NCERT Archive

SOLUTIONS BOOK

CLASS 9

Science · Exploration

CHAPTER 13

Earth as a System: Energy, Matter, and Life

Complete Questions and Activities Solutions

In-text Questions | Activities and Example | Revise, Reflect, Refine

Contents

Class 9 Science · Exploration · Chapter 13 — Earth as a System: Energy, Matter, and Life

13.1 **In-text Questions** — 11 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 — 3

13.2 **Activities and Example** — 7 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 — 11

13.3 **Revise, Reflect, Refine** — 15 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 — 20

Every question is followed by its answer. Question numbers above are clickable and the PDF bookmarks panel lets you jump to any exercise set or question. Figures are reproduced from the NCERT textbook (© NCERT) for educational use.

NCERT ARCHIVE

13.1

CLASS 9 SCIENCE · CHAPTER 13

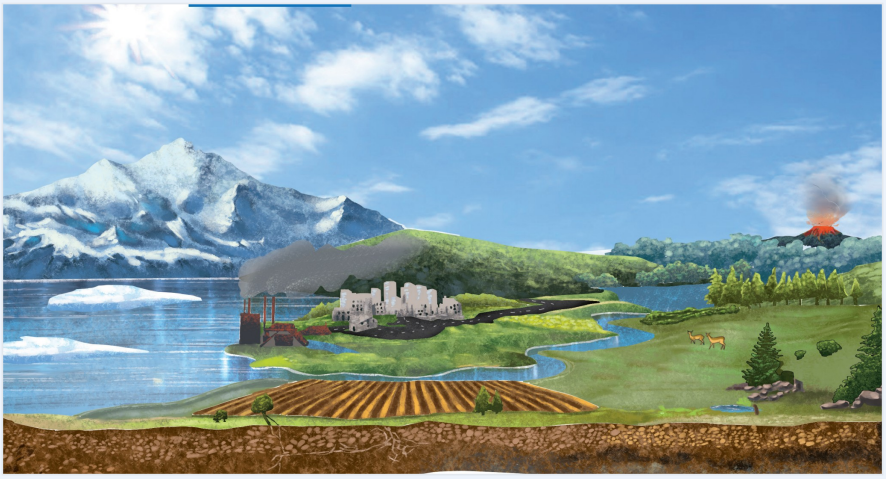
In-text Questions

Solutions · 11 questions

Directions (Questions 1–11): These are the questions that appear inside the chapter (Think It Over, Pause and Ponder and What If), numbered in the order in which they appear. Model answers based on the chapter are given.

QUESTION 1 *Think It Over · p. 252*

How does the warming of Arabian Sea water affect the southwest monsoon in India?



Chapter-opening illustration: the spheres of the Earth system

ANSWER

Warmer sea water changes the amount of water that evaporates, and this changes the behaviour of the southwest monsoon.

a Chain of effects

- Warmer Arabian Sea water leads to **more evaporation** from the sea (hydrosphere and atmosphere).
- This causes **fluctuations in the southwest monsoon**, which results in variability in rainfall.

NCERT ARCHIVE

- Some regions of India get floods, while others are left in drought; this disrupts the hydrosphere.
- Insolation (solar radiation) drives the southwest monsoon, so changes in sea temperature directly change the monsoon that India's climate and agriculture depend on.

Therefore, a warmer Arabian Sea increases evaporation and makes the southwest monsoon and rainfall more variable, causing floods in some regions and drought in others.

QUESTION 2 *Think It Over · p. 252*

If a large forest is cleared, how can that affect the flow of a river in that area?

ANSWER

Forests link the air, water, soil and living things. Clearing them changes how rain water reaches the river.

a Effects of clearing a forest

Change	Effect on the river
Decreased photosynthesis and reduced transpiration	Less water vapour goes into the air, which can lead to a decline in local rainfall, so less water reaches the river
Sudden or heavy rain on bare ground	More run off and less infiltration, so the river rises quickly and can flood
Less infiltration	Less recharge of groundwater, so less water is released slowly to the river in dry months
No tree roots to hold the soil	Soil erosion increases and soil washes into the river

Therefore, clearing a large forest makes the river's flow more irregular (floods in wet spells, less water in dry spells) and increases erosion.

NCERT ARCHIVE

QUESTION 3 *Think It Over · p. 252*

What might happen to coastal cities in India if glaciers and polar ice keep melting faster?

ANSWER

Melting ice in the cryosphere adds water to the hydrosphere, which can threaten places at the coast.

- Melting glaciers add more water to rivers and, in the long run, **raise the sea level**.
- Low-lying coastal regions can be flooded, which threatens coastal cities such as Mumbai and Chennai.
- Flooding and habitat loss disturb ecosystems in the biosphere and affect the people living there.

Therefore, faster melting of glaciers and polar ice could raise sea levels and flood low-lying coastal cities of India.

QUESTION 4 *Think It Over · p. 252*

How would increasing carbon dioxide levels in the atmosphere affect the ocean plankton?

ANSWER

The oceans absorb part of the extra carbon dioxide, and this changes the water in which plankton live.

- More atmospheric CO_2 means more is absorbed by the ocean, making the sea water **more acidic**.
- Plankton use the carbonate and bicarbonate ions that form for photosynthesis, and some marine organisms use them to form shells. This could threaten tiny plankton and coral reefs.
- Warmer ocean water also reduces the ocean's capacity to absorb CO_2 as a carbon sink.
- Plankton form the base of marine ecosystems, so the whole marine ecosystem is disrupted.

NCERT ARCHIVE

Therefore, increasing CO_2 acidifies the ocean and could threaten plankton and, through them, marine ecosystems.

QUESTION 5 *Pause and Ponder 1 · p. 258*

Visit the website given below and study the effect of the concentration of greenhouse gas on surface temperature, https://phet.colorado.edu/en/simulations/greenhouse-effect

ANSWER

This is a simulation activity. The result follows the idea in the chapter: more greenhouse gas means a warmer surface.

a What to expect

Greenhouse gas concentration	Effect on surface temperature
Very low	Most of the outgoing infrared escapes to space, so the surface is cooler
Higher	More of the re-radiated infrared is absorbed by gases such as CO_2, CH_4 and water vapour and sent back, so the surface warms
Much higher	The greenhouse effect intensifies and the surface becomes still warmer (global warming)

Therefore, a higher concentration of greenhouse gases raises the surface temperature, because more of the outgoing heat is trapped.

QUESTION 6 *Pause and Ponder 2 · p. 261*

How does the cool mountain breeze benefit agriculture activity, particularly the crops and soil?

ANSWER

The mountain breeze is the cool air that flows down the slopes into the valley after sunset. The chapter notes that these local winds help regulate temperature and moisture and support soil and crop health.

- It brings cooler air to the warm valley floor at night, which regulates temperature and gives crops relief after the day’s heat.

NCERT ARCHIVE

- Cooler conditions reduce loss of water from the soil and the plants, which helps keep moisture conditions suitable.
- Stable temperature and moisture support soil and crop health in mountainous regions.



Fig. 13.8 (b). Mountain breeze

Therefore, the cool mountain breeze helps agriculture by regulating temperature and moisture, which supports the soil and the crops.

QUESTION 7 *Pause and Ponder 3 · p. 261*

What happens to the warm surface of water from the equator as it travels toward the poles? What impact does this movement have on the area?

ANSWER

Warm equatorial surface water flows towards the poles, loses heat on the way, and then returns towards the equator.

a What happens to the water

- It carries heat from the equator towards the poles and gradually cools.
- The colder, denser water slowly flows back towards the equator through deeper ocean levels.

b Impact on the area

- Ocean currents transport heat, so they reduce temperature differences across the planet.
- For example, the warm North Atlantic Drift (an extension of the Gulf Stream) flows towards the north-western coast of Europe and keeps many ports ice-free in winter, even at high latitudes.
- This moderating influence on climate supports human activities such as trade and commerce, and the currents also transport nutrients that support marine ecosystems.

NCERT ARCHIVE



Fig. 13.10 (b). Gulf Stream brings warm water from the equator

Therefore, the warm water moves heat towards the poles, cools, and returns at depth, which moderates the climate of the areas it reaches.

QUESTION 8 *Pause and Ponder 4 · p. 263*

The CO_2 dissolved in the ocean is disturbed when the global temperature increases. What will happen to marine life?

ANSWER

The ocean is a large store of carbon and regulates the carbon dioxide in the atmosphere. Warming and extra CO_2 upset this balance.

- Warmer ocean water reduces the ocean's capacity to absorb CO_2, so less is taken up and more stays in the air.
- The CO_2 that does dissolve makes sea water more acidic, which could threaten tiny plankton and coral reefs.
- Phytoplankton and shell-forming organisms depend on the carbonate and bicarbonate ions formed from dissolved CO_2; if these are disturbed, marine food webs and fisheries are disrupted.

Therefore, marine life, especially plankton, corals and shell-forming organisms, would be threatened and marine ecosystems disrupted.

NCERT ARCHIVE

QUESTION 9 *Pause and Ponder 5 · p. 265*

What would happen to plants and animals on Earth if the biogeochemical cycles were disrupted and stopped? Explain by giving a few examples.

ANSWER

Biogeochemical cycles recycle the nutrients that life needs. If they stopped, the supply of these materials would end and life could not continue.

Cycle	If it stopped
Carbon cycle	No CO_2 would be taken up for photosynthesis and no carbon would return from respiration and decomposition; food could not be made
Nitrogen cycle	Nitrogen would not be converted into forms plants can absorb, so proteins and nucleic acids could not be made
Oxygen cycle	Oxygen used in respiration and combustion would not be restored by photosynthesis, and living things would run short of it
Water cycle	No evaporation and precipitation, so no rain, rivers or groundwater for land organisms

Therefore, plants and animals could not survive, since all of them depend on these cycles for essential nutrients, water and oxygen.

QUESTION 10 *What if ... · p. 265*

What if photosynthesis stopped, what would happen on the Earth?

ANSWER

Photosynthesis is the primary source of food for most organisms and the main way oxygen is restored. Without it, the whole system would fail.

- Plants would make no glucose, so the food chains that start with plants would collapse.
- Oxygen is used up by respiration and combustion, and would no longer be restored.
- Plants would stop taking in CO_2, so it would build up in the air and strengthen the greenhouse effect.

NCERT ARCHIVE

- The fast carbon cycle would break and life would not be sustained across the spheres.

Therefore, if photosynthesis stopped, food and oxygen would run out and life on the Earth could not continue.

QUESTION 11 *Pause and Ponder 6 · p. 266*

Discuss how human activities increase the concentration of greenhouse gases in the atmosphere. What would you do as an individual to reduce the emission of greenhouse gas?

ANSWER

a How human activities raise greenhouse gases

- Burning fossil fuels for electricity, transport, cooking and industry releases CO_2.
- Deforestation removes forests, which are natural carbon sinks, and fewer trees absorb less CO_2.
- Vehicular emissions and the energy used to make fertilisers add further gases and pollutants.
- The result: atmospheric CO_2 has risen from about 315 ppm to 420 ppm since 1960 (Fig. 13.14).

b What I can do as an individual

- Save electricity and fuel, and use renewable energy such as solar where possible.
- Plant trees, save water and food, and reduce waste.
- Reuse and recycle materials, and prefer walking, cycling or public transport.
- Follow the Mission LiFE idea: simple, mindful, eco-friendly habits.

Therefore, burning fuels and deforestation raise greenhouse gases, and individuals can reduce them by saving energy, planting trees and cutting waste.

NCERT ARCHIVE

13.2

CLASS 9 SCIENCE · CHAPTER 13

Activities and Example

Solutions · 7 questions

Directions (Questions 1–7): These are the activities, the worked example and the Journey Beyond tasks of the chapter, in the order in which they appear. Model answers are given for the open-ended and project tasks; your own findings may differ.

NCERT ARCHIVE

QUESTION 1 *Activity 13.1 · p. 253*

Activity 13.1: Let us explore. 1. Observe the features of the Earth as shown in Fig. 13.1. Identify and circle one example representing each of the geosphere, hydrosphere, cryosphere, atmosphere, and biosphere. 2. How does snow (cryosphere) eventually become part of the lake (hydrosphere)? 3. If there is less snowfall during winters for a few years, how would this affect the lake's level and the grass available for the sheep? 4. Discuss with your classmates and write down how all the spheres are interconnected, and how a disturbance in one can lead to changes in others.



Fig. 13.1. Some features of the Earth's surface

ANSWER

a 1. One example of each sphere in Fig. 13.1

Sphere	Example in the picture
Geosphere	The rocks and soil, and the mountains
Hydrosphere	The lake
Cryosphere	The snow on the mountains
Atmosphere	The air and clouds around the mountains
Biosphere	The sheep, the grass and the shepherd

b 2. From snow to lake

When the snow melts as the temperature rises, the melt water flows down the slopes as streams and run off and collects in the lake.

c 3. Less snowfall for a few years

- Less snow means less melt water, so the lake level falls.
- With less water, the growth of grass is reduced, so less grass is available for the sheep (and so for the shepherd who depends on them).

NCERT ARCHIVE

d 4. Interconnection of spheres

Disturbance in	Changes in the other spheres
Atmosphere (less snowfall)	Cryosphere shrinks, the lake (hydrosphere) gets less water, grass (biosphere) and soil (geosphere) are affected
Cryosphere (faster melting)	More water to the hydrosphere, sea level rises, habitats in the biosphere are lost

Therefore, all the spheres are interconnected, and a disturbance in one leads to changes in the others.

QUESTION 2 *Example 13.1 · p. 255*

How much solar energy will be received by a 1 m^2 area in one hour, if the insolation on the surface of the Earth were 1 kWm^{-2}?

ANSWER

a Given

Quantity	Value
Insolation (intensity)	1 kW m^{-2} = 1000 J s^{-1} m^{-2}
Area	1 m^2
Time	1 hour = 3600 s

b Solution

Step	Working	Result
1	Energy = intensity × area × time	Formula
2	E = 1000 J s^{-1} m^{-2} × 1 m^2 × 3600 s	3600000 J
3	Write in standard form	**3.6 × 10^6 J**

Check: 1 kW for 1 hour is 1 kWh, which is one unit of household electricity, and 1 kWh = 3.6 × 10^6 J.

Therefore, a 1 m^2 area receives 3.6 × 10^6 J in one hour.

NCERT ARCHIVE

QUESTION 3 *Think as a Scientist · p. 255*

An interesting estimation problem that helps us to appreciate the enormous amount of energy that we get from the Sun is to estimate how much of the Earth's surface would be needed to be covered with solar panels to supply all the electric power that our country uses today (Fig. 13.4). To make this estimate, you can find these numbers on the internet, assume some insolation on the Earth's surface and consider that some fraction of this energy is converted into electricity. You will probably find that even a fraction of the area of the Thar desert, if covered with solar panels, could supply India's electricity needs.



Fig. 13.4. Solar panel in the desert

ANSWER

This is an estimation problem. The figures below are assumptions; your numbers from the internet may differ, but the answer stays in the same range.

a Assumed numbers

Quantity	Assumed value
India's yearly electricity (about 1821 billion units in FY 2024–25, CEA data)	$\approx 1.8 \times 10^{12}$ kWh
Insolation on clear days (chapter)	≈ 1 kW m^{-2}
Full-sun hours per day (assumed)	5.5 h
Fraction converted into electricity (assumed)	20%
Area of the Thar desert (approximate)	$\approx 2 \times 10^{5}$ km^{2}

NCERT ARCHIVE

b Estimate

Step	Working	Result
1	Solar energy per m^2 per year = 1 kW × 5.5 h × 365	≈ 2000 kWh
2	Electricity per m^2 per year = 20% of 2000	≈ 400 kWh
3	Area needed = 1.8×10^{12} kWh / 400 kWh per m^2	≈ 4.5×10^9 m^2
4	Convert (1 km^2 = 10^6 m^2)	≈ 4500 km^2
5	Fraction of the Thar desert = 4500 / 200000	≈ 2%

Real systems have extra losses and need space for roads and equipment, so the area could be a few times larger, but it would still be only a small fraction of the Thar desert.

Therefore, panels covering about 4500 km^2 (roughly 2% of the Thar desert) could supply India's present electricity use.

QUESTION 4 *Activity 13.2 · p. 256*

Activity 13.2: Let us find out. Complete Table 13.1 using information from authentic sources like websites and books.

ANSWER

Albedo is the fraction of solar radiation reflected by a surface. Typical values from reference tables are given; they vary a little between sources, with moisture and with the angle of the Sun.

a Table 13.1: Reflection of solar radiation by surfaces of materials

S. No.	Materials	Albedo
1.	Snow	0.80 – 0.90
2.	Ice	0.50 – 0.70
3.	Crushed rock	0.25 – 0.30
4.	Light coloured soil	**about 0.25 – 0.40**
5.	Black soil	**about 0.05 – 0.15**
6.	Ocean water	**about 0.06 – 0.10**

Rows 1 to 3 are given in the chapter. For rows 4 to 6 the approximate typical values are from standard albedo tables (open ocean is about 0.06; dark soil is low; light sand and soil are higher).

NCERT ARCHIVE

Therefore, snow and ice have high albedo and reflect most sunlight, while black soil and ocean water have low albedo and absorb more, so they are warmer.

QUESTION 5 *The Journey Beyond · p. 268*

Consider two hypothetical Earth-sized planets that have an atmosphere. Assume that one planet is entirely covered by oceans and the other is entirely by land. Knowing that the Sun heats the equator more than the poles, how would the wind patterns on these planets compare with the wind systems we observe on Earth, with its combination of land and sea?

ANSWER

On both planets the equator is heated more than the poles, so the same basic belts of rising and sinking air would form. What changes is how the surface itself heats and cools.

a What stays the same

- Warm air rises near the equator and sinks around 30° latitude, with matching circulation cells towards the poles (Fig. 13.9).
- If the planet rotates, the winds are deflected and follow curved paths.

b What would differ from Earth

Planet	Surface heating	Expected wind pattern
All ocean	Water heats and cools slowly, so surface temperature changes little	Smooth, steady planetary winds; no land and sea breezes or monsoons
All land	Land heats and cools quickly, so day-night and seasonal contrasts are large	More variable, stronger local winds; no land-sea contrast for monsoons
Earth	Land and sea heat unequally	Planetary winds modified by land and sea breezes and the monsoon

NCERT ARCHIVE

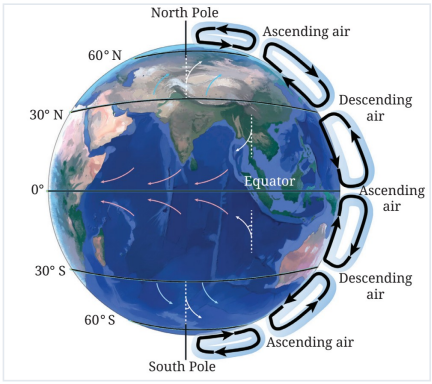


Fig. 13.9 (b). The distribution of pressure belts and planetary winds

Therefore, both planets would show the equator-to-pole wind belts, but only Earth's mixture of land and sea creates monsoons and local breezes.

QUESTION 6 *The Journey Beyond · p. 268*

Choose any one meal you ate recently (it could be anything, for example, roti and dal, rice and sambar, idli and chutney, and so on). For each main item in the meal, find out and explain: (i) how the carbon in it originally came from carbon dioxide in the air through photosynthesis, and (ii) how the nitrogen in it likely came from the atmosphere into the soil (for example, by bacteria or through the Haber-Bosch process and fertilisers) and then into the plant. Further, list other human activities involved in producing or cooking this meal that add extra carbon dioxide or nitrogen to the environment.

ANSWER

This is a project. A model answer for roti and dal is given; choose your own meal.

a Model answer: roti and dal

Item	Carbon	Nitrogen
Roti (wheat)	Wheat plants took CO_2 from the air and made glucose and starch by photosynthesis	Soil nitrogen came from fixation by bacteria, lightning, or fertilisers made by the Haber-Bosch process; the plant absorbed it and used it to make proteins
Dal (lentils)	The same, through photosynthesis in the plant	Legumes have Rhizobium bacteria in root nodules that convert atmospheric N_2 into ammonia, which the plant assimilates into protein

NCERT ARCHIVE

b Human activities that add CO_2 or nitrogen

- Fuel for tractors, pumps and transport of grain; fossil fuels for electricity and processing.
- Making fertilisers (the Haber-Bosch process is energy intensive) and overusing them, which sends extra nitrogen into soil and water.
- Cooking fuel (LPG, wood or coal) and refrigeration; burning crop residue.

Therefore, the carbon in food comes from air CO_2 through photosynthesis and the nitrogen from the air through fixation, while farming, transport and cooking add extra CO_2 and nitrogen.

QUESTION 7 *The Journey Beyond · p. 268*

Using data from the India Meteorological Department (IMD, https://mausam.imd.gov.in/) or newspaper records, find the average monsoon rainfall (June – September, or the local season) for your city or district for 5 years during two decades, such as the 1980s and 2020s. Note any trend you may find (increasing or decreasing, or the total number of days) with heavy rain (>50 mm). How can this be connected to the warmer Arabian Sea temperatures or changes in land use (forests to farms to cities) as discussed in the chapter?

ANSWER

This is a data project. The steps, a model report format and the possible connections are given; fill in your own data.

a Steps

- From IMD records or newspapers, note the June–September rainfall of your city or district for 5 years in the 1980s and 5 years in the 2020s.
- Find the average for each decade and the number of days with heavy rain (above 50 mm).
- Compare the two decades: is the rainfall or the number of heavy-rain days increasing or decreasing?

b Model report format

Period	Average monsoon rainfall (mm)	Days above 50 mm	Trend
1980s (5 years)	your data	your data	—
2020s (5 years)	your data	your data	increase / decrease

NCERT ARCHIVE

c Connecting the trend to the chapter

- Warmer Arabian Sea water gives more evaporation, so more variable monsoon rainfall, with floods in some years and drought in others.
- A warmer atmosphere holds more moisture, which can cause heavier rain in some areas.
- Land use change: clearing forests reduces transpiration and can reduce local rainfall, and cities and farms increase run off and reduce infiltration.

Therefore, a good report states the data for both decades, the trend, and how it may link to the warmer Arabian Sea and changing land use.

NCERT ARCHIVE

13.3

CLASS 9 SCIENCE · CHAPTER 13

Revise, Reflect, Refine

Solutions · 15 questions

Directions (Questions 1–15): These are the questions of Revise, Reflect, Refine at the end of the chapter (pages 267–268). Each is answered step by step with reasons.

QUESTION 1

Question 1 · p. 267

Choose the most appropriate option to describe the role of biogeochemical cycles in an ecosystem.
(i) To provide food directly to all organisms.
(ii) To recycle essential nutrients between biotic and abiotic components.
(iii) To create new elements for use by living things.
(iv) To remove pollutants and toxins from the organism.

ANSWER

The correct option is **(ii) To recycle essential nutrients between biotic and abiotic components.**

Option	Reason
(i)	Wrong: cycles do not give food directly; plants make food by photosynthesis.
(ii)	**Correct:** biogeochemical cycles move carbon, nitrogen, oxygen and water between living (biotic) and non-living (abiotic) parts, so nutrients are recycled and remain available.
(iii)	Wrong: elements are not created, they are only cycled.
(iv)	Wrong: removing toxins is not the role of these cycles.

Therefore, option (ii) is correct.

NCERT ARCHIVE

QUESTION 2 *Question 2 · p. 267*

Which of the following is primarily responsible for warming of the Earth?
(i) Solar radiation is immediately absorbed by carbon dioxide, which then releases it as heat.
(ii) The atmosphere's tiny particles absorb incoming solar radiation, which directly heats the Earth.
(iii) The Earth's surface absorbs solar radiation, which is then re-radiated and trapped by greenhouse gases.
(iv) The Earth's environment is heated only by the solar radiation reflected by the clouds.

ANSWER

The correct option is **(iii)**: the surface absorbs sunlight and re-radiates it as infrared, and greenhouse gases trap part of it.

Option	Reason
(i)	Wrong: sunlight reaches the surface; carbon dioxide mainly absorbs the outgoing infrared, not the incoming sunlight.
(ii)	Wrong: the atmosphere absorbs only part of the incoming radiation and does not directly heat the Earth this way.
(iii)	**Correct:** the Earth's surface absorbs sunlight and re-radiates it in the infrared; greenhouse gases like CO_2, CH_4 and water vapour absorb this heat and keep the Earth warm.
(iv)	Wrong: clouds reflect part of the sunlight away; they do not heat the Earth by reflection.

Therefore, option (iii) is correct.

NCERT ARCHIVE

QUESTION 3 *Question 3 · p. 267*

Explain how climate change affects the water cycle. Illustrate with examples.

ANSWER

Climate change (global warming) alters evaporation, rainfall, melting and run off, so it changes every step of the water cycle.

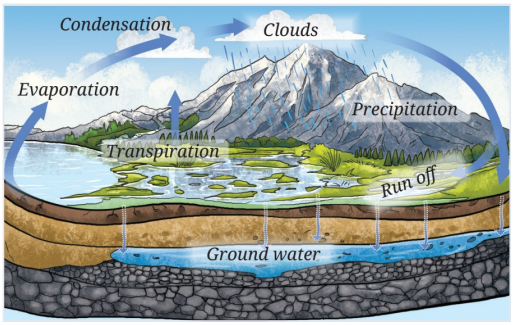


Fig. 13.12. Water cycle

a Effects with examples

Change	Example
A warmer atmosphere holds more moisture	Heavier rains in some areas (like intensified monsoons) and droughts elsewhere
Melting glaciers (cryosphere)	More water in rivers, and in the long run higher sea levels that threaten coastal cities such as Mumbai and Chennai
Sudden bursts of intense rain	More run off, which erodes the soil, and less infiltration
Less infiltration	Less recharge of groundwater, making agriculture difficult, especially in dry months

Therefore, climate change links the cryosphere, hydrosphere, atmosphere, geosphere and biosphere through the water cycle, bringing floods, droughts, sea level rise and loss of groundwater.

NCERT ARCHIVE

QUESTION 4 *Question 4 · p. 267*

Describe how albedo affects the Earth’s surface temperature and its climate.

ANSWER

Albedo is the fraction of solar radiation reflected by a surface. The lower the albedo, the more radiation is absorbed and the warmer the surface becomes.

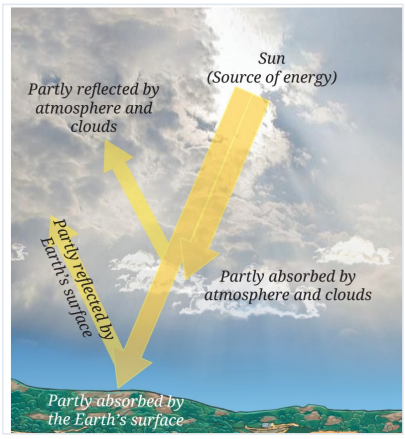


Fig. 13.5. Solar radiation and warming of the Earth

Surface	Albedo	Effect on temperature
Snow and ice	High (snow 0.80–0.90, ice 0.50–0.70)	Reflect most radiation, so the surface stays cold; this keeps polar regions very cold
Black soil, ocean water	Low	Absorb more radiation, so they are relatively warmer
Dark roads and clothes vs light surfaces	Low vs high	Dark ones heat up faster; light ones stay cooler

Changing the albedo changes the local climate. For example, clearing forests alters the surface albedo, and as ice melts it exposes darker surfaces that absorb more heat.

Therefore, high albedo keeps a surface cool and low albedo makes it warmer, so albedo helps decide temperature and climate.

NCERT ARCHIVE

QUESTION 5 *Question 5 · p. 267*

How are mountain and valley breezes formed? Suppose there are two mountains, one covered with grass and another covered with barren rocks; would the temperature of the two mountain breezes be different? If so, how?

ANSWER

Both breezes are caused by uneven heating of the mountain slopes and the valley floor.

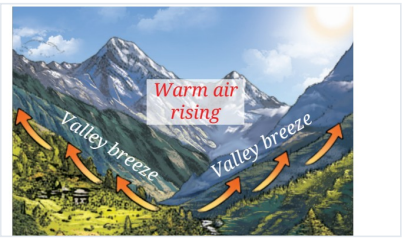


Fig. 13.8 (a). Valley breeze



Fig. 13.8 (b). Mountain breeze

a Formation

Breeze	When and why	Direction
Valley breeze	Day: slopes facing the Sun heat faster than the valley floor; air over them warms and rises, creating low pressure	Cooler air moves up the slopes from the valley
Mountain breeze	After sunset: slopes lose heat faster and become cooler; the air becomes cooler and denser	Cold air flows down into the valley

b Grass versus barren rock

- Yes, they would differ. Vegetation keeps a slope cooler through shade and transpiration, while bare rock heats up more.
- At night the barren slope loses its heat quickly and cools more, so the mountain breeze from it should be colder (and the daytime valley breeze towards it stronger).
- The grass-covered mountain stays more moderate, so its breeze is less cold.

Therefore, breezes form because slopes and valley heat and cool unequally, and the barren-rock mountain would give a colder mountain breeze than the grass-covered one.

NCERT ARCHIVE

QUESTION 6 *Question 6 · p. 267*

You have witnessed weather phenomena, such as winds, storms, rainfall, etc. Which atmospheric layer is mainly responsible for such phenomena and what is the primary reason for its occurrence?

ANSWER

The layer is the **troposphere** (0–12 km on average), where nearly all weather occurs.

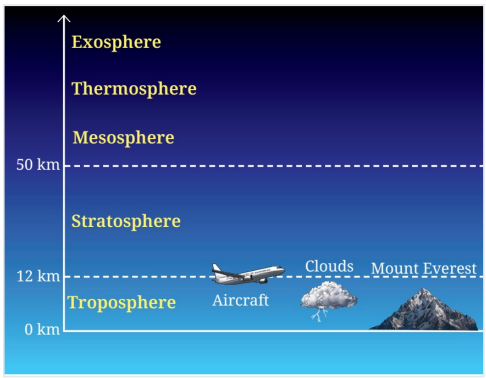


Fig. 13.7. Layers of the Earth's atmosphere

- The troposphere is heated from the Earth's surface, so the air near the ground is warmest and the temperature decreases with height (about 6.5 °C per km).
- As the warm air rises it drives winds and storms; water evaporates, condenses and falls as rain here.
- In the stratosphere the temperature rises with height, which calms the layer and keeps the weather confined to the troposphere.

Therefore, weather occurs in the troposphere because it is heated from the surface, so warm air rises and drives winds and storms.

NCERT ARCHIVE

QUESTION 7 *Question 7 · p. 267*

Explain the processes involved in the nitrogen cycle. How would life on Earth be affected if nitrogen were not cycled?

ANSWER

Nitrogen gas (N_2) in the air cannot be used directly by plants and animals, so the nitrogen cycle converts it into forms living things can use and returns it to the air.

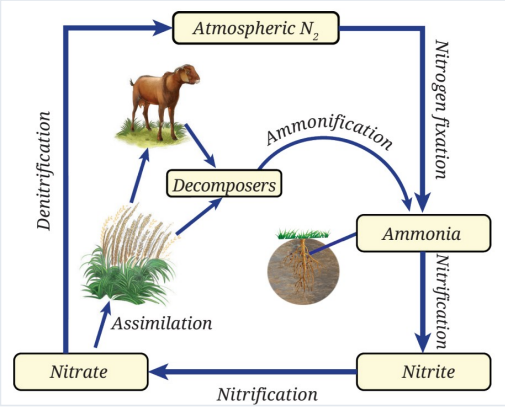


Fig. 13.15. Nitrogen cycle

a Processes

Process	What happens
Nitrogen fixation	Bacteria such as Rhizobium (in legume root nodules) and Azotobacter (in soil) convert N_2 into ammonia (NH_3); lightning and the Haber-Bosch process also fix nitrogen
Nitrification	Nitrosomonas convert ammonia into nitrite, and Nitrobacter convert nitrite into nitrate
Assimilation	Plants absorb these nitrogen compounds from the soil; animals get nitrogen by eating plants or other animals
Ammonification	Decomposers (bacteria and fungi) break down dead matter and waste, returning ammonia to the soil
Denitrification	Denitrifying bacteria such as Pseudomonas convert some nitrates back into nitrogen gas

b If nitrogen were not cycled

- Soil would run out of usable nitrogen, so plants could not make proteins and nucleic acids.
- Animals depend on plants, so food chains would collapse and life could not be sustained.

NCERT ARCHIVE

Therefore, the nitrogen cycle keeps nitrogen available to living things; without it proteins could not be made and life would not survive.

QUESTION 8 *Question 8 · p. 267*

What are the impacts of deforestation on the Earth's oxygen and carbon cycles? What are the other consequences of deforestation?

ANSWER

Forests are major carbon sinks and sources of oxygen, so removing them upsets both cycles.

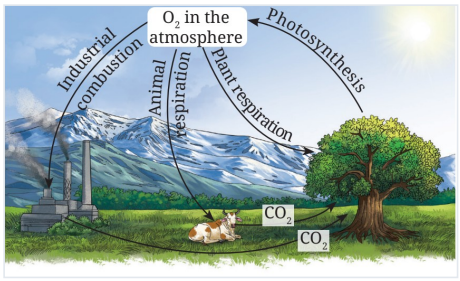


Fig. 13.16. Oxygen cycle

a Impact on the oxygen and carbon cycles

- Fewer trees mean **decreased photosynthesis**, so less oxygen is restored to the atmosphere.
- Less CO_2 is absorbed, so more stays in the air and strengthens the greenhouse effect, disrupting the carbon cycle.

b Other consequences

- Reduced transpiration, which can lead to a decline in local rainfall.
- Altered surface albedo.
- More soil erosion, since there are no tree roots to hold the soil together.
- Destruction of habitats and a decline in biodiversity as many species lose their natural homes.

Therefore, deforestation lowers oxygen production, raises atmospheric CO_2, reduces rainfall, erodes soil and reduces biodiversity.

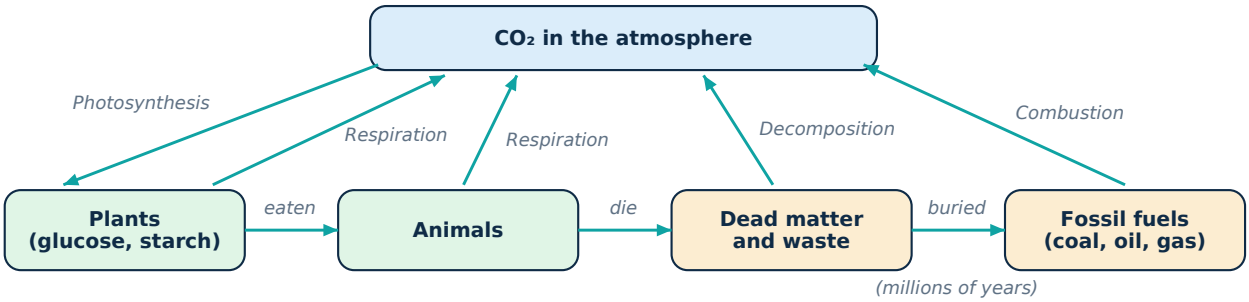
NCERT ARCHIVE

QUESTION 9 *Question 9 · p. 267*

Explain with suitable diagram the path that carbon takes to go back to the atmosphere. You may start from plants using CO_2 from the atmosphere.

ANSWER

Plants take CO_2 from the air. The carbon then returns to the atmosphere along several paths, shown in the diagram.



Fast cycle: photosynthesis, respiration, decomposition (days to years).
Slow cycle: burial of dead matter, fossil fuels, combustion (millions of years).

a Paths back to the atmosphere

Path	Explanation
1. Plant respiration	Plants use glucose and release CO_2 through respiration
2. Animal respiration	Animals eat plants (and other animals) and release CO_2 through respiration
3. Decomposition	When plants and animals die, decomposers break them down and CO_2 returns to the air
4. Burning fossil fuels	Over millions of years, buried dead matter becomes coal, oil and gas; when burnt, the carbon is released as CO_2 quickly
5. Ocean exchange	The atmosphere and ocean water continuously exchange CO_2

NCERT ARCHIVE

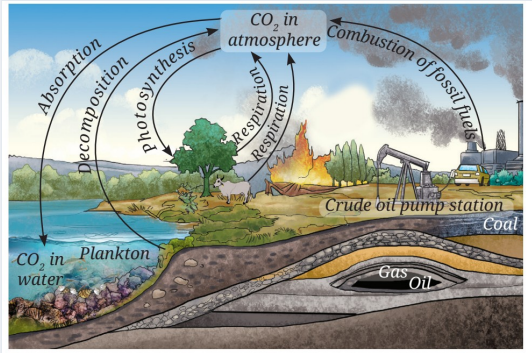


Fig. 13.13. Carbon cycle

Therefore, carbon goes back to the atmosphere through respiration, decomposition, burning of fossil fuels and exchange with the ocean.

QUESTION 10 *Question 10 · p. 267*

Why is an excess of CO_2 in the atmosphere considered undesirable even though it is required by plants?

ANSWER

Plants need some CO_2, and a certain amount keeps the Earth warm enough for life, but the balance is critical.

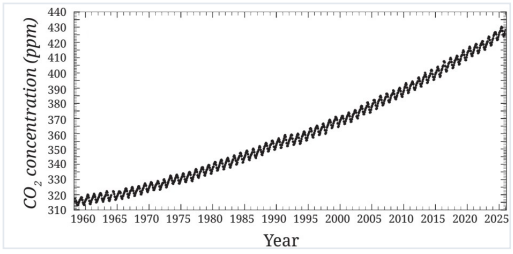


Fig. 13.14. Atmospheric CO_2 concentration (1960–2025), the Keeling curve

- Excess CO_2 intensifies the greenhouse effect and causes global warming.
- This melts glaciers and Arctic sea ice, raises sea levels and brings more extreme weather; in India it may lead to more intense monsoons and threats to agriculture.
- More CO_2 absorbed by the ocean makes sea water more acidic, threatening plankton and coral reefs.
- Human activities have raised atmospheric CO_2 from about 315 ppm to 420 ppm since 1960 (a rise of about one-third; the chapter quotes about 35%).

NCERT ARCHIVE

Therefore, too much CO_2 is undesirable because it intensifies global warming and harms oceans and ecosystems.

QUESTION 11 *Question 11 · p. 267*

How is heat lost from the surface of the Earth? What is its significance?

ANSWER

The Earth's surface loses heat by re-radiating it (as infrared) back into the atmosphere.

a How the heat is lost

- The surface absorbs sunlight and re-radiates this energy in the infrared region; all objects radiate heat.
- A portion of this outgoing heat is trapped by greenhouse gases (carbon dioxide, methane, water vapour); the rest escapes towards space.

b Significance

- The trapped heat keeps the Earth warm enough for life; without the atmosphere the Earth would be too cold.
- If too much is trapped (excess CO_2), global warming results, as seen on Venus where the greenhouse effect is uncontrolled.

Therefore, the Earth loses heat by infrared radiation, and how much is trapped decides whether the planet stays suitable for life.

NCERT ARCHIVE

QUESTION 12 *Question 12 · p. 267*

If the Earth were a flat disc instead of a sphere, how would the patterns of solar radiation and temperature be different?

ANSWER

Because the Earth is spherical, the Sun's rays strike different latitudes at different angles. A flat disc would not give this difference.

Point	Spherical Earth	Flat disc (if the rays fall straight on it)
Radiation per unit area	Concentrated over a small area at the equator, spread over a large area at the poles	Nearly the same everywhere
Temperature pattern	Warm equator, cold poles	Little equator-to-pole difference
Winds and ocean currents	Driven by the uneven heating	Much weaker, as there is little uneven heating by latitude
Seasons	From the spherical shape and the tilt	Would not arise in the same way

Therefore, a flat disc would receive far more even radiation, so the equator-to-pole temperature contrast and the winds and currents it drives would be much weaker.

QUESTION 13 *Question 13 · p. 268*

Suppose there is a rise in atmospheric temperature on Earth. How would this affect the cryosphere, hydrosphere and biosphere?

ANSWER

Sphere	Effect of a rise in temperature
Cryosphere	Glaciers and polar ice melt faster
Hydrosphere	More evaporation and variable monsoon rain (floods and droughts); more water in rivers and a rise in sea level; the warmer ocean absorbs less CO_2
Biosphere	Habitat loss for organisms in flooded or changed regions, harm to plankton and coral reefs, and threats to crops and agriculture

NCERT ARCHIVE

Therefore, a warmer atmosphere melts ice, disturbs water bodies and rainfall, and harms living organisms and their habitats.

QUESTION 14 *Question 14 · p. 268*

Explain how the Earth's atmosphere helps in maintaining a suitable temperature for life to survive on the Earth.

ANSWER

The atmosphere plays two crucial roles in protecting life.

- **It partly absorbs the incoming solar radiation.** The ozone layer blocks harmful UV rays, and clouds and other gases absorb some sunlight before it reaches the surface.
- **It traps outgoing heat.** The surface re-radiates sunlight as infrared, and greenhouse gases like CO_2, CH_4 and water vapour absorb this heat and prevent it from escaping into space.
- Without the atmosphere the Earth would be too cold for life; Venus shows what an uncontrolled greenhouse effect does.

Therefore, the atmosphere shields life from harmful radiation and traps heat, keeping the Earth's temperature suitable for life.

NCERT ARCHIVE

QUESTION 15 *Question 15 · p. 268*

Describe the interrelationship between different spheres of the Earth. Illustrate with example how these spheres function in a delicate balance.

ANSWER

The Earth system is made of five interacting spheres. Energy and matter move between them, so a change in one affects the others.

Sphere	What it includes	Link with other spheres
Geosphere	Rocks, soil, landforms, the Earth’s interior	Soil supports plants; rocks and soil are eroded by run off
Hydrosphere	Oceans, rivers, lakes, groundwater	Evaporates into the atmosphere; fed by melting ice
Cryosphere	Ice and snow	Melts into the hydrosphere; raises sea level
Atmosphere	The air we breathe	Carries moisture and heat; drives winds and monsoons
Biosphere	All living organisms and habitats	Cycles carbon, nitrogen and oxygen with the other spheres

a Example of the delicate balance

Warmer Arabian Sea water (hydrosphere) gives more evaporation and a variable southwest monsoon (atmosphere). The warmer atmosphere melts glaciers and polar ice (cryosphere), raising sea levels that threaten coastal cities, and may disturb ecosystems by causing habitat loss (biosphere).

Therefore, the spheres are interconnected, and a disturbance in one, such as warming, changes the others, so their balance is delicate.

NCERT ARCHIVE