (029)

Time: 3 Hours **Class-XI** **Maximum Marks: 70**

SECTION-A

1. Assertion (A): Planetesimals are small objects that form during the early stages of planet formation.
   Reason (R): Cohesion and collisions among smaller particles lead to the development of planetesimals.

A. Both A and R are true, and R explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, but R is false.
D. A is false, but R is true.

2. Which one of the following is not related to the formation or modification of the present atmosphere?

A. Solar winds
B. Photosynthesis
C. Degassing
D. Differentiation

3. Consider the various sources of information about the interior of the earth:
   1. Seismic Activity
   2. Volcanoes
   3. Gravitational force
   4. Magnetic field
   5. Meteors
   6. Surface Rocks

   Which one of the above sources are indirect source of information about the Interior of the Earth?

A. 1, 3, 4 and 5
B. 1, 2, 3 and 5
C. 6 only
D. All of the above

4. Which of the following is not a reason for landslide in Western Ghat and Nilgiri region?

A. Steeper slopes
B. Mechanical weathering due to temperature changes
C. Heavy rainfall
D. Tectonic instability

5. Arrange the following steps in the development of a tropical cyclone in the correct sequence:
   1. Low-pressure area forms.
   2. Warm Ocean water evaporates and rises
   3. Wind speeds increase to form a cyclone.
   4. Thunderstorms organize into a spiral structure

A. $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$
B. $2 \rightarrow 1 \rightarrow 4 \rightarrow 3$
C. $1 \rightarrow 3 \rightarrow 2 \rightarrow 4$
D. $3 \rightarrow 2 \rightarrow 1 \rightarrow 4$

6. Assertion (A): The Western coastal plain is a narrow belt and provides natural conditions for the development of ports and harbours.
   Reason (R): The western coastal plain is an example of submerged coastal plain.

OPTIONS:

A. Only assertion is correct
B. Only reason is correct
C. Both assertion and reason are correct and reason is the correct explanation for assertion
D. Both assertion and reason are correct but reason is not the correct explanation for assertion

7. Orographic rainfall is more on-
A. Windward slopes
B. leeward slopes
C. plains
D. valleys

8. The salinity for normal open ocean ranges between-
A. 15 ‰ – 22 ‰
B. 22 ‰ – 32 ‰
C. 33 ‰ - 37 ‰
D. 38 ‰ – 45 ‰

9. Assertion (A): All watches in Kolkata Delhi Mumbai Chennai show the same time.
Reason (R): All these places are located on standard meridian of India.
A. Both A and R are true, and R explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, but R is false.
D. A is false, but R is true.

10. What is the actual distance length wise from north to south of India?
A. 3214 km
B. 2933 km
C. 3000 km
D. 3300 km

11. What causes rainfall in the coastal areas of Tamil Nadu in the beginning of winters?
A. South-West monsoon
B. North-East monsoon
C. Temperate cyclones
D. Local air circulation

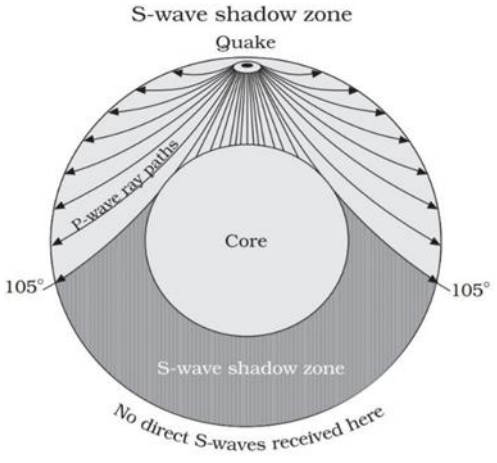
12. Which is the largest physical division of India among these-
A. Thar Desert
B. Deccan Plateau
C. Eastern coastal Plain
D. Western coastal plain

13. The headstreams of river Ganga are –
A. Alaknanda and Ghaghra
B. Alaknanda and Bhagirathi
C. Gangotri and Gandak
D. Gangotri and Yamunotri

14. Which one of the following is not a fact regarding South India?
A. Diurnal range of temperature is less here.

B. Annual range of temperature is less here.
C. Temperatures here are high throughout the year.
D. Extreme climatic conditions are found here.

15. Read the following figures and answer question no 15.



The S wave shadow zone is caused by the _____
A. the crust-mantle boundary
B. the outer core
C. the lower mantle
D. the inner core

16. Assertion (A): The mangrove tidal forests are found in the areas of coasts influenced by tides.
Reason (R): At higher elevations, temperate grasslands are common.
A. Both A and R are true, and R explains A.
B. Both A and R are true, but R does not explain A.
C. A is true, but R is false.
D. A is false, but R is true

17. Farm forestry refers to the-
A. raising and management of trees on public property.
B. raising of trees and agriculture crops on the same land.
C. promotion of agro-forestry.
D. farmers who grow trees for commercial and non-commercial purposes.

SECTION-B

Question 18 & 19 are Source Based questions.

18. In mountainous areas, the decrease in temperature with increasing altitude leads to the corresponding change in natural vegetation. As such, there is a succession of natural vegetation belts in the same order as we see from the tropical to the tundra region. The wet temperate type of forests are found between a height of 1,000 and 2,000 metres. Evergreen broad-leaf trees, such as oaks and chestnuts predominate. Between 1,500 and 3,000 metres, temperate forests containing coniferous trees, like pine, deodar, silver fir, spruce and cedar, are found. These forests cover mostly the

southern slopes of the Himalayas, places having high altitude in Southern and North-East India. At higher elevations, temperate grasslands are common. At high altitudes, generally, more than 3,600 metres above the sea level, temperate forests and grasslands give way to the Alpine vegetation. Silver fir, junipers, pines and birches are the common trees of these forests.

a. What is montane vegetation?
b. What type of forests are found between 1,500 and 3,000 meters of height?
c. What kind of Vegetation found in Montane?

19. Read the given Passage carefully and answer the questions that follow:

Normally, temperature decreases with increase in elevation. It is called normal lapse rate. At times, the situations is reversed and the normal lapse rate is inverted. It is called Inversion of temperature. Inversion is usually of short duration but quite common nonetheless. A long winter night with clear skies and still air is ideal situation for inversion. The heat of the day is radiated off during the night, and by early morning hours, the earth is cooler than the air above. Over polar areas, temperature inversion is normal throughout the year.

Surface inversion promotes stability in the lower layers of the atmosphere. Smoke and dust particles get collected beneath the inversion layer and spread horizontally to fill the lower strata of the atmosphere. Dense fogs in mornings are common occurrences especially during winter season. This inversion commonly lasts for few hours until the sun comes up and beings to warm the earth.

The inversion takes place in hills and mountains due to air drainage. Cold air at the hills and mountains, produced during night, flows under the influence of gravity. Being heavy and dense, the cold air acts almost like water and moves down the slope to pile up deeply in pockets and valley bottoms with warm air above. This is called air drainage. It protects plants from frost damages.

a. What is air drainage?
b. What is the rate of normal lapse rate of temperature with increasing altitudes?
c. What are the ideal conditions for temperature inversion?

SECTION-C

Question numbers 20 to 23 are Short Answer type questions.

20. What are important of tides? How are tides related to navigation? 2+1=3
21. What are the implications of India having a long coastline? 3
22. Distinguish between systematic and regional approaches to geography. 3
23. Why is troposphere the most important of all the layers of the atmosphere?

OR

Describe the composition of the atmosphere. 1+2=3

SECTION-D

Question numbers 24 to 28 are Long Answer Types questions.

24. What are the major physiographic divisions of India? Explain the chief characteristics of the northern plain.

OR

If you move from Badrinath to Sunderbans delta along the course of the river Ganga, what major geomorphological features will you come across? Elaborate. 5

25. How many distinct seasons are found in India as per the Indian Meteorological Department? Discuss the weather conditions associated with any one season in detail.

OR

Notwithstanding the broad climatic unity, the climate of India has many regional variations. Elaborate this statement giving suitable examples. 1+4=5

26. Elaborate the Erosional and Depositional landforms of Running water (Rivers)?

OR

Limestones behave differently in humid and arid climates. Why? What is the dominant and almost exclusive geomorphic process in limestone areas and what are its results? 5

27. What are the socio-economic advantages and disadvantages of inter-linking of rivers in India? 5

28. Bring about the basic difference between the Continental Drift theory and Plate Tectonics.

OR

What are the evidences suggested by Wegener in support of the continental drift theory?

SECTION –E

Question numbers 29 & 30 are Map based questions having 7 sub-parts each.

29. On the given outline political map of the World, following seven geographical features have been marked as A, B, C, D, E, F and G. Identify any five with the help of the following information and write their correct names on the line drawn near each feature.

A. A hot desert
B. A waterbody (Sea)
C. A warm ocean current
D. A cold ocean current
E. A minor tectonic plate
F. An Ecological hotspot
G. A Continent as well as Ocean

30. Locate and label any five of the following geographical features on the Political Outline map of India with appropriate symbols:

A. Satpura Range
B. River known as 'South Ganga'.
C. Malabar coast
D. Kanchenjunga Peak
E. Southern Most point of main land of India
F. Chilka lake
G. Kaziranga National Park

MARKING SCHEME

1. (A)Both A and R are true, and R explains A.
2. (D) Differentiation
3. (A) 1, 3, 4 और 5
4. (D)Tectonic instability
5. (B) 2 → 1 → 4 → 3
6. (C) Both assertion and reason are correct and reason is the correct explanation for assertion
7. (A) Windward slopes

8. (C) 33 ‰ - 37 ‰
9. (C) A is true, but R is false.
10. (A) 3214 km
11. (B)North-East monsoon
12. (B)Deccan plateau
13. (B) Alaknanda and Bhagirathi
14. (D) Extreme climatic conditions are found here.
15. (B) the outer core
16. (B) Both A and R are true, but R does not explain A.
17. (D) farmers who grow trees for commercial and non-commercial purposes.

SECTION-B

Question 18 & 19 are Source Based questions.

18. (i) Montane vegetation refers to plant life found in mountainous regions, characterized by distinct zones that change with increasing altitude, from broadleaf forests at lower elevations to conifers (pine, fir, cedar) in mid-altitudes, and finally alpine tundra (grasses, shrubs, mosses) or barrenness at the highest, coldest reaches, all shaped by cooler temperatures, higher winds, and distinct moisture levels.
(ii) Between 1,500 and 3,000 metres, temperate forests containing coniferous trees, like pine, deodar, silver fir, spruce and cedar, are found.
(iii) Montane vegetation consists of distinct, altitude-dependent zones, transitioning from subtropical forests at lower elevations to temperate, needle-leaved coniferous forests and finally alpine shrublands/meadows. Key trees include oaks, rhododendrons, pines, cedars (deodar), firs, and spruces, with dense undergrowth of mosses, ferns, and lichens.
19. (i) Air drainage (or katabatic wind) is the gravity-driven flow of cold, dense air down slopes from higher elevations into valley bottoms, typically occurring on calm, clear nights. It is a key factor in temperature inversion (valley inversion), where colder air accumulates in lower areas while warmer air stays above, crucial for understanding local climate and preventing frost damage.
(ii)1degree Celsius/165 metre
(iii) A long winter night with clear skies and still air is ideal situation for inversion. The heat of the day is radiated off during the night, and by early morning hours, the earth is cooler than the air above. Over polar areas, temperature inversion is normal throughout the year.

SECTION-C

Question numbers 20 to 23 are Short Answer type questions.

20. Tides are the periodic rise and fall of sea levels caused by the gravitational forces of the Moon and Sun, crucial for navigating shallow, tidal ports like Kolkata's Diamond Harbour by raising water levels for large ships. They facilitate maritime trade, support fishing, drive ocean circulation, and generate renewable energy.
Importance of Tides:
Navigation & Shipping: High tides enable large ships to enter or leave shallow, narrow, or river-based harbors by providing increased depth.

21. India’s long coastline of over 7,516.6 km (including islands) serves as a vital economic, strategic, and climatic asset. It facilitates international trade via numerous ports, supports a massive fishing industry, boosts coastal tourism, and

provides access to offshore oil/mineral resources. It also enhances maritime security and influences the country's monsoonal climate.

Key Implications of India's Long Coastline Economic Impact (Trade and Resources):

- o Port Development
- o Fishing Industry
- o Energy & Minerals
- o Tourism
- • Strategic and Geopolitical Importance:
- o Maritime Security
- o Global Connectivity
- • Climatic and Environmental Significance:
- o Monsoon Influence
- o Maritime Climate
- o Natural Hazards
- • Cultural and Social Impact:
- o Cultural Exchange
- o Employment

22. Branches of Geography-

The major approaches to study geography have been-

(i) Systematic

(ii) Regional

The systematic geography approach is the same as that of general geography. Alexander Von Humboldt, a German geographer (1769-1859) while another German geographer, Karl Ritter (1779-1859) (I) Systematic approach, developed regional geography approach, introduced this approach. In systematic approach, we select one geographical factor and study its distribution for the whole world or a part thereof.

Relief,drainage,climate,vegetation,soil,mineral,wealth,agriculture,industry,transport ,trade and commerce and population are some of the important geographical elements. These elements are studied separately with reference to a particular area. This area could be a country, a continent or the whole world. The best way to study the systematic geography is to consider the variations on the surface of the earth with reference to a particular geographical element.

(ii) Regional approach-In regional approach, the world is divided into regions at different hierarchical levels and then all the geographical phenomena in a particular region are studied. These regions may be natural, political or designated region. The phenomena in a region are studied in a holistic manner. Regional geography helps us in identifying the region. Larger regions are further divided into smaller regions. Eg; Ganga plain, Chotanagpur plateau or Assam valley and study their location,relief,drainage,climate,soil,vegetation,mineral,agriculture,industry, transport, trade, population, etc.

23. The troposphere is the lowermost layer of the atmosphere. Its average height is 13 km and extends roughly to a height of 8 km near the poles and about 18 km at the equator. Thickness of the troposphere is greatest at the equator because heat is transported to great heights by strong convectional currents. This layer contains dust particles and water vapour. All changes in climate and weather take place in

this layer. The temperature in this layer decreases at the rate of 1 C for every 165m of height. This is the most important layer for all biological activity.

OR

The atmosphere is composed of gases, water vapour and dust particles. The proportion of gases changes in the higher layers of the atmosphere in such a way that oxygen will be almost in negligible quantity at the height of 120 km. Similarly, carbon dioxide and water vapour are found only up to 90 km from the surface of the earth.

SECTION-D

Question numbers 24 to 28 are Long Answer Types questions.

24.

- 1. The Himalayan Mountains.
- 2. The Northern Plains.
- 3. The Peninsular Plateau.
- 4. The Indian Desert.
- 5. The Coastal Plains.
- 6. The Islands.

The Northern Plains are divided into 4 regions based on variations in relief from north to south. They are bhabar, terai, bhangar and khadar. Further Reading: Physiographic Division of Great Plains of India.

OR

Moving from Badrinath to the Sunderbans along the Ganga, you will traverse three distinct geomorphological zones: the Himalayan Mountain course (V-shaped valleys, gorges), the Piedmont zone/Bhabar (alluvial fans), and the Indo-Gangetic Plains (meanders, oxbow lakes, levees), ending in the deltaic swamps and mangrove forests of the Sunderbans.

Detailed Geomorphological Features:

- Upper Course (Himalayas - Uttarakhand):
- V-Shaped Valleys & Gorges: The river starts in high-altitude, steep terrain, creating deep valleys and narrow gorges.
- Rapids & Waterfalls: High velocity causes rapid flow, creating small waterfalls and rocky, steep slopes.
- Landslides: The steep, young mountains are prone to slope failure.
- Mid-Course (Piedmont and Plains):
- Bhabar & Tarai Region: Upon leaving the hills (e.g., Haridwar), the river drops heavy sediments, creating porous alluvial fans (Bhabar).
- Meanders: As the slope decreases, the river forms large, sweeping, sinuous curves (meanders).
- Oxbow Lakes: The river abandons old, sharp meanders, leaving behind horseshoe-shaped lakes.
- Floodplains & Levees: Natural levees are formed by sediment deposition during floods on the fertile Gangetic plain.
- Lower Course (Delta Region - West Bengal/Bangladesh):
- Distributaries: The river divides into multiple channels as it approaches the sea, forming a complex network.
- Deltaic Plains & Mudflats: Huge deposits of fine silt create vast mudflats.

- Mangrove Forests: The tidal, saline environment of the Sunderbans hosts mangroves (sundari trees).
- Confluence Points: Throughout the journey, the main stream meets numerous tributaries (e.g., Alaknanda, Yamuna, Ghaghara), creating distinct confluence points (Prayags in the upper course).

25. The Indian Meteorological Department (IMD) recognizes four distinct seasons:
Winter (Dec–Feb)-cold weather season
Summer (Mar–May) - hot weather season
Rainy season-Southwest Monsoon (Jun–Sep), and
Retreating Monsoon (Oct–Nov).
These seasons are characterized by specific temperature, wind, and rainfall patterns, with significant regional variations across the country.
Detailed Weather Conditions: Southwest Monsoon Season (June – September)
This is the principal rainy season, marking the crucial agricultural period for India
- Wind Pattern: The season is dominated by the humid Southwest monsoon winds that blow from the Arabian Sea and the Bay of Bengal towards the landmass, replacing the dry, hot winds of the summer.
- Temperature: Temperatures are generally lower than the preceding summer, but the weather remains very hot and humid, with average temperatures often around 34∘C34 raised to the composed with power 34∘C.
- Rainfall: This period provides nearly 75-90% of India's total annual rainfall. It arrives in two branches: the Arabian Sea branch (hitting the Western Ghats first) and the Bay of Bengal branch (moving towards the Northeast and Bengal).
- Weather Characteristics: The sky is usually overcast, humidity is very high, and the weather is marked by heavy downpours, thunderstorms, and severe cyclonic activity.
- Regional Variation: Rainfall is heaviest along the western coast and in the north eastern states, while the interior parts of the peninsula and the north western regions receive comparatively less.

OR

Despite India's overall monsoon climate unity, significant regional variations exist in temperature, rainfall, and seasons, ranging from the icy cold Himalayas (Drass at -45°C) and scorching Thar Desert (Rajasthan at 50°C) to extremely wet (Mawsynram) and dry (Jaisalmer) zones, showcasing diverse microclimates like tropical South India and cold deserts in the north, illustrating India's climatic heterogeneity.
Variations in Temperature
- Extreme Cold: Drass (Ladakh) experiences winter nights as low as -45°C, contrasting sharply with coastal areas.
- Extreme Heat: Rajasthan's Churu can hit 50°C or more in June, while Pahalgam (Kashmir) stays around 20°C.
- Diurnal Range: The Thar Desert sees large day-night swings (e.g., 50°C day to 15-20°C night), unlike Kerala or Andaman & Nicobar Islands where day-night temp difference is minimal (7-8°C).
- Variations in Rainfall
- High Rainfall: Mawsynram (Meghalaya) receives over 1080 cm annually, making it one of the wettest places, while the Ganga delta also gets heavy rain.

- Low Rainfall: Jaisalmer (Rajasthan) rarely gets more than 9 cm, illustrating extreme dryness, notes Brainly.in.
- Seasonal Shift: While most of India gets summer monsoon rain, the Coromandel Coast (Tamil Nadu) receives winter rainfall.
    - Variations in Climatic Types
- Cold Desert: Ladakh and parts of the Himalayas have alpine/cold desert conditions with snowfall, contrasting with the tropical south, say Filo and Vedantu.
- Tropical Climates: Southern India experiences tropical climates, while central India has tropical savanna, notes Filo.
- Humid Subtropical: Northeastern states have humid subtropical conditions with heavy rainfall, notes Filo.

These examples highlight that India's climate, unified by the monsoon system, diversifies into distinct zones, from the intense heat of the deserts to the freezing winters of the Himalayas and the heavy rains of the northeast.

26. Erosion is the wearing away of the landscape by different agents like water, wind and ice. The eroded material is carried away or transported by water, wind, etc. and eventually deposited. Landforms created because of erosion are called erosional landforms and landforms created because of deposition are called depositional landforms.
Erosional landforms: Valleys, potholes, entrenched Meanders and river Terraces.
Depositional landforms: Alluvial Fans, deltas, meanders and braided channels.
(About 150 words)

OR

The most dominant and almost exclusive type of geomorphic process in limestone areas is that of processes of solution and deposition by the action of the groundwater. The erosional landforms produced by the action of the groundwater are pools, sinkholes, lapies and limestone pavements. (About 150 words)

27. The river interlinking project makes water available to areas with shortages and makes agriculture possible in such areas of India. The areas that frequently experience flood-like situations can benefit from the river linking project.
The socio-economic advantages of interlinking of rivers in India are followings:
(i)The surplus water can be transferred to the deficit areas.
(ii) When there is a flood in one part of the country the water can be used in other drought like areas for irrigation.
Disadvantage-

1. Loss of Biodiversity.
2. Displacement of ingenious people.
3. Rehabilitation problem
4. Cultural conflicts etc.

28. Tectonic plates are the different pieces of the Earth's crust that move around as they float on top of the mantle. Plate tectonics is how those pieces move and interact with each other. Thus, tectonic plates are objects while plate tectonics are actions as well as the theories and forces involved in those actions.
The idea that all of earth's land masses were once joined together was first postulated in the late 1500's after mankind had discovered and mapped enough

territory to realize the continents could be arranged to fit together. This suggested they were once all part of a greater landmass.

The idea is not excluded by plate tectonics, the study of landmass movement across the surface of the planet. Plate tectonics describes how the segments of the earth's crust are in motion due to enormous convection currents within the upper layer of the viscous, plastic, semi-solid magma. Plate tectonics relies on recent innovation and specialized equipment to monitor the motion of landmasses.

OR

- The following are the evidence of continental drift theory:
- The Matching of Continents: The shorelines of Africa and South America facing each other have a remarkable and unmistakable match.
- Rocks of Same Age Across the Oceans: The belt of ancient rocks of 2,000 million years from Brazil coast matches with those from western Africa.
- Tillite: The Gondwana system of sediments from India is known to have its counterparts in six different landmasses of the Southern Hemisphere. Counterparts of this succession are found in Africa, Falkland Island, Madagascar, Antarctica and Australia besides India.
- Placer Deposits: Rich placer deposits of gold in the Ghana coast. But there is no source rock in the region. The gold-bearing veins are in Brazil and it is obvious that the gold deposits of Ghana are derived from the Brazil plateau when the two continents lay side by side
- Distribution of Fossils: Identical species of plants and animals adapted to living on land or in freshwater are found on either side of the marine barriers.

SECTION –E

Question numbers 29 & 30 are Map based questions having 5 sub-parts each.

29. On the given outline map of the world, following five features are shown. Identify these features and write their correct names on the lines marked near each features.

A. PATAGONIAN DESERT
B. CASPIAN SEA
C. AGULHAS CURRENT
D. LABRADOR CURRENT
E. ARABIAN PENINSULA
F. INDONESIA, ASIA
G. ANTARCTICA

30. On the political outline map of India, locate and label the following features with appropriate symbols. (Any five)

A. Satpura Range
B. River known as ‘South Ganga’- GODAVARI RIVER
C. KERALA COAST
D. Kanchenjunga Peak - SIKKIM
E. Kanyakumari
F. Chilka lake - ODISHA
G. ASSAM

SAMPLE PAPER 2 (SOLVED PAPER)
KENDRIYA VIDYALAYA SANGTHAN
SESSION ENDING EXAMINATION
SUBJECT – GEOGRAPHY

Time – 3Hrs **Class- XI** **MM- 70**

Section – A (Q1 to 17) (1 Marks each)

1. Which one of the following disciplines attempt temporal synthesis?
A. Sociology
B. Geography
C. Anthropology
D. History

2. Light year is used to measure-
A. Years B. Light C. Distance D. Diameter

3. Arrange the layers of the earth in sequence from exterior to interior.
1. Crust 2. Outer Core 3. Inner Core 4. Mantle
Codes:
A. 1-4-3-2 B. 1-4-2-3 C. 1-2-3-4 D. 1-3-2-4

4. Match column I with column II and select the correct answer using the codes given below :

Column I	Column II
1. Cocos plate	A. Between South America and Pacific plate
2. Nazca plate	B. North – East of Australia
3. Caroline plate	C. Between Central America and Pacific Plate
4. Fuji plate	D. Between Phillippines and Indian plate

Code :
A. 1-A, 2-B, 3-D, 4-C
B. 1-A, 2-C, 3-B, 4-D
C. 1-C, 2-A, 3-D, 4-B
D. 1-C, 2-A, 3-B, 4-D

5. Assertion (A): Human beings have no role in biological weathering.
Reason (R): Human beings help in creating new contacts between air, water and minerals in earth materials by disturbing vegetation and ploughing soils.
Codes
A. Both A and R are true and R is the correct explanation of A.
B. Both A and R are true, But R is not the correct explanation of A.
C. A is true, but R is false.
D. A is false, but R is true.

6. Which of the following correctly defines meanders?
A. Large natural hollow in cliff.
B. Loop like channel patterns develop over flood and delta plain.

C. Ridge of sand and shingle in off- shore zone of sea.

D. Off-shore bar exposed due to addition of sand.

7. Which of the given statement is incorrect?

A. The atmosphere is composed of gases, water vapour and dust particles.

B. Ozone absorbs the harmful ultra-violate radiation received from Sun.

C. Water vapour increases from equator towards the pole

D. Dust particles act as hygroscopic nuclei.

8. Which of the following is/are the factors responsible for variation in insolation ?

1. The rotation of the Earth on its axis.
2. The length of the day.
3. Transparency of the atmosphere.

Code:

A. 1 and 2 C. 2 and 3

B. 1 and 3 D. All of these

9. Which of the following are the lines connecting places having equal pressure?

A. Isobars C. Isoneph

B. Isochrones D. Isohyet

10. When the moisture is deposited in the form of water droplets on cooler surface of solid objects such as stone, grass blades and plant leaves, it is known as:

A. Dew B. Frost C. Fog D. Mist

11. The distance between the Earth and the moon is minimum when the moon is in….

A. Aphelion B. Perigee C. Perihelion D. Apogee

12. Which of the following countries is/are larger than India in terms of area?

1. USA 2. Canada 3. China

Codes:

A. Only 1 C. 2 and 3

B. 1 and 2 D. All of these

13. Consider the following about the Thar Desert and choose the option, which is correct?

1. It lies to the northwest of Aravalli hills.
2. It is covered with Barchans.
3. It has tropical evergreen climate.

Codes:

A. 1 and 2 C. 2 and 3

B. 1 and 3 D. 1,2 and 3

14. Which of the following rivers is known as sorrow of Bihar :

A. Damodar B. Kosi C. Son D. Chambal

15. Which of the following statements about the South West Monsoon is correct?

A. Monsoon winds blow from the land to the sea in summer.

B. Monsoon winds blow from the sea to the land in summer.

C. Monsoon winds blow from the land to the sea in winter.

D. Monsoon winds blow from the sea to the land in winter.

16. What causes rainfall on the coastal areas of Tamil Nadu in the beginning of winters?

A. South-West monsoon C. Temperate cyclones

B. North-Eastern monsoon D. Local air circulation

17. Which one of the following proportion of area of the country was targeted to be under forest in Forest Policy of India?

A. 33% B. 55% C. 44% D. 22%

SECTION B (Q.No.18-19)(3 Marks each)

SOURCE BASED

18. Read the following passage and answer the question that follows:

The salinity for normal Open Ocean ranges between 33 ₀/₀₀ and 37 ₀/₀₀. In the land locked Red Sea. It is as high as 41 ₀/₀₀, while in the estuaries and the Arctic, the salinity fluctuates from 0-35 ₀/₀₀, seasonally. In hot and dry regions, where evaporation is high, the salinity sometimes reaches to 70 ₀/₀₀.

The salinity variation in the Pacific Ocean is mainly due to its shape and larger areal extent. Salinity decreases to about 32‰ near the equator because of heavy rainfall. It increases to about 35‰ near the Tropic of Cancer and the Tropic of Capricorn. In the northern part of the Pacific Ocean, salinity decreases to 31‰ because of the influx of melted water from the Arctic regions. In the same way, after 15^{o} – 20^{o} south, it decreases to 33 ₀/₀₀.

The average salinity of the Atlantic Ocean is around 36 ₀/₀₀.The highest salinity is recorded between 15^{o} and 20^{o} latitudes. Maximum salinity (37 ₀/₀₀) is observed between 20^{o} N and 30^{o} N and 20^{o} W – 60^{o} W. It gradually decreases towards the north. The North Sea, in spite of its location in higher latitudes, records higher salinity due to more saline water brought by the North Atlantic Drift. Baltic Sea records low salinity due to influx of river waters in large quantity. The Mediterranean Sea records higher salinity due to high evaporation. Salinity is, however, very low in Black Sea due to enormous fresh water influx by rivers.

The average salinity of the Indian Ocean is 35 ₀/₀₀. The salinity trend is observed in the Bay of Bengal due to influx of river water by the river Ganga. On the contrary, the Arabian Sea shows higher salinity due to high evaporation and low influx of fresh water.

a. Why does the Baltic Sea record low salinity?

b. What is the average salinity of the Indian Ocean?

c. Which ocean has the highest average salinity among the major oceans?

19. Read the following passage and answer the questions that follow :

The Ganga is the most important river of India both from the point of view of its basin and cultural significance. It rises in the Gangotri glacier near Gaumukh (3,900

m) in the Uttarkashi district of Uttarakhand. Here, it is known as the Bhagirathi. It cuts through the Central and the Lesser Himalayas in narrow gorges. At Devprayag, the Bhagirathi meets the Alaknanda; hereafter it is known as the Ganga. The Alaknanda has its source in the Satopath glacier above Badrinath. The Alaknanda consists of the Dhauli and the Vishnu Ganga, which meet at Joshimath or Vishnu Prayag.

The other tributaries of Alaknanda such as the Pindar joins it at Karna Prayag while Mandakini or Kali Ganga meets it at Rudra Prayag. The Ganga enters the plains at Haridwar. From here, it flows first to the South, then to the South-East and East before splitting into two distributaries, namely the Bhagirathi and the Padma. The river has a length of 2525 km. Uttarakhand (110 km) and Uttar Pradesh (1,450 km), Bihar (445 km) and West Bengal (520 km) share it. The Ganga basin covers about 8.6 lakh sq. km area in India alone.

The Ganga river system is the largest in India having a number of perennial and non- perennial rivers originating in the Himalayas in the North and the Peninsula in the South, respectively. The son is its major right bank tributary. The important left bank tributaries are the Ramganga, the Gomati, the Ghaghara, the Ghandak, the Kosi and the Mahananda. The river finally discharges itself into the Bay of Bengal near the Sagar Island.

a. Where does the Ganges River originate?
b. At which place do the Bhagirathi and Alaknanda rivers meet?
c. Which is the major right-bank tributary of the Ganges River?

SECTION C (Q.No.20- 23)(3 Marks each)

20. "Along with multiple merits, tides are also supportive to economy of the nation." Give your argument in support of this statement.

Or

What are tides? Explain spring tide and neap tides?

21. Running water is by far the most dominating geomorphic agent in shaping the Earth surface in humid as well as an arid climate. Explain any three erosional landforms made by running water?

22. What is the subcontinent? Name the countries included in Indian subcontinent?

23. The monsoon winds flowing in the South – Westerly direction approach the landmass of India in two branches. Describe how the Arabian sea branch of the monsoon causes rainfall in various regions.

Or

What is climate? Name the four seasons of India?

SECTION D (Q.No.24- 28)(5 Marks each)

24. Discuss the process with suitable diagram through which the earth atmosphere system maintains heat balance?

Or

Explain about the factors which influence the temperature of air at any place.

25. What do you mean by tropical cyclones? Explain the favourable conditions for their formations.

26. What are the important characteristics features of North Indian rivers? How are these different from Peninsular rivers?

27. Notwithstanding the broad climatic unity, the climate of India has many regional variations. Elaborate this statement giving suitable examples.

28. Differentiate between forest area and forest cover. Why and how the British had exploited the forests in India?

Or

What is natural vegetation? Name the different types of forest found in India? Distinguish between the two types of tropical deciduous forest?

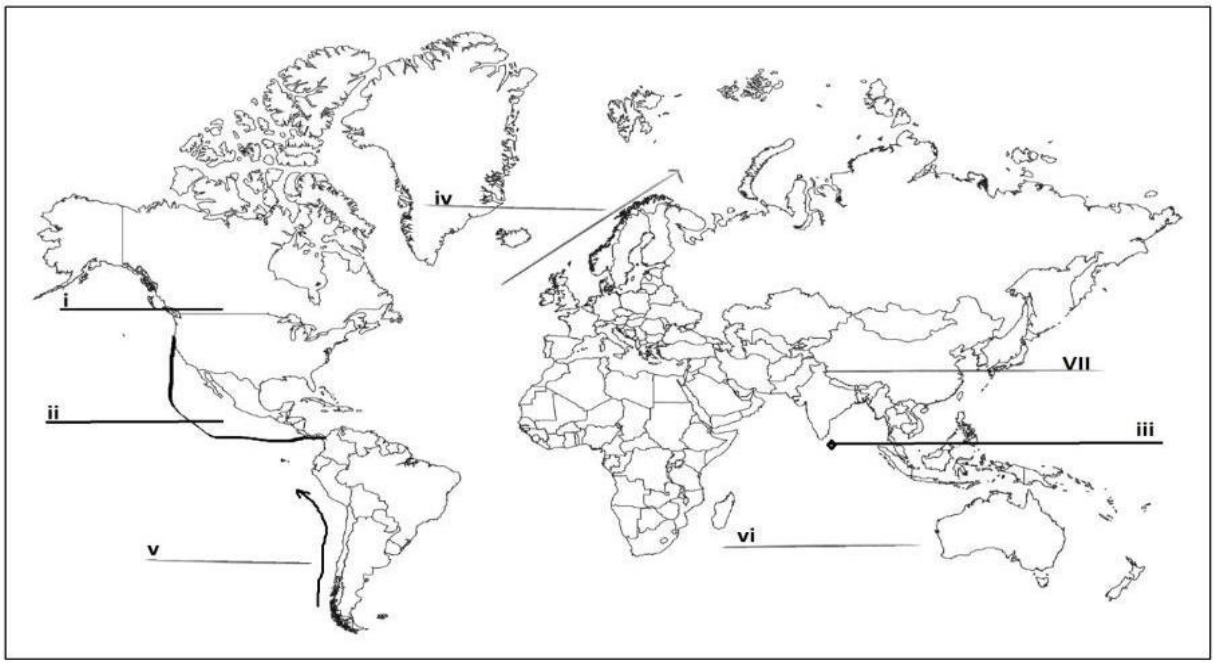
SECTION E (Q.No.29-30)(5 Marks each)

29. On the given political map of India, locate and label any five of the following with appropriate symbols:

A. Capital of Karnataka
B. Aravali Range
C. Chilika Lake
D. Area of rainfall with more than 200 cm
E. Area of Littoral and Swamp Forest
F. Nilgiri Biosphere Reserve
G. Coromandal Coast

30. On the given political map of the world, the following seven features are shown. Identify any five of these features and write their correct names on the answer sheet.

A. Name of a continent
B. A minor tectonic plate.
C. A Neighboring country of India
D. A warm oceanic current
E. A cold oceanic current
F. Name of the Ocean
G. Highest mountain peak of India



MARKING SCHEME
KENDRIYA VIDYALAYA SANGTHAN
SESSION ENDING EXAMINATION

Time – 3Hrs **Class- XI** **MM- 70**

SECTION A

1. d) History
2. c) Distance
3. b) 1-4-2-3
4. c) 1-C, 2-A, 3-D, 4-B
5. d) A is false, but R is true.
6. b) loop like channel patterns develop over flood and delta plain
7. c) Water vapour increases from equator towards the pole
8. d) All of these
9. a) Isobars
10. a) Dew
11. b) Perigee
12. d) All of these
13. a) 1 and 2
14. b) Kosi
15. b) Monsoon winds blow from the sea to the land in summer.
16. b) North-Eastern monsoon
17. a) 33 %

SECTION B

18.

a. Baltic Sea records low salinity due to influx of river waters in large quantity.
b. The average salinity of the Indian Ocean is 35 $^{o}/_{oo}$.
c. The average salinity of the Atlantic Ocean is around 36 $^{o}/_{oo}$.

19.

a. Ganga rises in the Gangotri glacier near Gaumukh (3,900 m) in the Uttarkashi district of Uttarakhand.

b. At Devprayag, the Bhagirathi meets the Alaknanda; hereafter it is known as the Ganga.

c. The son is its major right bank tributary.

SECTION C

20. Navigation, Shipping, Electricity, Minerals, Fishery, Salt Industries etc.

Or

Tides are the regular rise and fall of sea levels caused by the gravitational pull of the Moon and the Sun, along with the Earth's rotation.

Spring tide-when the sun, the moon and the earth are in straight line, the height of the tide will be higher these are called spring tides.

Neap tide-normally there is a 7 day interval between the spring tide and neap tide, at this time the sun and moon are at right angles to each other.

21. Running water is one of the most powerful geomorphic agents, shaping the Earth's surface through erosion. It forms various landforms in both humid and arid regions by eroding rocks and sediments. Below are three significant erosional landforms created by running water:

1. V-Shaped Valleys: Running water in rivers cuts vertically into the Earth's surface, eroding the bedrock and carrying sediments downstream.

2. Waterfalls: Waterfalls form where a river flows over layers of hard and soft rocks.

3. Gorges : A gorge is a deep, narrow valley with nearly vertical walls, created by a river cutting into hard bedrock.

22. A subcontinent is a large, distinct landmass that is part of a continent but is geographically, culturally, and politically unique. It is often separated from the rest of the continent by natural boundaries such as mountains, rivers, or seas.

The Indian subcontinent comprises the following seven countries:

1. India 2. Pakistan 3. Bangladesh 4. Nepal 5. Bhutan 6. Sri Lanka 7. Maldives

23. 1. One branch obstructed by Western ghats. Heavy rainfall in Sahyadri's and western coastal plain, Little rainfall East of Western Ghats.

2. second branch strikes the coast North of Mumbai and cause rainfall in central highlands.

3. The third branch of these winds strike the saurashtra Peninsula and the Kachchh and move further towards Rajasthan, Punjab and Haryana.

Or

Climate refers to the average weather conditions of a region over a long period, typically 30 years or more. It includes factors such as temperature, precipitation, humidity, wind patterns, and atmospheric pressure that prevail in a specific area.

Four Seasons of India

1. Cold weather season/Winter (January to February)

2. Hot weather season/Summer/Pre-Monsoon (March to May)

3. Advance Monsoon season/Southwest Monsoon (June to September)

4. Retreating monsoon season/ Post-Monsoon/Autumn (October to December)

SECTION D

24. Heat budget : 27 reflected back from clouds, 2 units from the snow and ice covered area, 6 units by scattering. 17+34 absorbed by earth, 14 absorbed by atmosphere.
Out of 51, 17 units are radiated to space directly and remaining 34 units are absorbed by the atmosphere. Within 34 units 6 absorbed by atmosphere, 9 units through convection and turbulence and 19 units through latent heat of condensation. Explanation of each with diagram.

Or

The latitude, 2. The altitude, 3. Distance from sea 4. Air Mass and Ocean currents etc. Explanation of Each.

25. A tropical cyclone is a rapidly rotating storm system , form over warm ocean waters in tropical and subtropical regions and are called different names based on their location: hurricanes (Atlantic and Eastern Pacific), typhoons (Western Pacific), and cyclones (Indian Ocean).
Favorable Conditions for the Origin of Tropical Cyclones
1. Warm Ocean Waters
2. High Humidity
3. Presence of a Pre-Existing Disturbance
4. Weak Vertical Wind Shear
5. Coriolis Force
6. Atmospheric Instability
7. Divergence in the Upper Atmosphere

26. Characteristics of the North-Indian rivers are as follows :
They are fed by melting of snow and precipitation. 2. These are perennial in nature or have water throughout the year. 3. Forms gorges, V shape valleys etc. And any other point.
Differentiation from peninsular river :
1. Himalayan river are perennial but peninsular are seasonal.
2.Himalayan rivers have very large basins but peninsular relatively smaller basin.
3.Himalayan rivers are young and youthful but peninsular rivers are old rivers with graded profile. Any other suitable difference.

27. The monsoon regime emphasizes the unity of India with the rest of Southeast Asian region. This view of broad unity of the monsoon type of climate should not, however, lead one to ignore its regional variations, which differentiate the weather and climate of different regions of India. The climate of Kerala and Tamil Nadu in the south is so different from that of Uttar Pradesh and Bihar in the north, and yet all of these have a monsoon type of climate.
1.While in the summer the mercury occasionally touches 55°C in the western Rajasthan, it drops down to as low as minus 45°C in winter around Leh. Churu in Rajasthan may record a temperature of 50°C or more on a June day while the mercury hardly touches 19°C in Tawang (Arunachal Pradesh) on the same day.
2. On a December night, temperature in Drass (Jammu and Kashmir) may drop down to minus 45°C while Thiruvananthapuram or Chennai on the same night records 20°C or 22°C.

3. In Kerala and in the Andaman Islands, the difference between day and night temperatures may be hardly seven or eight degree Celsius. But in the Thar desert, if the day temperature is around 50°C, at night, it may drop down considerably upto 15°-20°C.

4. While snowfall occurs in the Himalayas, it only rains over the rest of the country. Similarly, variations are noticeable not only in the type of precipitation but also in its amount. While Cherrapunji and Mawsynram in the Khasi Hills of Meghalaya receive rainfall over 1,080 cm in a year, Jaisalmer in Rajasthan rarely gets more than 9 cm of rainfall during the same period.

5. Tura situated in the Garo Hills of Meghalaya may receive an amount of rainfall in a single day which is equal to 10 years of rainfall at Jaisalmer. While the annual precipitation is less than 10 cm in the north-west Himalayas and the western deserts, it exceeds 400 cm in Meghalaya.

These examples confirm that there are seasonal variations in temperature from place to place and from region to region in India. In spite of these differences and variations, the climate of India is monsoonal in rhythm and character.

28. Meaning: The forest area is the area notified and recorded as the forest land irrespective of the existence of trees, while ie actual forest cover is the area occupied by forests with canopy.

Estimation: The former is based on the records of the State Revenue Department, while the latter is based on aerial photographs and satellite imageries.

The British were aware of the economic value of the forests in India, hence, large scale exploitation of these forests was started. The structure of forests was also changed. The oak forests in Garhwal and Kumaon were replaced by pine (chirs) which was needed to lay railway lines. Forests were also cleared for introducing plantations of tea, rubber and coffee. The British also used timber for construction activities as it acts as an insulator of heat. The protectional use of forests was, thus, replaced by commercial use.

Or

Natural vegetation refers to plant life that grows naturally without human interference, adapted to the specific climatic and soil conditions of a region. It varies depending on factors like temperature, rainfall, and altitude.

Types of Natural Vegetation in India

1. Tropical Evergreen Forests
2. Tropical Deciduous Forests
3. Tropical Thorn Forests
4. Montane Forests
5. Mangrove Forests
6. Temperate Forests
7. Alpine Vegetation
8. Tropical Moist Deciduous Forests

Features of Two Types of Tropical Deciduous Forests in India

Location: Found in regions with moderate rainfall (100 cm to 200 cm), such as parts of the Himalayan foothills, Eastern and Western Ghats, and Madhya Pradesh.

Characteristics:

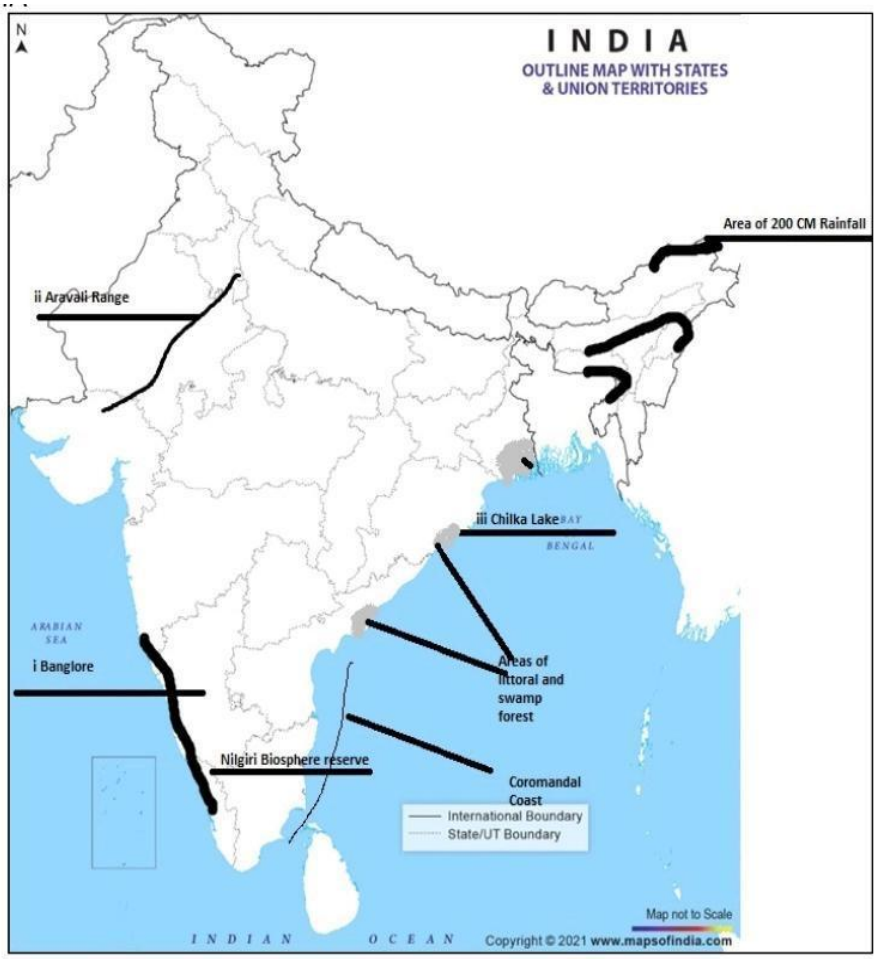
1. Trees shed leaves during the dry season to conserve water.

Includes species like teak, sal, sandalwood, and rosewood.

Can be dense in areas with abundant rainfall.

These forests are important for timber and fuelwood.
2. Tropical Dry Deciduous Forests
Location: Found in areas with slightly lower rainfall (70 cm to 100 cm), such as Rain-shadow regions of the Western Ghats, interior Deccan Plateau, and parts of Uttar Pradesh and Bihar.
Characteristics:
Trees shed leaves in the dry season to adapt to water scarcity.
Vegetation is less dense and trees are shorter compared to moist deciduous forests.
Common tree species include acacia, mango, bamboo, and kikar.
These forests are important for grazing and timber.

29. INDIA



30. WORLD MAP

A. North America
B. Cocos plate
C. Srilanka
D. Gulf stream
E. Humboldt (Peru)
F. Indian ocean
G. Kanchenjunga

SAMPLE PAPER 3
KENDRIYA VIDYALAYA SANGTHAN
SESSION ENDING EXAMINATION
SUBJECT – GEOGRAPHY

Time – 3Hrs **Class- XI** **MM- 70**

SECTION A

1. What is the main focus of physical geography as a sub-discipline of geography?
A. Study of cultural practices and languages in different regions
B. Study of economic activities and trade routes across the world
C. Study of natural features and processes of the earth's surface
D. Study of governmental systems and political boundaries

2. A researcher is studying climate patterns across continents by focusing only on temperature variation worldwide. Which geographical approach is being used?
A. Regional approach
B. Systematic approach
C. Human approach
D. Environmental approach

3. Which of the following best represents the concept of sustainable development in geography?
A. Rapid use of non-renewable resources
B. Ignoring future needs
C. Balanced use of resources for present and future generations
D. Complete ban on resource use

4. Oceans on Earth were formed after the planet cooled sufficiently. In this context, consider the following statements:
1. Water vapour was released into the atmosphere through volcanic activity.
2. Continuous cooling caused condensation of water vapour.
3. Precipitation over millions of years led to the formation of oceans.
Which of the statements given above are correct?
A. 1 and 2 only
B. 2 and 3 only
C. 1 and 3 only
D. 1, 2 and 3

5. Match List-I (Landform) with List-II (Dominant Process):

Match List-I (Landform)	List-II (Dominant Process)
a V-shaped valley	1 Glacial erosion
b U-shaped valley	2 Fluvial erosion
c Delta	3 Deposition
d Sand dune	4 Aeolian deposition

Select the correct answer using the code below:

A. a-2, b-1, c-3, d-4
B. a-1, b-2, c-4, d-3
C. a-2, b-3, c-1, d-4
D. a-3, b-1, c-2, d-4

6. Which of the following landforms are primarily depositional in nature?
1. Delta 2. Flood plain
3. Cirque 4. Sand dune
Select the correct answer using the code below:
A. 1 and 2 only
B. 1, 2 and 4 only
C. 3 and 4 only
D. 1, 2, 3 and 4

7. In which of the following regions the chemical weathering process is more dominant than the mechanical process?
A. Desert region
B. Arid region
C. Limestone region
D. Glacier region

8. Arrange the following layers of the atmosphere in increasing order of their height from the Earth's surface:
1. Mesosphere 2. Troposphere
3. Stratosphere 4. Thermosphere
Options:
A. 2, 3, 1, 4
B. 2, 1, 3, 4
C. 4, 1, 3, 2
D. 2, 3, 4, 1

9. Which of the following conditions is NOT required for the formation of a Tropical Cyclone?
A. Presence of the Coriolis force
B. A pre-existing weak low-pressure area
C. Large variations in the vertical wind speed
D. Sea surface temperature higher than 27 degrees Celsius

10. High-altitude clouds that are thin, detached, and have a feathery or fibrous appearance are called:
A. Stratus
B. Cirrus
C. Cumulus
D. Nimbus

11. Assertion (A): The oceans in the Northern Hemisphere record higher temperatures than the oceans in the Southern Hemisphere.

Reason (R): The Northern Hemisphere has a larger proportion of landmass compared to the Southern Hemisphere.

A. Both A and R are true, and R is the correct explanation of A.
B. Both A and R are true, but R is NOT the correct explanation of A.
C. A is true, but R is false.
D. A is false, but R is true.

12. The longitudinal extent of India has significant implications for its time zone. Which of the following states would be the FIRST to see the sunrise?

A. Nagaland
B. Arunachal Pradesh
C. Assam
D. Manipur

13. Assertion (A): Gujarat has the longest coastline among all Indian states.
Reason (R): The presence of numerous indentations, gulfs (Kutch and Khambhat), and creeks significantly increases the length of Gujarat's coast.
Options:

A. Both A and R are true, and R is the correct explanation of A.
B. Both A and R are true, but R is NOT the correct explanation of A.
C. A is true, but R is false.
D. A is false, but R is true.

14. The 'Mango Showers' are common pre-monsoon rainfall occurring towards the end of the summer season. In which of the following states are they most prominent?

A. West Bengal and Assam
B. Kerala and Karnataka
C. Rajasthan and Gujarat
D. Punjab and Haryana

15. What is the primary reason for the presence of long roots and thick bark in the trees of 'Tropical Thorn Forests'?

A. To stay upright in swampy soils.
B. To protect against heavy snowfall.
C. To minimize transpiration and access deep groundwater.
D. To absorb nutrients from the air.

16. Consider the following statements regarding 'Tropical Evergreen Forests' in India:
    1. They are found in regions with rainfall exceeding 200 cm.
    2. The trees have a distinct season for shedding leaves to conserve moisture.
    3. Common species include Rosewood, Mahogany, and Ebony.

Which of the statements given above are correct?

A. 1, 2, and 3
B. 2 and 3 only
C. 1 and 3 only
D. 1 and 2 only

17. Match the Forest Type (List I) with its characteristic Tree Species (List II):

List I	List II	
a Tropical Thorn	1	Teak
b Tropical Deciduous	2	Acacia
c Littoral/Swamp	3	Deodar
d Montane	4	Sundari

Which of the following is the correct matching?

A. a-1, b-2, c-3, d-4

B. a-2, b-1, c-4, d-3

C. a-2, b-4, c-1, d-3

D. D. a-4, b-1, c-2, d-3

Section B

18. Read the following paragraph and answer the questions that follow:

"The ocean water is dynamic. The horizontal and vertical movements are governed by the density of water and external forces. Waves are the manifestation of energy; they are not the water moving across the ocean surface, but the energy that travels. The actual motion of the water beneath the waves is circular. While waves are short-lived, ocean currents are a relatively permanent flow of water. These currents act as a global conveyor belt, transferring heat from the tropics to the poles. Furthermore, the gravity of the sun and moon causes tides, which are periodically occurring rise and fall of sea levels. These movements significantly impact coastal navigation and the global climate."

a. According to the passage, what is the primary difference between waves and ocean currents in terms of their duration?

b. Describe the actual physical movement of water particles beneath a traveling wave?

c. What is the climatic significance of ocean currents mentioned in the source?

19. Read the following paragraph and answer the questions that follow:

The northern boundary of the Peninsular Block may be taken as an irregular line running from Kachchh along the western flank of the Aravali Range near Delhi and then roughly parallel to the Yamuna and the Ganga as far as the Rajmahal Hills and the Ganga delta. Apart from these, the Karbi Anglong and the Meghalaya Plateau in the northeast and Rajasthan in the west are also extensions of this block. The northeastern parts are separated by the Malda fault in West Bengal from the Chotanagpur plateau. In Rajasthan, the desert and other desert– like features overlay this block. The Peninsula is formed essentially by a great complex of very ancient gneisses and granites, which constitutes a major part of it. Since the Cambrian period, the Peninsula has been standing like a rigid block with the exception of some of its western coast which is submerged beneath the sea and some other parts changed due to tectonic activity without affecting the original basement. As a part of the Indo-Australian Plate, it has been subjected to various vertical movements and block faulting. The rift valleys of the Narmada, the Tapi and the Mahanadi and the Satpura block mountains are some examples of it. The Peninsula mostly consists of relict and residual mountains like the Aravali hills, the Nallamala hills, the Javadi hills, the Veliconda hills, the Palkonda range and the Mahendragiri hills, etc. The river valleys here are shallow with low gradients.

a. What geological process explains the presence of the Narmada and Tapi valleys in the stable Peninsular block?

b. Which specific fault separates the northeastern extensions like the Meghalaya plateau from the main Chotanagpur plateau?

c. Mention two relict mountains found within the Peninsular Block.

Section C

20. Briefly explain the indirect sources of information of the interior of the earth other than those of seismic activity.
21. Name the two main types of geomorphic processes and give two differences between them.

OR

"Physical weathering is not a passive process but depends on various applied forces." Elaborate on this statement by discussing the role of these applied forces.

22. "While the sun has already risen in Arunachal Pradesh, it is still dark in Gujarat." Explain the reason for this time lag.
23. "Discuss the three major factors that led to large-scale deforestation in India under British rule."

Or

"The western slopes of the Western Ghats are covered with thick evergreen forests, while the eastern slopes are not." Explain the geographical reason behind this variation.

Section D

24. "The continents we see today were once part of a single landmass that drifted apart." Support this statement by explaining the various evidences provided by Alfred Wegener for the Continental Drift Theory.

OR

The ocean floor may be segmented into how many major divisions based on the depth as well as the forms of relief? Explain these major divisions.

25. Explain the different processes through which the atmosphere gets heated and cooled.
26. “India’s one coast is a result of submergence (sinking), creating natural harbours; the other is a result of emergence (rising), creating wide fertile lands.” Identify which is which and compare their features.
27. What are the important characteristic features of north Indian rivers? How are these different from Peninsular rivers?

Or

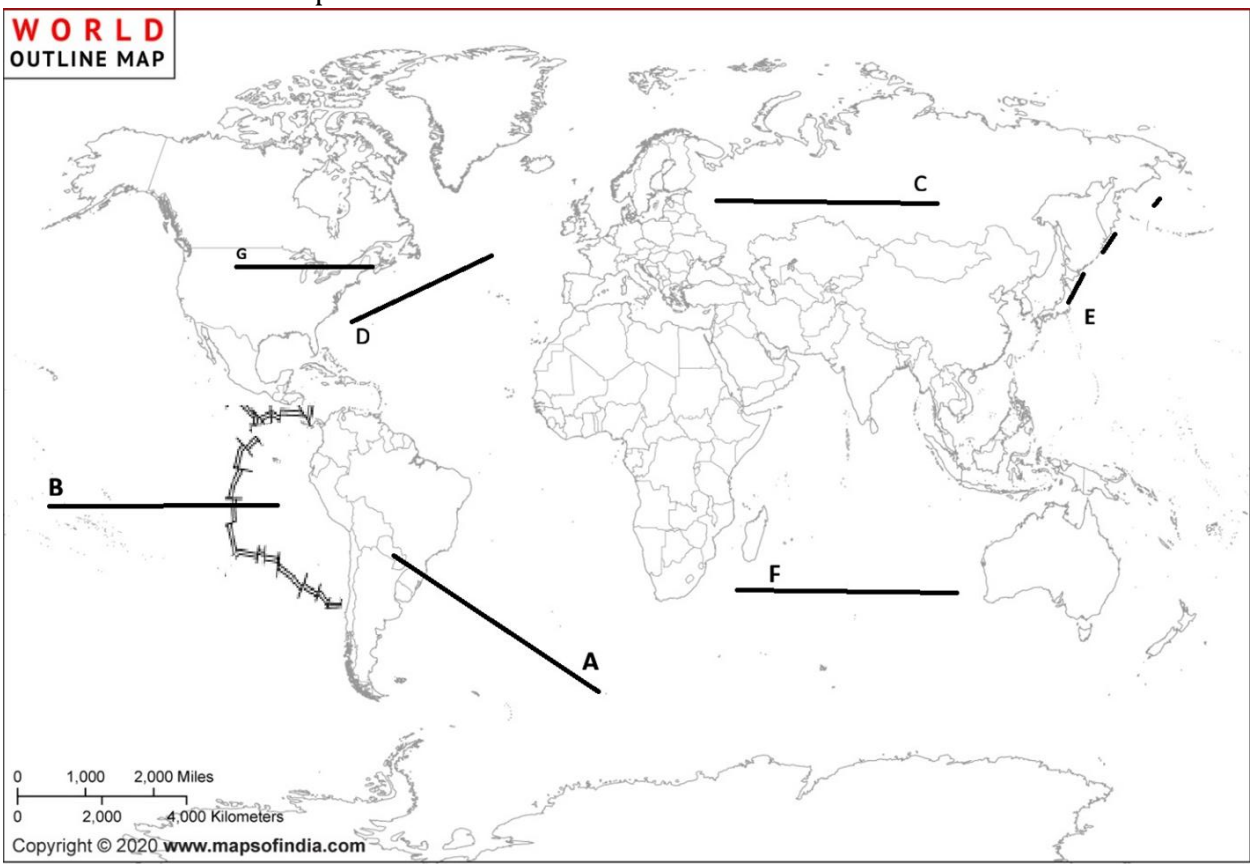
"Write a detailed note on the largest West-flowing River and the largest East-flowing River of Peninsular India."

28. Discuss the mechanism of the Southwest Monsoon by explaining the path and impact of its two main branches.
29. With the help of the following key, identify the areas marked as A, B, C, D , E, F, G on the given outline map of the World. Write the correct name of the place in the blank space given on the map.

A. A Continent
B. A Minor Plate
C. A Major Plate
D. A Warm Current
E. A Cold Current

F. An Ocean
G. G - Famous for the highest tides in the world

30. Locate and label any five of the following geographical features on the Political Outline map of India with appropriate symbols:
A. Namcha Barwa Peak
B. Aravali Range
C. Coromandal Coast
D. Brahmputra River
E. Area receiving lowest rainfall In India
F. Deccan Plateau
G. Sundarban Biosphere Reserve



Sample Paper 4
KENDRIYA VIDYALAYA SANGATHAN
Session Ending Examination
GEOGRAPHY (029)

Time: 3 Hours **Class-XI** **Maximum Marks: 70**

SECTION-A
MULTIPLE-CHOICE QUESTIONS (MCQs) (1*17=17 Mark)

1. Which one of the following figures represents the age of the earth?
A. 4.6 million years
B. 4.6 billion years
C. 13.7 billion years
D. 13.7 trillion years

2. _____ instrument is used to record the earthquake waves.
A. Anemometer
B. Rain Gauge
C. Seismograph
D. Barometer

3. The crust and mantle are separated by which of the following discontinuities?
A. Gutenberg discontinuity
B. Moho discontinuity
C. Conrad discontinuity
D. Lehman discontinuity

4. A specific zone with active volcanoes in Pacific Ocean is called:
A. Ring of Fire
B. Ball of Fire
C. Fire rain area
D. Volcanic area

5. Which force helps in Geomorphic Processes?
A. Endogenic Forces
B. Exogenic Forces
C. Both a & b
D. None of these

6. In which category of wind Monsoon is kept:
A. Local winds
B. Seasonal winds
C. Planetary winds
D. Periodic winds

7. Which one of the following is the highest cloud in the sky?
A. Cirrus B. Stratus C. Nimbus D. Cumulus

8. Identify the element which is not a part of the hydrological cycle:
A. Evaporation
B. Hydration
C. Precipitation
D. Condensation

9. Which one of the following countries shares the longest land frontier with India?
A. Bangladesh
B. China
C. Pakistan
D. Myanmar

10. Which country does NOT comes under INDIAN SUB-CONTINENT?
A. Bhutan
B. China

C. Pakistan D. Nepal

11. What are some important consequences of the northward movement of the Indian plate?

A. Formation of the Himalayas C. Shifts in river courses
B. Changes in climate patterns D. All of these

12. ASSERTION (A): The Ganga River system is the largest river system in India.
REASON (R): The Ganga River has the maximum number of tributaries among all Indian rivers.

A. Both A and R are true, and R is the correct explanation of A.
B. Both A and R are true, but R is not the correct explanation of A.
C. A is true, but R is false.
D. A is false, but R is true.

13. Choose the correct option

Column A	**Column B**
1. Ganga River	a) Perennial River
2. Godavari River	b) Rift Valley
3. Indus River	c) Largest River
4. Narmada River	d) Peninsular River

	1.	2.	3.	4.
A.	c	d	a	b
B.	d	a	b	c
C.	c	a	d	b
D.	a	c	b	d

14. Which of the following is a greenhouse gas?

A. Oxygen C. Carbon dioxide
B. Nitrogen D. Helium

15. Which of the following statements about the south west monsoon is correct?

A. Monsoon winds blow from the land to the sea in summer.
B. Monsoon winds blow from the sea to the land in summer.
C. Monsoon winds blow from the land to the sea in winter.
D. Monsoon winds blow from the sea to the land in winter.

16. What causes rainfall on the coastal areas of Tamil Nadu in the beginning of winters?

A. South-West monsoon C. Temperate cyclones
B. North-Eastern monsoon D. Local air circulation

17. Which one of the following proportion of area of the country was targeted to be under forest in Forest Policy of India?

A. 33% B. 55% C. 44% D. 22%

SECTION-B
SOURCE BASED QUESTIONS (3*2=6 Marks)

18. SOLAR RADIATION

The earth's surface receives most of its energy in short wavelengths. The energy received by the earth is known as incoming solar radiation which in short is termed as insolation. As the earth is a geoid resembling a sphere, the sun's rays fall obliquely at the top of the atmosphere and the earth intercepts a very small portion of the sun's energy. On an average the earth receives 1.94 calories per sq. cm per minute at the top of its atmosphere. The solar output received at the top of the atmosphere varies slightly in a year due to the variations in the distance between the earth and the sun. During its revolution around the sun, the earth is farthest from the sun (152 million km) on 4th July. This position of the earth is called aphelion. On 3rd January, the earth is the nearest to the sun (147 million km). This position is called perihelion. Therefore, the annual insolation received by the earth on 3rd January is slightly more than the amount received on 4th July. However, the effect of this variation in the solar output is masked by other factors like the distribution of land and sea and the atmospheric circulation. Hence, this variation in the solar output does not have great effect on daily weather changes on the surface of the earth.

a) What do you understand by Insolation?
b) On which date earth is farthest from the sun?
c) Explain perihelion.

19. Biosphere Reserve

A Biosphere Reserve is a unique and representative ecosystem of terrestrial and coastal areas which are internationally recognised within the framework of UNESCO's Man and Biosphere (MAB) Programme.The Biosphere Reserve aims at achieving the three objectives: Conservation of Biodiversity and Ecosystem, Association of environment with development, International network for research and monitoring There are 18 biosphere reserves in India. They protect larger areas of natural habitat than a typical national park or animal sanctuary, and often include one or more national parks or reserves, along with buffer zones that are open to some economic uses. Protection is granted not only to the flora and fauna of the protected region, but also to the human communities who inhabit these regions, and their ways of life. In total there are 18 biosphere reserves in India. Twelve of the eighteen biosphere reserves are a part of the World Network of Biosphere Reserves, based on the UNESCO Man and the Biosphere (MAB) Programme list.

a) What do you understand by Biosphere Reserves?
b) What are the objectives of establishing Biosphere Reserves?
c) Which Biosphere Reserves is situated in Sikkim?

SECTION-C
SHORT ANSWER QUESTIONS (3*4=12 Marks)

20. Define Geography and How Physical Geography is helpful for the managing the natural resources?

21. What do you understand by atmosphere? Explain in your words.

Or

Draw the diagram of the different layers of the atmosphere? Explain the lowest layer of the atmosphere.

22. What are tides? Name the two types of tides on basis of location of sun earth and the moon.

23. How is the latitudinal spread of India advantageous to India?

SECTION-D

LONG ANSWER QUESTIONS (5*5=25 Marks)

24. What are the evidences in support of the continental drift theory?

Or

Differentiate between divergent and convergent plate boundaries.

25. Explain the depositional landform created by running water with pictures/Diagram.

Or

Explain the depositional landform created by Glaciers with pictures/Diagram.

26. Discuss the formation and characteristics of the Himalayan mountain range in India.

Or

Explain the physiographic features of the Peninsular Plateau in India and their significance.

27. Discuss the causes and effects of river pollution in India. Suggest measures to control it.

28. How many distinct Seasons are found in India as per the Indian Meteorological Department? Discuss the weather conditions associated with any one season in detail.

SECTION-E

MAP BASED QUESTIONS (1*10=10 Marks)

29. Identify the geographical features marked as A, B, C, D, E, F and G on the basis of information given and write their names against the space provided in the map. (Attempt any five)

A. A hot desert in north Africa

B. A major sea.

C. A cold ocean current

D. A warm ocean current

E. A major ocean

F. A major tectonic plate.

G. A minor tectonic plate

30. Locate and label the following features with appropriate symbols on the given political outline map of India. (Attempt any five)

A. Kaziranga National Park

B. Area with lowest rainfall in India

C. Pulicat Lake

D. Nathula mountain pass

E. Lakshadweep islands

F. Deccan plateau

G. Coromandel coastal plains

Sample Paper 5
KENDRIYA VIDYALAYA SANGATHAN
Session Ending Examination
GEOGRAPHY (029)

Time: 3 Hours **Class-XI** **Maximum Marks: 70**

SECTION – A

1. A specific zone with active volcanoes in Pacific Ocean is called:

A. Ring of Fire
B. Ball of Fire
C. Fire rain area
D. Volcanic area

2. Which one of the following material is affected by hydration process ?

A. Granite B. Clay C. Quartz D. Salt

3. The Inter Tropical Convergence Zone normally occurs ....

A. Near the equator
B. Near the Tropic of Cancer
C. Near the Tropic of Capricorn
D. Near the Arctic Circle

4. Given below is a list of climatic phenomena and their type according to classification. Which of the following pair is NOT correctly matched ?

	Phenomena	Characteristics
A.	ITCZ.	Winds Converge
B.	Tropical Cyclone	Arabian Sea
C.	Jet Stream	North of Himalayas
D.	El –Nino.	Warm Current

5. Which of the following countries is larger in area than India?

A. China B. Egypt C. France D. Iran

6. There are two statement marked as assertion (A) and reason (R), Mark your answer as the codes provided.

Assertion (A) – The air at the ITCZ rises because of convection caused by high insolation.

Reason (R) – The winds from the tropic diverge this low pressure zone.

OPTIONS –

A. Both (A) and (R) are true and R is not correct explanation of (A)
B. Both (A) and (R) are true and (R) is the correct explanation of (A)
C. Both (A) and (R) are incorrect.
D. Only (A) is correct but (R) is incorrect.

7. Consider the following and choose the correct answer with the help of given codes-

	Column 1	Column 2
i)	Equatorial Low	1)60° N-S
ii)	Sub-tropical High	2) Near 90°

iii)	Sub polar Low	3) Near 0°
iv)	Sub Polar High	4) 90° N-S

OPTIONS-

	i	ii	iii	iv
A.	3	4	2	1
B.	2	4	1	3
C.	3	4	1	2
D.	4	3	2	1

8. Given below is a list of natural vegetation and the type of trees found 0^0 density. Which of the following pair is NOT correctly matched?

	Natural Vegetation	**Tree**
A.	Tropical Evergreen	Ebony
B.	Tropical Deciduous	Tendu
C.	Tropical Thorn	Babool
D.	Montane	Amaltas

9. Which one of the following rivers was known as the sorrow of Bengal?

A. The Gandak C. The Kosi
B. The Son D. The Damodar

10. Which one of the following rivers flows in a rift valley?

A. The Son C. The Yamuna
B. The Narmada D. The Luni

11. Which one of the following process is responsible for transforming liquid into vapour?

A. Condensation C. Evaporation
B. Transpiration D. Precipitation

12. Which one of the following longitudes of the standard meridian for India?

A. 69’30’ E B. 82’30’ E C. 75’30’ E D. 90’30’ E

13. Consider the following and choose the correct answer with the help of given codes.

	Column 1	Column 2
i)	Peninsular Plateau	1) Nilgiri Hills
ii)	Meghalaya Plateau	2) Anaimundi
iii)	Western Ghats	3) Raj Mahal Hills
iv)	Central Highlands	4) Khasi Hills

Codes

	I	II	III	IV
A.	2	4	1	3
B.	3	4	1	2
C.	3	2	4	1
D.	4	3	2	1

14. If the surface air pressure is 1000 mb, the air pressure at km above the surface will be?

A. 700 mb B. 1100 mb C. 900 mb D. 1300 mb

15. Which of the following statements about the south west monsoon is correct?

A. Monsoon winds blow from the land to the sea in summer.
B. Monsoon winds blow from the sea to the land in summer.
C. Monsoon winds blow from the land to the sea in winter.
D. Monsoon winds blow from the sea to the land in winter.

16. What causes rainfall on the coastal areas of Tamil Nadu in the beginning of winters?

A. South-West monsoon C. Temperate cyclones
B. North-Eastern monsoon D. Local air circulation

17. Which one of the following proportion of area of the country was targeted to be under forest in Forest Policy of India?

A. 33% B. 55% C. 44% D. 22%

Section – B
Source Based Question (3x2=6)

18. Read the following paragraph carefully and give the answer of the following questions.

Earthquake waves get recorded in seismographs located at far off locations. However, there exist some specific areas where the waves are not reported. Such a zone is called the 'shadow zone'. The study of different events reveals that for each earthquake, there exists an altogether different shadow zone. It was observed that seismographs located at any distance within 105° from the epicentre, recorded the arrival of both P and S-waves. However, the seismographs located beyond 145° from epicentre, record the arrival of P-waves, but not that of S-waves. Thus, a zone between 105° and 145° from epicentre was identified as the shadow zone for both the types of waves. The entire zone beyond 105° does not receive S-waves. The shadow zone of S-wave is much larger than that of the P-waves. The shadow zone of P-waves appears as a band around the earth between 105° and 145° away from the epicentre. The shadow zone of S-waves is not only larger in extent but it is also a little over 40 per cent of the earth surface. You can draw the shadow zone for any earthquake provided you know the location of the epicentre.

a. What is a shadow zone?
b. Between which degrees is the shadow zone for P and S-waves found?
c. Which wave has a larger shadow zone, P-wave or S-wave?

19. Read the following paragraph and answer the question given below.

Forests have an intricate interrelationship with life and environment. These provide numerous direct and indirect advantages to our economy and society. Hence, conservation of forest is of vital importance to the survival and prosperity of humankind. Accordingly, the Government of India proposed to have a nation-wide forest conservation policy, and adopted a forest policy in 1952, which was further

modified in 1988. According to the new forest policy, the Government will emphasise sustainable forest management in order to conserve and expand forest reserve on the one hand, and to meet the needs of local people on the other. The forest policy aimed at : (i) bringing 33 per cent of the geographical areas under forest cover; (ii) maintaining environmental stability and to restore forests where ecological balance was disturbed; (iii) conserving the natural heritage of the country, its biological diversity and genetic pool; (iv) checks soil erosion, extension of the desert lands and reduction of floods and droughts; (v) increasing the forest cover through social forestry and afforestation on degraded land; (vi) increasing the productivity of forests to make timber, fuel, fodder and food available to rural population dependent on forests, and encourage the substitution of wood; (vii) creating of a massive peoples movement involving women to encourage planting of trees, stop felling of trees and thus, reduce pressure on the existing forest. Forests and Life To a vast number of tribal people, the forest is a home, a livelihood, their very existence.

a) When was the first forest policy adopted?

b) How much geographical area should be covered in forest policy?

c) Give any two points of forest policy.

SECTION C

20. As a scientific discipline with how many categories of questions is geography concerned? Explain.

21. What are the factors that control temperature distribution on the surface of the Earth?

22. How do Currents affect the temperature? How does it affect the temperature of coastal areas in the North –west Europe?

23. What are the implications of India having a long coastline?

SECTION –D

24. Explain the basic concept of continental drift theory.

OR

How many divisions the ocean floor may be segmented into based on the depth as well as the forms of relief?

25. Glacial valleys show up many linear dispositional forms. Give their locations and names?

OR

What are the causes behind formation of river meander land form?

26. Explain the characteristics or features of northern plain.

OR

Difference between Western Ghats and Eastern Ghats.

27. What are socio –economic advantages of interlinking of river in India?

OR

What are the important characteristics features of North India Rivers? How are they different from Peninsular Rivers?

28. How many distinct seasons are formed in India as per the Indian meteorological department? Discuss the weather conditions associated with one season in detail.

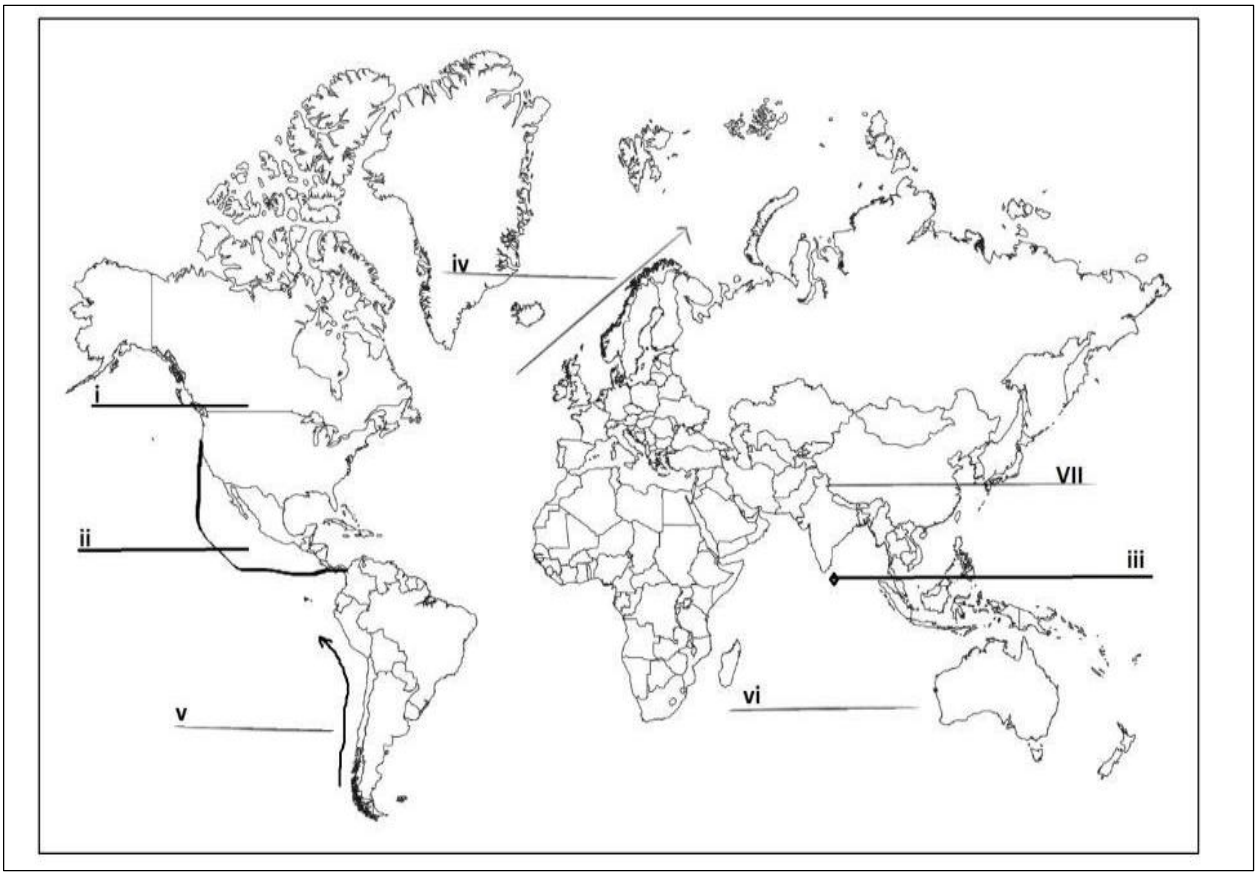
SECTION –E

29. On the outline map of India show the following . Any five

A. Any one area of winter rainfall
B. Narmada River
C. Great Rann of Kutch
D. Kanchenjunga
E. Sundarbans.
F. Nilgiri Hills

30. On the given political map of the world, the following seven features are shown. Identify any five of these features and write their correct names on the answer sheet.

A. Name of a continent
B. A minor tectonic plate.
C. A Neighboring country of India
D. A warm oceanic current.
E. A cold oceanic current
F. Name of the Ocean.
G. Highest mountain peak of India.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