



CLASS 9 SCIENCE — CHAPTER 13

EARTH AS A SYSTEM: ENERGY, MATTER, AND LIFE



New NCERT *Exploration* Science Textbook | 2026–27

This is the **final chapter of the new Class 9 Science *Exploration* textbook**. The supplied textbook contents place Chapter 13 at page 252 and identify it as “**Earth as a System: Energy, Matter, and Life.**”

The chapter connects Earth's major spheres, solar energy, atmosphere, winds, ocean currents, biogeochemical cycles, human impacts and sustainable living.



1. EARTH — A SYSTEM

Earth is not made up of separate, independent parts.

Different components of Earth continuously interact with one another.

For example:



Sun heats the Earth



Water evaporates



Clouds form



Rain falls



 Plants grow



 Animals depend on plants



 Nutrients return to the environment

★ **Therefore:**

Earth functions as an interconnected system.



2. FIVE MAJOR SPHERES OF EARTH

Earth can be divided into five major interacting spheres:



1. Geosphere



2. Hydrosphere



3. Cryosphere



4. Atmosphere



5. Biosphere



3. GEOSPHERE

The geosphere includes the:



Rocks



Mountains



Earth's crust



and the solid parts of Earth.

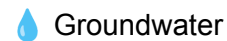
★ **In simple words:**

Geosphere = Solid Earth



4. HYDROSPHERE

The hydrosphere includes Earth's water:



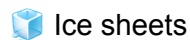
Hydrosphere = All forms of Earth's water



5. CRYOSPHERE

The cryosphere is the frozen part of Earth's water.

It includes:



 Sea ice



Cryosphere = Frozen water

6. ATMOSPHERE

The atmosphere is the:

Layer of gases surrounding Earth.

It contains mainly:

 Nitrogen

 Oxygen

and smaller amounts of:

CO₂

Water vapour

Other gases

7. BIOSPHERE

The biosphere includes:

 Plants

 Animals

 Microorganisms

 Humans

and the regions where life exists.



Biosphere = Zone of life



8. INTERACTION BETWEEN EARTH'S SPHERES

The five spheres constantly interact.

For example:



Rain from the atmosphere



enters the hydrosphere



supports plants in the biosphere



roots interact with soil in the geosphere.

Therefore:

Atmosphere ↔ Hydrosphere ↔ Biosphere ↔ Geosphere



9. EXAMPLE — MELTING GLACIER

Suppose a glacier melts.



Cryosphere decreases.



Water enters rivers and oceans.



 Hydrosphere changes.



 Aquatic ecosystems may be affected.



 Biosphere is affected.

★ **One change can affect several Earth spheres.**

10. SUN — THE MAIN ENERGY SOURCE

The Sun is the primary energy source driving most processes on Earth.

Solar energy drives:

 Photosynthesis

 Water cycle

 Atmospheric circulation

 Temperature differences

 Ocean circulation

 Weather

11. SOLAR RADIATION

Energy from the Sun reaches Earth mainly in the form of:

Electromagnetic radiation

It travels through space without requiring a material medium.



12. ELECTROMAGNETIC WAVES

Electromagnetic waves are waves consisting of changing electric and magnetic fields.

They can travel through:

Vacuum

Therefore, sunlight can travel from the Sun to Earth through space.



13. SPEED OF ELECTROMAGNETIC WAVES

Electromagnetic waves travel through vacuum at approximately:

3×10^8 m/s

This is the speed of light in vacuum.



14. ELECTROMAGNETIC SPECTRUM

Electromagnetic radiation includes a range of wavelengths and frequencies.

From lower frequency to higher frequency:



Radio waves



Microwaves



Infrared

 **Visible light**

 **Ultraviolet**

 **X-rays**

 **Gamma rays**

15. FREQUENCY AND WAVELENGTH

For electromagnetic waves:

Higher frequency → Shorter wavelength

Lower frequency → Longer wavelength

The relationship is:

$$c = f \times \lambda$$

where:

c = speed of light

f = frequency

λ = wavelength

16. VISIBLE LIGHT

Visible light is the portion of electromagnetic radiation that our eyes can detect.

It enables:

 Vision

 Photosynthesis

 Colour perception

★ **Visible light is extremely important for life on Earth.**

17. ULTRAVIOLET RADIATION

Ultraviolet radiation is commonly abbreviated as:

UV

Too much UV exposure can damage:

 Skin

 Eyes

 DNA

The ozone layer helps absorb much of the harmful UV radiation reaching Earth.

18. INFRARED RADIATION

Infrared radiation is associated with:

Heat

Earth absorbs solar radiation and emits energy back toward space, including infrared radiation.

Greenhouse gases absorb and re-emit some of this outgoing infrared radiation.

19. INSOLATION

 **Definition**

Insolation means incoming solar radiation received by Earth.

The amount of solar energy received varies with:

 Latitude

 Angle of sunlight

 Time of day

 Atmospheric conditions

 Earth's shape

20. SOLAR CONSTANT

The solar constant is the approximate amount of solar energy received per unit area at the top of Earth's atmosphere on a surface perpendicular to the Sun's rays.

Its approximate value is:

1.4 kW/m²

or:

1400 W/m²

21. WHY DOES EARTH HEAT UNEVENLY?

Earth receives solar energy unevenly.

The major reason is:

 **Earth's curved shape.**

Sunlight strikes different parts of Earth at different angles.

22. EQUATORIAL REGIONS

Near the equator:

 Sun's rays are more nearly direct.

Energy is concentrated over a smaller area.

Therefore:

 **More heating occurs.**

23. POLAR REGIONS

Near the poles:

 Sun's rays strike at a lower angle.

The same energy is spread over a larger area.

Therefore:

 **Heating is less intense.**

24. LATITUDE AND HEATING

Generally:

Equator → More concentrated solar energy

Poles → Less concentrated solar energy

This difference contributes to:

 Winds

 Ocean currents

 Weather patterns

25. ALBEDO

Definition

Albedo is the fraction or percentage of incoming solar radiation reflected by a surface.

A surface with:

High albedo

reflects more radiation.

A surface with:

Low albedo

absorbs more radiation.

26. HIGH ALBEDO

Examples:

 Snow

 Ice

These surfaces reflect a large proportion of incoming sunlight.

Therefore:

High albedo → More reflection → Less absorption

27. LOW ALBEDO

Dark surfaces generally absorb more solar radiation.

Examples:

🖤 Dark soil

🌊 Some ocean surfaces

Low albedo → Less reflection → More absorption

28. ALBEDO AND CLIMATE

If ice melts:

🧊 Less reflective ice



🌊 More dark ocean/water exposed



☀️ More solar energy absorbed



🌡️ More warming

This is an example of a:

Positive feedback

29. URBAN HEAT ISLAND EFFECT

Cities often contain:

🏢 Buildings

🛣️ Roads

🅑 Concrete

asphalt and other materials.

These surfaces absorb and store heat.

Cities can therefore become warmer than nearby rural areas.

This is called:

Urban Heat Island Effect



30. ATMOSPHERE — COMPOSITION

The atmosphere consists mainly of:

Nitrogen

and

Oxygen

with smaller amounts of:



Argon



Carbon dioxide



Water vapour

and other gases.



31. NITROGEN

Nitrogen makes up approximately:

78%

of dry air.



32. OXYGEN

Oxygen makes up approximately:

21%

of dry air.



33. CARBON DIOXIDE

Carbon dioxide is present in a much smaller proportion.

But it has major importance because it:



Is used in photosynthesis.



Is a greenhouse gas.



Participates in the carbon cycle.



34. ATMOSPHERIC LAYERS

The atmosphere is divided into several layers.

Important layers include:



Troposphere



Stratosphere



Mesosphere



Thermosphere



Exosphere

35. TROPOSPHERE

The troposphere is the:

Lowest atmospheric layer.

Most weather occurs here.

It contains much of the atmosphere's:

 Water vapour

and supports:

 Clouds

 Rain

 Storms

36. TEMPERATURE IN TROPOSPHERE

Generally:

Temperature decreases with increasing altitude

in the troposphere.

37. STRATOSPHERE

Above the troposphere is the:

Stratosphere

The ozone layer is located within the stratosphere.



38. OZONE LAYER

Ozone is:

O_3

The ozone layer absorbs a large portion of harmful ultraviolet radiation from the Sun.



Therefore:

Ozone layer → Protection from harmful UV radiation



39. TEMPERATURE IN STRATOSPHERE

Unlike the troposphere, temperature generally:

Increases with altitude

in the stratosphere.

One reason is absorption of UV radiation by ozone.



40. GREENHOUSE EFFECT

Certain gases in the atmosphere absorb and re-emit some outgoing infrared radiation.

These are called:

Greenhouse gases

Examples include:



Carbon dioxide



Water vapour

 Methane

This warming process is called:

Greenhouse effect

41. WHY IS THE GREENHOUSE EFFECT IMPORTANT?

The natural greenhouse effect helps keep Earth warm enough for life.

Without it:

 **Earth would be much colder.**

However, increasing concentrations of greenhouse gases can enhance warming.

42. GREENHOUSE GASES

Important greenhouse gases include:

CO₂ — Carbon dioxide

CH₄ — Methane

N₂O — Nitrous oxide

H₂O — Water vapour

and some other gases.

43. WHAT IS WIND?

Definition

Wind is moving air.

Wind develops because of:

Differences in air pressure

44. WHY DO PRESSURE DIFFERENCES DEVELOP?

Uneven heating of Earth's surface causes differences in:

 Temperature



 Air density



 Air pressure



 Wind movement

45. AIR MOVEMENT

Warm air:

 Tends to rise

Cooler, denser air:

 Tends to sink

This produces:

Convection currents

which contribute to atmospheric circulation.



46. VALLEY BREEZE

During the day:



Mountain slopes heat up.



Air over slopes becomes warmer.



Warm air rises.



Cooler air moves up the valley.

This is called:

Valley breeze



47. MOUNTAIN BREEZE

At night:



Mountain slopes cool rapidly.



Air becomes cooler and denser.



It flows down the slopes.

This is called:

Mountain breeze



48. PLANETARY WINDS

Large-scale wind systems that operate over extensive regions of Earth are called:

Planetary winds

They are influenced by:



Uneven heating



Earth's rotation



Pressure differences



49. CORIOLIS EFFECT

Because Earth rotates, moving air and water appear to be deflected relative to Earth's surface.

This is called:

Coriolis effect

It influences:



Winds



Ocean currents

and large-scale circulation.



50. OCEAN CURRENTS

Definition

Ocean currents are large-scale movements of seawater.

They transport:

 Heat

 Salts

 Water

around ocean basins.

51. FACTORS AFFECTING OCEAN CURRENTS

Ocean currents are influenced by:

 Winds

 Temperature differences

 Salinity differences

 Earth's rotation

 Shape of coastlines

 Ocean basin structure

52. SURFACE AND DEEP OCEAN CIRCULATION

 **Surface currents**

Strongly influenced by:

 Winds

Deep currents

Strongly influenced by:

 Temperature

 Salinity

Density differences.

Together, these movements contribute to:

Global ocean circulation

53. GYRES

Large circular systems of ocean currents are called:

Gyres

They occur in major ocean basins.

Their direction is influenced by:

 Earth's rotation

and the arrangement of continents.

54. OCEAN CURRENTS AND CLIMATE

Ocean currents transport heat.

A warm current can:

 Warm nearby coastal regions.

A cold current can:

 Cool nearby coastal regions.

Therefore:

Ocean currents influence climate.

55. BIOGEOCHEMICAL CYCLES

Elements and compounds continuously move between:

 Living organisms

 Rocks and soil

 Water

 Atmosphere

This movement is called:

Biogeochemical cycling

56. FOUR IMPORTANT CYCLES

This chapter discusses:

 **Water cycle**

 **Carbon cycle**

 **Nitrogen cycle**

 **Oxygen cycle**

57. WATER CYCLE

The water cycle describes the continuous movement of water through:

 Oceans

 Atmosphere

 Land

 Groundwater

58. EVAPORATION

Definition

Evaporation is the conversion of liquid water into water vapour.

Solar energy drives much of Earth's evaporation.

59. TRANSPIRATION

Plants release water vapour into the atmosphere through their aerial parts, especially leaves.

This process is called:

Transpiration

60. EVAPOTRANSPIRATION

The combined loss of water through:

Evaporation + Transpiration

is called:

Evapotranspiration

61. CONDENSATION

Water vapour cools and changes into tiny liquid water droplets.

This is:

Condensation

It contributes to:

 Cloud formation

62. PRECIPITATION

Water falls from clouds to Earth's surface as:

 Rain

 Snow

 Hail

This is called:

Precipitation

63. WATER CYCLE — COMPLETE FLOW

 Evaporation



 Condensation



 **Precipitation**



 **Runoff / Infiltration**



 **Rivers / Groundwater / Oceans**



 **Evaporation**

 **Cycle repeats**



64. CARBON CYCLE

Carbon moves between:

 **Atmosphere**

 **Plants**

 **Animals**

 **Soil**

 **Oceans**

and Earth's rocks.



65. PHOTOSYNTHESIS IN CARBON CYCLE

Plants take in:

CO₂

during photosynthesis.

Carbon becomes incorporated into organic compounds in plants.



66. RESPIRATION

Plants and animals release:

CO₂

during respiration.

Therefore:

Photosynthesis → Removes CO₂

Respiration → Releases CO₂



67. COMBUSTION

Burning fuels and biomass releases carbon dioxide.

Examples:

 Coal

 Petrol

 Diesel

 Natural gas

 Wood

Therefore:

Combustion → CO₂ released

68. DECOMPOSITION

When organisms die:

 Dead matter



 Decomposers break it down.

Carbon returns to:

 Soil

 Atmosphere

69. NITROGEN CYCLE

Nitrogen is essential for:

 Proteins

 DNA

 Plant growth

Although Earth's atmosphere contains a large amount of nitrogen gas, most organisms cannot directly use atmospheric N₂.

70. NITROGEN FIXATION

Certain microorganisms convert atmospheric nitrogen into forms that can enter biological processes.

This is:

Nitrogen fixation

Some nitrogen fixation is carried out by bacteria associated with plants.



71. NITRIFICATION

Certain bacteria convert:

Ammonia/ammonium compounds

into:

Nitrites

and then:

Nitrates

This process is called:

Nitrification



72. AMMONIFICATION

Decomposers convert nitrogen-containing organic matter into:

Ammonia/ammonium compounds

This process is called:

Ammonification



73. DENITRIFICATION

Certain bacteria convert nitrates back into:

Nitrogen gas

which returns to the atmosphere.

This process is:

Denitrification

74. OXYGEN CYCLE

Oxygen moves among:

 Atmosphere

 Plants

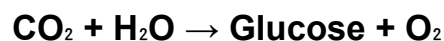
 Animals

 Water

and other components of Earth.

75. PHOTOSYNTHESIS AND OXYGEN

Photosynthesis releases oxygen:



Therefore:

★ **Photosynthesis is a major natural process that replenishes atmospheric oxygen.**

76. RESPIRATION AND OXYGEN

During aerobic respiration:

 Organic food

•

 Oxygen



CO₂ + H₂O + Energy

Therefore:

Respiration consumes oxygen.

77. COMBUSTION AND OXYGEN

Burning also uses oxygen.

Therefore:

Combustion → Consumes O₂

Photosynthesis → Produces O₂

78. FOUR BIOGEOCHEMICAL CYCLES

Cycle	Important processes
 Water	Evaporation, condensation, precipitation
 Carbon	Photosynthesis, respiration, combustion, decomposition
 Nitrogen	Fixation, nitrification, ammonification, denitrification
 Oxygen	Photosynthesis, respiration, combustion

79. EUTROPHICATION

Definition

Eutrophication is the enrichment of a water body with nutrients, especially nitrogen and phosphorus, which can cause excessive growth of algae and aquatic plants.

80. HOW DOES EUTROPHICATION HAPPEN?

Excess fertilisers:

 Agricultural fields



 Runoff



 Lakes/rivers



 Excess nutrients



 Algal growth



 Dead algae decompose



 Oxygen levels may decrease



 Fish and other aquatic organisms may die.

81. HUMAN IMPACT ON EARTH SYSTEM

Humans interact with every Earth sphere.

Activities such as:

 Industrialisation

 Transport

 Deforestation

 Intensive agriculture

 Urbanisation

 Fossil-fuel burning

can alter Earth's systems.

82. DEFORESTATION

Definition

Deforestation is the large-scale removal of forests.

It can result in:

 Loss of biodiversity

 Increased CO₂

 Changes in water cycle

 Soil erosion

 Climate impacts



83. HUMAN ACTIVITIES AND CARBON CYCLE

Burning fossil fuels releases stored carbon.

Coal → CO₂

Petroleum → CO₂

Natural gas → CO₂

Deforestation can also reduce the amount of carbon removed from the atmosphere through photosynthesis.



84. CLIMATE CHANGE

Human activities have increased concentrations of greenhouse gases.

This contributes to:

Global warming and climate change

Possible effects include:



Rising temperatures



Ice loss



Sea-level rise



Changing rainfall patterns



More frequent/intense heat extremes in some regions



Ecosystem changes



85. MELTING ICE AND SEA LEVEL

When land-based ice melts:



Glaciers / ice sheets



More water enters oceans



Sea level rises.

Warming ocean water also expands, contributing to sea-level rise.



86. SUSTAINABLE DEVELOPMENT



Definition

Sustainable development means meeting present needs while protecting the ability of future generations to meet their needs.

It requires balancing:



Human needs



Environmental protection



Economic development



87. SUSTAINABLE ACTIONS

We can reduce environmental impacts by:



Saving electricity



Saving water

-  Planting and protecting trees
 -  Using public transport
 -  Walking or cycling when practical
 -  Reducing waste
 -  Reusing materials
 -  Recycling
 -  Using renewable energy
-

88. MISSION LiFE

LiFE stands for:

Lifestyle for Environment

It encourages individuals and communities to adopt environmentally responsible lifestyles.

Examples:

-  Save water
-  Save energy
-  Reduce waste
-  Avoid unnecessary consumption
-  Protect nature

The chapter connects sustainable actions with **Mission LiFE**.

89. WHY EARTH'S SPHERES MUST BE STUDIED TOGETHER

Suppose forests are removed.

 Forest loss



 Less vegetation



 Less carbon absorption



 Changes in water cycle



 Soil erosion



 Habitat loss

★ **Therefore:**

A change in one sphere can create changes in several other spheres.

90. IMPORTANT RELATIONSHIPS

 **Sun**

Solar energy → Drives Earth's systems

 **Albedo**

High albedo → More reflection

Low albedo → More absorption

 **Greenhouse effect**

Greenhouse gases → Absorb/re-emit outgoing infrared radiation

Wind

Pressure differences → Air movement

Ocean currents

Transport heat → Influence climate

Photosynthesis

Consumes CO₂ + Releases O₂

91. IMPORTANT FORMULAS

Electromagnetic wave

$$c = f \times \lambda$$

where:

c = speed of light

f = frequency

λ = wavelength

Solar constant

Solar constant $\approx 1.4 \text{ kW/m}^2$

or

$\approx 1400 \text{ W/m}^2$

Water balance — conceptual

Precipitation = Evaporation + Runoff + Change in storage

for a simplified water-budget system over an appropriate time period.



92. IMPORTANT DEFINITIONS



Earth system

The interconnected system formed by Earth's major spheres and their interactions.



Geosphere

Solid Earth including rocks and soil.



Hydrosphere

All of Earth's water.



Cryosphere

Frozen water on Earth.



Atmosphere

Gaseous envelope surrounding Earth.



Biosphere

Part of Earth where life exists.



Insolation

Incoming solar radiation received by Earth.



Albedo

Fraction of incoming radiation reflected by a surface.



Greenhouse effect

Warming resulting from absorption and re-emission of outgoing infrared radiation by greenhouse gases.

Wind

Moving air caused by pressure differences.

Ocean current

Large-scale movement of seawater.

Biogeochemical cycle

Movement of elements and compounds between living and non-living components of Earth.

Eutrophication

Nutrient enrichment of water bodies causing excessive biological growth.

Deforestation

Large-scale removal of forests.

93. IMPORTANT EXAM QUESTIONS

Q1. Name the five major spheres of Earth.

Geosphere, hydrosphere, cryosphere, atmosphere and biosphere.

Q2. Why is Earth called an interconnected system?

Because changes in one sphere can influence other spheres through exchanges of matter and energy.

Q3. What is solar radiation?

Energy from the Sun transmitted mainly as electromagnetic radiation.

Q4. What is insolation?

Incoming solar radiation received by Earth.

Q5. What is albedo?

The fraction or percentage of incoming solar radiation reflected by a surface.

Q6. Why does snow have high albedo?

Because snow reflects a large proportion of incoming sunlight.

Q7. What is the greenhouse effect?

It is the warming caused when greenhouse gases absorb and re-emit some outgoing infrared radiation.

Q8. What is the role of the ozone layer?

It absorbs much of the Sun's harmful ultraviolet radiation.

Q9. What causes wind?

Differences in air pressure caused largely by uneven heating of Earth's surface.

Q10. What are ocean currents?

Large-scale movements of seawater that transport heat and water.

Q11. What is a biogeochemical cycle?

The continuous movement of substances between living organisms and Earth's physical components.

Q12. Name four biogeochemical cycles.

Water, carbon, nitrogen and oxygen cycles.

Q13. What is eutrophication?

Nutrient enrichment of a water body that can lead to excessive algal growth and oxygen depletion.

Q14. What is deforestation?

Large-scale removal of forests.

Q15. What is Mission LiFE?

Lifestyle for Environment, an initiative promoting environmentally responsible lifestyle choices.

94. COMPETENCY-BASED QUESTION

A snow-covered area receives sunlight.

Does it absorb all the solar energy?

 **No.**

Snow has relatively high albedo.

Therefore, it reflects a large proportion of incoming solar radiation.

95. COMPETENCY-BASED QUESTION

Why are equatorial regions generally warmer than polar regions?

Because sunlight reaches equatorial regions more directly and is concentrated over a smaller area.

At the poles, sunlight arrives at a lower angle and is spread over a larger area.

96. COMPETENCY-BASED QUESTION

A forest is removed from a large area.

Name three Earth systems that could be affected.

Answer:

 **Biosphere** → Habitat and biodiversity loss

 **Atmosphere** → Carbon balance affected

 **Hydrosphere** → Water cycle and runoff may change

 **Geosphere** → Soil erosion may increase

97. COMPETENCY-BASED QUESTION

A farmer applies excessive fertiliser near a lake.

What could happen?

Fertiliser runoff



 Nutrients enter lake



 Algal growth increases



 Algae die



 Decomposition increases



 Dissolved oxygen decreases



 Aquatic organisms may die.

 **This is eutrophication.**

98. COMPETENCY-BASED QUESTION

Why does burning fossil fuel affect the carbon cycle?

Fossil fuels contain stored carbon.

When they burn:



Therefore, combustion transfers carbon from geological stores to the atmosphere.

99. COMPETENCY-BASED QUESTION

Why are ocean currents important for climate?

Ocean currents transport heat from one region to another.

Warm currents can warm nearby coastal areas, while cold currents can cool them.

100. COMPETENCY-BASED QUESTION

Why can a reduction in snowfall affect grass availability?

Less snowfall can mean:

 Less stored water



 Less meltwater



 Less water available to plants



 Reduced grass growth

This demonstrates the interaction between the:

Cryosphere → Hydrosphere → Biosphere

101. COMMON MISTAKES TO AVOID

Mistake 1

Albedo means absorption.

 **Correct:**

Albedo = Reflection

Mistake 2

High albedo means more heating.

 **Correct:**

High albedo → More reflection → Less absorption

Mistake 3

Ozone is a greenhouse gas whose main role is to warm Earth.

 **Correct:**

The ozone layer's major role discussed here is absorbing harmful **UV radiation**.

Mistake 4

Weather occurs mainly in the stratosphere.

 **Correct:**

Most weather occurs in the **troposphere**.

✗ Mistake 5

Wind moves from low pressure to high pressure.

✓ Correct:

Air tends to move from **higher pressure toward lower pressure**, producing wind.

✗ Mistake 6

All nitrogen in the atmosphere can be directly used by plants.

✓ Correct:

Most atmospheric N₂ must first be converted into usable forms through processes such as nitrogen fixation.

✗ Mistake 7

Eutrophication means clean water.

✓ Correct:

Eutrophication is **excess nutrient enrichment** that can cause algal blooms and oxygen depletion.

102. QUICK REVISION

 Earth → Interconnected system

 Geosphere → Solid Earth

 Hydrosphere → Water

 Cryosphere → Frozen water

 Atmosphere → Gases

 Biosphere → Life

 Sun → Main energy source

 Solar radiation → Electromagnetic radiation

 Visible light → Vision + photosynthesis

 UV → Can damage living tissues

 Infrared → Associated with heat

 Insolation → Incoming solar radiation

 Albedo → Reflection

 Snow → High albedo

 Dark surfaces → Lower albedo

 Atmosphere → Mainly nitrogen + oxygen

 Troposphere → Weather

 Ozone → Absorbs harmful UV

 Greenhouse effect → Warming

 Wind → Moving air

 Coriolis effect → Deflects large-scale moving air/water

 Ocean currents → Transport heat

 Water cycle → Evaporation → Condensation → Precipitation

 Carbon cycle → Photosynthesis + respiration + combustion + decomposition

 Nitrogen cycle → Fixation + nitrification + ammonification + denitrification

 Oxygen cycle → Photosynthesis + respiration + combustion

 Eutrophication → Excess nutrients → Algal growth → Oxygen depletion

 Deforestation → Habitat + climate + water-cycle impacts

 Mission LiFE → Sustainable lifestyle

103. MEMORY TRICKS

FIVE EARTH SPHERES

G H C A B

 Geosphere

 Hydrosphere

 Cryosphere

 Atmosphere

 Biosphere

104. ALBEDO MEMORY TRICK

A = Away

High albedo → Radiation goes **away** by reflection.



High albedo → High reflection

Low albedo → High absorption

105. CARBON CYCLE MEMORY

P-R-C-D

 Photosynthesis

 **Respiration**

 **Combustion**

 **Decomposition**

106. NITROGEN CYCLE MEMORY

F-N-A-D

 **Fixation**

 **Nitrification**

 **Ammonification**

 **Denitrification**

107. WATER CYCLE MEMORY

E-C-P

 **Evaporation**

 **Condensation**

 **Precipitation**

108. ATMOSPHERE MEMORY

T → S

 **Troposphere**



 **Stratosphere**

Remember:

Troposphere → Weather

Stratosphere → Ozone



109. MOST IMPORTANT CONCEPTS

- ★ 1. Earth is an interconnected system.
 - ★ 2. The Sun provides the main energy driving Earth's systems.
 - ★ 3. Earth receives solar radiation unevenly.
 - ★ 4. Albedo controls how much sunlight is reflected.
 - ★ 5. The atmosphere regulates Earth's temperature and weather.
 - ★ 6. Winds result from pressure differences.
 - ★ 7. Ocean currents transport heat.
 - ★ 8. Matter continuously cycles through Earth's systems.
 - ★ 9. Human activities can disturb these cycles.
 - ★ 10. Sustainable actions can reduce environmental impacts.
-



110. COMPLETE CHAPTER FLOWCHART



SOLAR ENERGY

Sun



Solar radiation



Uneven heating of Earth



Temperature differences



Pressure differences



 **Winds**

-

 **Ocean currents**



 **Climate and weather**



MATTER CYCLING



Water

Evaporation → Condensation → Precipitation → Runoff/Infiltration



Carbon

Photosynthesis ↔ Respiration

-

Combustion + Decomposition

Nitrogen

Fixation → Nitrification → Assimilation → Ammonification → Denitrification

Oxygen

Photosynthesis ↔ Respiration + Combustion

111. CHAPTER 13 — FINAL TAKEAWAY

Earth is not a collection of isolated parts. 

It is a dynamic system in which:

Geosphere

interacts with

Hydrosphere

which interacts with

Cryosphere

which interacts with

Atmosphere

which supports

Biosphere.

At the centre of many of these interactions is:

SOLAR ENERGY

Solar energy drives atmospheric circulation, the water cycle and photosynthesis. Matter continuously moves through Earth's **water, carbon, nitrogen and oxygen cycles**.

Human activities such as deforestation, excessive resource use, pollution and fossil-fuel combustion can disturb these natural systems.

Therefore:

 **Understanding Earth as a system helps us understand why environmental problems are interconnected — and why sustainable action is essential.**