



Class 9 Science Chapter 13 – NCERT Solutions

Earth as a System: Energy, Matter, and Life

New NCERT *Exploration* | 2026–27

These solutions are based on the **new NCERT Class 9 Science *Exploration* textbook**, Chapter 13, and follow the exact “**Revise, Reflect, Refine**” exercise questions from the textbook. The chapter-end exercise contains **12 questions**.



Q1. 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:

- (ii) To recycle essential nutrients between biotic and abiotic components.



Explanation:

Biogeochemical cycles continuously circulate substances such as **water, carbon, nitrogen and oxygen** between living organisms and the non-living environment.

They ensure that essential nutrients are continuously available to organisms and help maintain the balance of ecosystems.

Q2. 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:**

(iii) The Earth's surface absorbs solar radiation, which is then re-radiated and trapped by greenhouse gases.

 **Explanation:**

The Sun is the primary source of energy for Earth.

1. Solar radiation reaches Earth.
2. The Earth's surface absorbs much of this energy.
3. The warmed surface emits infrared radiation.
4. Greenhouse gases absorb and re-radiate some of this infrared energy.
5. This natural greenhouse effect helps keep Earth warm enough for life.

However, an **excessive increase in greenhouse gases** can cause additional warming.

Q3. Explain how climate change affects the water cycle. Illustrate with examples.

 **Answer:**

Climate change can disturb the **water cycle** by changing temperature, evaporation, rainfall and the storage of water as snow and ice.

 **Higher temperatures** increase evaporation from oceans, lakes and land.

☁ Increased evaporation can add more water vapour to the atmosphere, which may contribute to **heavier rainfall** in some regions.

☔ At the same time, changes in atmospheric circulation can cause **longer dry periods and droughts** in other regions.

🏔 Rising temperatures can cause **glaciers and snow to melt**, changing the amount of water stored in the cryosphere.

🌊 Changes in rainfall and melting ice can affect rivers, groundwater, agriculture and ecosystems.

Example:

A region may experience **drought for a long period followed by very heavy rainfall**, rather than receiving regular rainfall.

Thus, climate change affects the movement and storage of water between the atmosphere, land, oceans, ice and living organisms.

Q4. Describe how albedo affects the Earth's surface temperature and its climate.

Answer:

Albedo is the fraction of incoming solar radiation that a surface reflects.

-  **Snow and ice** have high albedo and reflect a large amount of sunlight.
-  Darker surfaces such as oceans and forests generally have lower albedo and absorb more solar energy.
-  A **low-albedo surface** absorbs more radiation and therefore tends to become warmer.
-  A **high-albedo surface** reflects more radiation and therefore absorbs less energy.

Climate connection:

When snow and ice melt, darker surfaces are exposed. These surfaces absorb more solar energy, causing further warming.

Therefore, albedo plays an important role in **Earth's energy balance and climate**.



Q5. 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:

Mountain and valley breezes are caused by **unequal heating and cooling of mountain slopes and valley floors**.



During the day — Valley Breeze

1. Mountain slopes are heated by the Sun.
2. The air above the slopes becomes warm.
3. Warm air rises.
4. Cooler air from the valley moves up the slopes.
5. This movement is called a **valley breeze**.



During the night — Mountain Breeze

1. Mountain slopes lose heat rapidly.
2. The air above the slopes becomes cooler and denser.
3. This cold, dense air flows down towards the valley.
4. This is called a **mountain breeze**.



Grass-covered vs barren mountain

Yes, their breezes can have different temperatures.

A **barren rocky surface** generally heats up and cools down more rapidly than a vegetated surface. Vegetation can moderate surface heating through shading and water loss by transpiration.

Therefore, the air above the barren mountain can become **warmer during the day**, potentially producing a warmer breeze compared with the grass-covered mountain.

 **Q6. 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 **troposphere** is the atmospheric layer mainly responsible for everyday weather phenomena.

It is the lowest layer of the atmosphere and contains most of the atmosphere's water vapour and much of its mass.

 Processes such as:

- evaporation
- condensation
- cloud formation
- rainfall
- storms
- winds

mainly occur in the troposphere.

 **Main reason:**

The troposphere is strongly affected by **uneven heating of Earth's surface by the Sun**. This produces differences in temperature and air pressure, causing air to move and producing winds and other weather phenomena.

Q7. Explain the processes involved in the nitrogen cycle. How would life on Earth be affected if nitrogen were not cycled?

Answer:

The **nitrogen cycle** is the continuous movement of nitrogen between the atmosphere, soil and living organisms.

Main processes:

1. Nitrogen fixation

Atmospheric nitrogen exists mainly as N_2 . Most plants cannot directly use atmospheric nitrogen efficiently.

Certain microorganisms convert nitrogen gas into usable nitrogen compounds.

2. Assimilation

Plants absorb usable nitrogen compounds from the soil and use them to make proteins and other nitrogen-containing substances.

3. Feeding

Animals obtain nitrogen by eating plants or other animals.

4. Ammonification

When plants and animals die or produce wastes, decomposers convert organic nitrogen into ammonium compounds.

5. Nitrification

Certain bacteria convert ammonium compounds into nitrites and then nitrates.

6. Denitrification 🦠

Denitrifying bacteria convert nitrogen compounds back into nitrogen gas, returning nitrogen to the atmosphere.

🌍 If nitrogen were not cycled:

Plants would not receive sufficient usable nitrogen to make proteins and other essential molecules. This would affect plant growth and, consequently, animals and entire food webs.

Therefore, nitrogen cycling is essential for **life and ecosystem balance**.

🌳 Q8. What are the impacts of deforestation on the Earth's oxygen and carbon cycles? What are the other consequences of deforestation?

✅ Answer:

Deforestation removes large numbers of trees and therefore affects several Earth systems.

🌿 Effect on the carbon cycle:

Trees absorb **CO₂** through **photosynthesis**.

When forests are removed:

- less CO₂ is absorbed from the atmosphere;
- burning or decomposition of trees releases stored carbon;
- atmospheric CO₂ can increase.

🫁 Effect on the oxygen cycle:

Plants release oxygen during photosynthesis. Therefore, large-scale deforestation can reduce the contribution of vegetation to atmospheric oxygen production.

⚠ Other consequences:

- 🌧 Reduced transpiration can affect rainfall patterns.
- 🪨 Soil erosion increases.
- 💧 Groundwater recharge can decrease.
- 🦁 Habitats are destroyed.
- 🦋 Biodiversity decreases.
- 🌡 Local and global climate can be affected.

Thus, deforestation can disturb the **carbon, oxygen and water cycles** and damage biodiversity.

🔄 **Q9. Explain with suitable diagram the path that carbon takes to go back to the atmosphere. You may start from plants using CO₂ from the atmosphere.**

✅ Answer:

Plants take CO₂ from the atmosphere during photosynthesis.

The carbon then moves through living organisms and eventually returns to the atmosphere.

🔄 Carbon pathway:

Atmospheric CO₂



🌱 Plants — photosynthesis



🐮 Animals — feeding on plants



💨 Respiration by plants and animals



CO₂ released into atmosphere

Carbon can also return through:

 **Dead plants and animals**



 **Decomposition**



CO₂ released into atmosphere

Another pathway is:

 **Plant/animal remains**



 **Burial over very long periods**



Fossil fuels



 **Combustion**



CO₂ released into atmosphere

 **Simple diagram:**

ATMOSPHERIC CO₂



 PHOTOSYNTHESIS



PLANTS



 ANIMALS



RESPIRATION



ATMOSPHERIC CO₂

Dead organisms



Decomposition



Atmospheric CO₂

Fossil fuels



Combustion



Atmospheric CO₂

Q10. Why is an excess of CO₂ in the atmosphere considered undesirable even though it is required by plants?

Answer:

CO₂ is essential for plants because it is used during **photosynthesis** to make food.

However, an **excess amount of atmospheric CO₂** is undesirable because CO₂ is also a greenhouse gas.

More atmospheric CO₂ can increase the amount of infrared radiation retained in the atmosphere, contributing to **global warming and climate change**.

Climate change can affect:

-  temperature
-  rainfall
-  water cycle
-  glaciers and ice
-  ecosystems
-  biodiversity
-  oceans

Therefore, CO₂ is essential for life, but its concentration must remain within a balanced range.

Q11. How is heat lost from the surface of the Earth? What is its significance?

Answer:

The Earth's surface absorbs solar radiation and becomes warm. It then loses heat mainly by **radiating infrared radiation** towards the atmosphere and space.

Some of this outgoing infrared radiation is absorbed and re-radiated by greenhouse gases in the atmosphere.

Significance:

Heat loss is important because it helps maintain **Earth's energy balance**.

If Earth continuously absorbed energy without losing energy, its temperature would keep increasing.

The balance between:

Incoming solar energy 

and

Outgoing infrared energy 

helps regulate Earth's temperature and climate.

The natural greenhouse effect also prevents excessive heat loss and makes Earth suitable for life.

Q12. If the Earth were a flat disc instead of a sphere, how would the

patterns of solar radiation and temperature be different?

✓ Answer:

Earth's spherical shape causes sunlight to strike different regions at different angles.

On the actual spherical Earth:

- 🌞 Near the equator, sunlight is more direct and concentrated over a smaller area.
- 📦 Towards the poles, sunlight arrives at a more slanting angle.
- Therefore, the same amount of solar energy is spread over a larger area at higher latitudes.
- This produces greater heating near low latitudes and less heating near the poles.

🌐 If Earth were a flat disc:

The pattern of solar radiation would be very different because the surface would not have the same curved geometry.

The systematic difference in the angle at which sunlight reaches different latitudes would change significantly. Consequently, the present global pattern of **uneven heating, temperature differences, winds and climate zones** would also be very different.

📌 Key idea:

Earth's shape + latitude + axial tilt → differences in insolation → uneven heating → winds and climate patterns.

The new textbook specifically identifies Earth's shape, latitude and axial tilt as important causes of variations in insolation and uneven heating.



CHAPTER 13 — QUICK ANSWER KEY

Q.

Answer

- 1 (ii) Recycle essential nutrients between biotic and abiotic components
- 2 (iii) Earth's surface absorbs solar radiation and re-radiates it; greenhouse gases trap some heat
- 3 Climate change disturbs evaporation, rainfall, droughts, snow/ice and water storage
- 4 High albedo → more reflection → less heating; low albedo → more absorption → more heating
- 5 Day: valley breeze; night: mountain breeze; surface type affects heating
- 6 Troposphere; uneven heating produces temperature/pressure differences
- 7 Fixation → assimilation → feeding → ammonification → nitrification → denitrification
- 8 Deforestation affects CO₂ absorption, oxygen production, water cycle, soil and biodiversity
- 9 CO₂ → plants → animals → respiration/decomposition/combustion → CO₂
- 10 Excess CO₂ strengthens greenhouse warming and contributes to climate change
- 11 Earth loses heat mainly as infrared radiation; this maintains energy balance
- 12 A flat Earth would have a very different pattern of solar incidence, heating and climate

★ Exam Focus for Chapter 13

The most important concepts to revise are:

-  Five Earth spheres
-  Solar radiation and electromagnetic spectrum
-  Uneven heating of Earth
-  Albedo
-  Atmosphere and greenhouse effect
-  Ozone layer
-  Mountain and valley breezes
-  Ocean currents
-  Water cycle
-  Carbon cycle
-  Nitrogen cycle
-  Oxygen cycle
-  Human impact and environmental balance

These match the chapter's stated learning outcomes for the 2026–27 syllabus, including Earth-system interactions, solar energy, differential heating, atmospheric phenomena, biogeochemical cycles and human impacts.

Note: Chapter 13 carries **5 marks** in the 2026–27 annual examination structure, so these 12 textbook-end questions are especially useful for focused revision.