Class 9 Science Chapter 13: Earth as a System: Energy, Matter and Life - Notes, Important Questions and MCQs (2026-27)

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These Class 9 Science Chapter 13 notes cover “Earth as a System: Energy, Matter and Life” from the new NCERT textbook Exploration (2026-27): solar energy and uneven heating, the atmosphere, local and planetary winds, ocean currents, the water, carbon, nitrogen and oxygen cycles, and how human activities disturb these systems – with tables, Q&A, 10 MCQs and a free PDF.

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Chapter Overview

Solar radiation is the main source of energy on the Earth. Because the Sun heats the Earth unevenly – depending on latitude, surface type and colour – differences in temperature and pressure arise. These drive winds in the atmosphere and currents in the oceans, which redistribute heat around the planet.

Matter on Earth is recycled through biogeochemical cycles: water, carbon, nitrogen and oxygen move between air, water, rocks and living things. Human activities such as burning fossil fuels and deforestation are disturbing these cycles, causing problems like ocean acidification and climate change.

Important Topics and Concepts

Solar Energy and Uneven Heating

- The Sun is Earth's main energy source.
- Because Earth is a sphere, sunlight falls directly near the equator and at a slant near the poles – so the equator is warmer.
- Land heats up and cools down faster than water.
- Dark surfaces absorb more heat; light surfaces (snow, ice) reflect more. The fraction reflected is called albedo.
- Uneven heating creates differences in air temperature and pressure.

The Atmosphere

- Mainly nitrogen (about 78%) and oxygen (about 21%), with small amounts of argon, carbon dioxide and water vapour.
- Weather happens in the lowest layer, the troposphere (up to about 12 km).
- Warm air expands, becomes lighter and rises, creating low pressure; cool air sinks, creating high pressure.
- Air moves from high-pressure to low-pressure areas – this is wind.

Local and Planetary Winds

- Local winds arise from local heating differences: valley breeze blows up the slopes by day; mountain breeze blows down the slopes at night. Sea and land breezes are similar.
- Planetary (global) winds: air rises at the equator (equatorial low), sinks near 30° latitude (sub-tropical highs) and rises again near 60°.
- Trade winds blow from the sub-tropical highs towards the equator; westerlies blow from 30° towards 60°; polar easterlies blow from the poles.
- Earth's rotation deflects winds, giving them their directions.

Ocean Currents

- Ocean currents are large, continuous movements of seawater.
- Driven by winds, differences in temperature and salinity (density), Earth's rotation and the shape of landmasses.
- Warm currents flow from the equator towards the poles; cold currents from the poles towards the equator.
- Currents redistribute heat and influence climate, rainfall and marine life of coastal regions.

Biogeochemical Cycles

- Water cycle: evaporation, transpiration, condensation, precipitation and runoff.
- Carbon cycle: plants take in CO_2 in photosynthesis; respiration, decomposition and burning return it; oceans, forests and rocks act as carbon sinks.
- Nitrogen cycle: nitrogen fixation by bacteria (Rhizobium in root nodules, Azotobacter in soil) and lightning; assimilation by plants; ammonification by decomposers; nitrification to nitrites and nitrates; denitrification back to N_2.
- Oxygen cycle: released in photosynthesis, used in respiration, combustion and decomposition.

Human Impact on Earth's Systems

- Burning fossil fuels and deforestation add CO_2 faster than sinks can absorb it.
- Extra CO_2 dissolving in oceans makes them more acidic, harming corals and plankton.
- Rising greenhouse gases trap more heat, changing climate patterns.
- Overuse of fertilisers disturbs the nitrogen cycle and pollutes water bodies.
- Saving energy, planting trees and using resources wisely help keep the cycles balanced.

Nitrogen Cycle Steps

Very frequently asked.

Step	What happens	Agent
Nitrogen fixation	N_2 → ammonia/nitrates	Rhizobium, Azotobacter, lightning
Assimilation	Plants absorb nitrates to make proteins	Plants
Ammonification	Dead matter → ammonia	Decomposers
Nitrification	Ammonia → nitrites → nitrates	Nitrifying bacteria
Denitrification	Nitrates → N_2 gas	Denitrifying bacteria

Local vs Planetary Winds

Local winds	Planetary winds
Small area	Cover large belts of the globe
Daily heating differences	Uneven heating between latitudes
Valley/mountain, sea/land breezes	Trade winds, westerlies, polar easterlies
Change direction day/night	Blow fairly steadily through the year

Global Pressure Belts and Winds

Latitude	Pressure / air movement	Winds
0° (equator)	Low – air rises	Trade winds converge here
~30° N/S	High – air sinks	Trade winds (to equator), westerlies (poleward)
~60° N/S	Low – air rises	Westerlies meet polar easterlies
90° (poles)	High – cold air sinks	Polar easterlies

Important Definitions and Terms

Term	Meaning
Albedo	Fraction of sunlight reflected by a surface
Troposphere	Lowest layer of the atmosphere where weather occurs
Wind	Movement of air from high to low pressure
Valley breeze	Daytime wind blowing up a mountain slope

Term	Meaning
Mountain breeze	Night-time wind blowing down a slope
Trade winds	Winds blowing from sub-tropical highs to the equator
Ocean current	Continuous large-scale movement of seawater
Biogeochemical cycle	Cycling of an element between living and non-living parts
Nitrogen fixation	Conversion of N_2 into usable compounds
Carbon sink	Reservoir that absorbs and stores carbon

Short Answer Questions

Q1. Why is the equator warmer than the poles?

Sunlight falls almost vertically at the equator and is concentrated on a smaller area; at the poles it falls at a slant and spreads over a larger area.

Q2. Why does land heat faster than water?

Water needs more heat to raise its temperature and mixes heat downward, so land surfaces warm and cool faster.

Q3. What is albedo? Give an example of a high-albedo surface.

The fraction of sunlight a surface reflects; fresh snow or ice has high albedo.

Q4. Distinguish between valley breeze and mountain breeze.

Valley breeze blows up the slope during the day; mountain breeze blows down the slope at night.

Q5. Name the three planetary winds in each hemisphere.

Trade winds, westerlies and polar easterlies.

Q6. List any three factors that drive ocean currents.

Winds, differences in temperature and salinity, and Earth’s rotation.

Q7. Name two bacteria that fix nitrogen.

Rhizobium (in root nodules of legumes) and Azotobacter (free-living in soil).

Q8. How does extra CO_2 harm marine life?

It dissolves in seawater and makes it more acidic, damaging corals and shell-forming plankton.

Long Answer Questions

Q1. Explain how uneven heating of the Earth produces planetary winds.

The equator receives the most direct sunlight; air there warms, rises and forms a low-pressure belt.

This air cools aloft and sinks near 30° latitude, forming sub-tropical high-pressure belts.

Air flows from these highs towards the equator as trade winds and towards 60° as westerlies.

Cold dense air at the poles forms high pressure and flows out as polar easterlies.

Q2. Describe the nitrogen cycle.

Atmospheric N_2 is fixed into ammonia and nitrates by Rhizobium, Azotobacter and lightning.

Plants absorb nitrates and make proteins (assimilation); animals get nitrogen by eating plants.

Decomposers convert dead matter and wastes into ammonia (ammonification).

Nitrifying bacteria convert ammonia into nitrites and then nitrates (nitrification).

Denitrifying bacteria convert nitrates back to N_2 gas, completing the cycle.

Q3. How are human activities disturbing Earth's systems?

Burning fossil fuels releases large amounts of CO_2.

Deforestation removes trees that act as carbon sinks.

Excess CO_2 traps heat and changes climate; dissolved CO_2 acidifies oceans.

Excess fertiliser use disturbs the nitrogen cycle and pollutes water.

Solutions: renewable energy, afforestation, efficient resource use.

MCQs with Answers

1. Main source of energy on Earth is(a) the Moon (b) the Sun (c) volcanoes (d) tidesAnswer: (b) the Sun

2. Nitrogen in the atmosphere is about(a) 21% (b) 78% (c) 1% (d) 50%Answer: (b) 78%

3. Weather occurs in the(a) stratosphere (b) troposphere (c) mesosphere (d) thermosphereAnswer: (b) troposphere

4. Valley breeze blows(a) down the slope at night (b) up the slope during the day (c) from sea to land at night (d) from poles to equatorAnswer: (b) up the slope during the day

5. Sub-tropical high-pressure belts are near(a) 0° (b) 30° (c) 60° (d) 90°Answer: (b) 30°

6. Winds from sub-tropical highs towards the equator are(a) westerlies (b) trade winds (c) polar easterlies (d) monsoonsAnswer: (b) trade winds

7. Rhizobium is found in(a) leaves of maize (b) root nodules of legumes (c) stems of sugarcane (d) fungiAnswer: (b) root nodules of legumes

8. Conversion of ammonia to nitrates is(a) fixation (b) ammonification (c) nitrification (d) denitrificationAnswer: (c) nitrification

9. High albedo surface is(a) forest (b) ocean (c) fresh snow (d) asphalt roadAnswer: (c) fresh snow

10. Ocean acidification is mainly caused by(a) oxygen (b) nitrogen (c) carbon dioxide (d) argonAnswer: (c) carbon dioxide

Quick Revision Points

- Sun = main energy; uneven heating (latitude, land/water, colour, albedo).
- Atmosphere: N_2 78%, O_2 21%; weather in troposphere.
- High → low pressure = wind; valley/mountain breezes.

- Pressure belts 0°, 30°, 60°, 90°; trade winds, westerlies, polar easterlies.
- Ocean currents: winds, temperature, salinity, rotation, landmasses.
- Water, carbon, nitrogen, oxygen cycles.
- Human impact: CO_2, acidification, climate change.

Chapter Summary

Earth works as one connected system powered mainly by the Sun. Uneven heating – due to latitude, the difference between land and water and surface colour – creates pressure differences that drive local and planetary winds and, together with temperature, salinity and Earth's rotation, ocean currents.

Matter cycles through air, water, rocks and living things in the water, carbon, nitrogen and oxygen cycles. Human activities, especially burning fossil fuels, deforestation and fertiliser overuse, are disturbing these cycles, leading to ocean acidification and climate change; careful use of resources can restore balance.

Exam Tips and PYQ Pattern

- Draw the pressure belts and planetary winds diagram neatly.
- Learn the nitrogen-cycle steps with their agents.
- Explain uneven heating with at least three causes.
- Valley vs mountain breeze is a common 2-mark question.
- Link human activities to effects on specific cycles.

Frequently Asked Questions

Is this chapter in the 2026-27 CBSE syllabus?

Yes. It is part of the new NCERT Class 9 Science textbook "Exploration" (first edition 2026), prescribed for the 2026-27 session.

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Yes. Use the free PDF link at the top of this page – no signup needed.

What are the planetary winds?

Trade winds, westerlies and polar easterlies, formed by the global pressure belts.

Which bacteria fix nitrogen?

Rhizobium in legume root nodules and free-living Azotobacter in soil.

Conclusion

Earth as a System ties together energy, air, water and life. Learn the pressure-belt table and nitrogen-cycle steps, practise the Q&A here and save the free PDF for revision.

More Notes: Class 9 Science Chapter 12: Patterns in Life: Diversity and Classification notes | All Class 9 Science notes

Author Bio: Written and reviewed by the Nextoper Editorial Team, a group of CBSE science educators who build chapter notes directly from the NCERT textbook and past board paper

Freshness Note: These notes follow the NCERT Class 9 Science textbook, Exploration (First Edition 2026, NCF-SE 2023), and the CBSE syllabus for the 2026-27 session. Last checked on 17 November 2026.