

Chapter 13: Earth as a System—Energy, Matter, and Life

Class 9th (NCERT Exploration Series)

Segment 1: Easy Level

Part A: 20 Multiple Choice Questions (Easy)

1. Which of the following is considered the primary source of energy for the Earth system? (a) Geothermal heat, (b) Sun, (c) Tidal energy, (d) Wind
2. The layer of the Earth that contains life is called the: (a) Atmosphere, (b) Lithosphere, (c) Biosphere, (d) Hydrosphere
3. The process by which plants convert solar energy into chemical energy is: (a) Respiration, (b) Photosynthesis, (c) Transpiration, (d) Evaporation
4. Water vapor in the atmosphere is part of which Earth sphere? (a) Lithosphere, (b) Biosphere, (c) Hydrosphere, (d) Atmosphere
5. Which gas is most abundant in the Earth's atmosphere? (a) Oxygen, (b) Nitrogen, (c) Carbon dioxide, (d) Argon
6. The solid outer layer of the Earth is known as the: (a) Crust, (b) Mantle, (c) Core, (d) Atmosphere
7. What do we call the continuous movement of water on, above, and below the Earth's surface? (a) Carbon cycle, (b) Hydrological cycle, (c) Nitrogen cycle, (d) Rock cycle
8. The greenhouse effect is primarily caused by: (a) Oxygen, (b) Nitrogen, (c) Carbon dioxide, (d) Helium
9. Organisms that break down dead organic matter are called: (a) Producers, (b) Consumers, (c) Decomposers, (d) Predators
10. The Earth's crust is primarily composed of: (a) Liquid metal, (b) Igneous and sedimentary rocks, (c) Gas, (d) Water
11. Which of these is a non-renewable resource? (a) Solar energy, (b) Wind energy, (c) Coal, (d) Water
12. The process of water changing from liquid to gas is called: (a) Condensation, (b) Precipitation, (c) Evaporation, (d) Sublimation
13. The ozone layer protects life on Earth by absorbing: (a) UV radiation, (b) Infrared radiation, (c) Visible light, (d) Radio waves
14. The Earth's core is mainly composed of: (a) Iron and nickel, (b) Oxygen and silicon, (c) Hydrogen and helium, (d) Carbon and sulfur
15. A community of living organisms and their physical environment is called an: (a) Habitat, (b) Ecosystem, (c) Population, (d) Biosphere
16. Which element is the basis of all organic molecules? (a) Nitrogen, (b) Oxygen, (c) Carbon, (d) Sulfur
17. What happens to solar energy once it enters the Earth's system? (a) It is all reflected back, (b) It is transformed into heat or chemical energy, (c) It is destroyed, (d) It stays as light
18. The movement of rocks through geological time is part of the: (a) Rock cycle, (b) Water

cycle, (c) Nutrient cycle, (d) Energy cycle

19. Which of the following is a renewable energy source? (a) Natural gas, (b) Solar energy, (c) Petroleum, (d) Coal

20. Plants contribute to the Earth system by releasing: (a) Carbon dioxide, (b) Oxygen, (c) Nitrogen, (d) Helium

Answer Key: 1-b, 2-c, 3-b, 4-c, 5-b, 6-a, 7-b, 8-c, 9-c, 10-b, 11-c, 12-c, 13-a, 14-a, 15-b, 16-c, 17-b, 18-a, 19-b, 20-b

Part B: 20 Subjective Questions (Easy)

1. Define the Earth system and its four major spheres.
2. Explain the role of the Sun in driving Earth's energy system.
3. How do plants contribute to the oxygen-carbon dioxide balance?
4. What is an ecosystem? Give an example.
5. Define the water cycle and its importance for life.
6. Why is the ozone layer important for the biosphere?
7. Differentiate between renewable and non-renewable resources.
8. What are decomposers and why are they necessary?
9. Explain the greenhouse effect simply.
10. Describe the Earth's crust.
11. How does water change states in the hydrological cycle?
12. Why is Carbon the basis of life?
13. Define lithosphere, hydrosphere, and atmosphere.
14. List three ways humans impact the Earth system.
15. What is meant by "flow of energy" in an ecosystem?
16. Why is coal considered a non-renewable resource?
17. How does solar energy become chemical energy?
18. What is precipitation?
19. Explain the term "Biosphere."
20. Name two gases essential for life.

Segment 2: Moderate Level

Part A: 20 Multiple Choice Questions (Moderate)

1. Which sphere acts as a primary heat reservoir for the Earth system? (a) Lithosphere, (b) Atmosphere, (c) Hydrosphere, (d) Cryosphere
2. In the nitrogen cycle, nitrogen is fixed into a usable form by: (a) Animals, (b) Bacteria, (c) Fungi, (d) Plants
3. What is the main driving force for plate tectonics? (a) Solar energy, (b) Mantle convection, (c) Atmospheric pressure, (d) Moon's gravity
4. The concentration of carbon dioxide in the atmosphere is regulated by: (a) Photosynthesis and respiration, (b) Erosion, (c) Tidal movement, (d) Solar wind
5. Which of these processes removes carbon from the atmosphere? (a) Combustion, (b) Photosynthesis, (c) Volcanic activity, (d) Decomposition
6. Energy in an ecosystem typically flows in: (a) A circle, (b) A straight line (one direction), (c) A zigzag pattern, (d) All directions
7. The Earth's magnetic field is generated by: (a) The outer core's molten iron, (b) Crustal

- rocks, (c) Solar wind, (d) Atmospheric gases
8. What percentage of solar energy reaching Earth is typically captured by producers? (a) Nearly 100%, (b) About 50%, (c) Less than 1%, (d) 10-20%
 9. Which of the following is an example of a chemical change in the Earth system? (a) Erosion, (b) Weathering of rock, (c) Photosynthesis, (d) Melting ice
 10. The nitrogen cycle is essential because nitrogen is a key component of: (a) Fats, (b) Sugars, (c) Proteins, (d) Water
 11. The thermosphere is characterized by: (a) High pressure, (b) Increasing temperature with height, (c) Weather phenomena, (d) Ozone concentration
 12. Which rock type is formed from the cooling of magma? (a) Sedimentary, (b) Metamorphic, (c) Igneous, (d) Fossilized
 13. The process by which soil is carried away by wind or water is: (a) Deposition, (b) Weathering, (c) Erosion, (d) Sedimentation
 14. What is the main source of atmospheric nitrogen? (a) Lightning, (b) Volcanic eruptions, (c) Biological fixation, (d) Denitrification
 15. Which factor is most responsible for current global temperature increases? (a) Solar cycles, (b) Anthropogenic greenhouse gas emissions, (c) Volcanic dust, (d) Plate tectonics
 16. In a food web, a secondary consumer eats: (a) Producers, (b) Primary consumers, (c) Tertiary consumers, (d) Decomposers
 17. Which of these contributes to the rock cycle? (a) Solar heat, (b) Subduction and volcanic action, (c) Photosynthesis, (d) Evaporation
 18. The movement of tectonic plates causes: (a) Seasons, (b) Earthquakes, (c) Tides, (d) Solar flares
 19. Which of the following is a byproduct of cellular respiration? (a) Oxygen, (b) Glucose, (c) Carbon dioxide, (d) Nitrogen
 20. The primary reason for the Earth's seasons is: (a) Distance from the sun, (b) Earth's axial tilt, (c) Atmospheric pressure, (d) Ocean currents
- Answer Key:** 1-c, 2-b, 3-b, 4-a, 5-b, 6-b, 7-a, 8-c, 9-c, 10-c, 11-b, 12-c, 13-c, 14-b, 15-b, 16-b, 17-b, 18-b, 19-c, 20-b

Part B: 20 Subjective Questions (Moderate)

1. How does mantle convection affect the surface of the Earth?
2. Describe the nitrogen cycle stages.
3. How does photosynthesis affect the atmosphere?
4. Explain the flow of energy through a food chain.
5. What is the significance of the outer core to Earth's magnetosphere?
6. Describe how igneous rocks are formed.
7. How does erosion shape the Earth's surface?
8. Explain the concept of an ecosystem's carrying capacity.
9. What is the importance of the ozone layer and how is it being depleted?
10. Differentiate between weather and climate.
11. How do human activities disrupt the carbon cycle?
12. Explain the role of bacteria in the nitrogen cycle.
13. What are the different layers of the atmosphere?
14. How do tectonic plates interact at boundaries?
15. Describe the difference between food chains and food webs.
16. Why is the Earth's axial tilt crucial for life?
17. How are sedimentary rocks formed?
18. What is the role of producers in a biosphere?

19. How do ocean currents influence climate?
20. Explain the process of subduction.

Segment 3: Difficult Level

Part A: 20 Multiple Choice Questions (Difficult)

1. The Earth system's "Gaia hypothesis" suggests that: (a) The Earth is a giant living organism, (b) Life and the physical environment evolve together, (c) Humans are unnecessary, (d) The Earth is expanding
2. Which of the following feedback loops is positive? (a) Cloud formation reflecting sunlight, (b) Ice-albedo feedback, (c) Photosynthesis, (d) Respiration
3. The "Redfield Ratio" refers to the constant ratio of which elements in marine organic matter? (a) C:N:P, (b) O:C:N, (c) H:C:O, (d) N:P:S
4. Why does the Earth's atmospheric pressure decrease exponentially with altitude? (a) Gravity, (b) Temperature changes, (c) Solar radiation, (d) Coriolis effect
5. Which mechanism prevents the Earth's atmosphere from being stripped by solar wind? (a) Atmospheric pressure, (b) The magnetic field, (c) Gravity, (d) Ozone layer
6. The rate of chemical weathering is highest in which environment? (a) Cold and dry, (b) Hot and wet, (c) Cold and wet, (d) Hot and dry
7. How does the "biological pump" affect atmospheric CO₂? (a) Increases it, (b) Decreases it, (c) Has no effect, (d) Cycles it
8. The "shadow zone" of earthquake waves confirms: (a) The existence of a liquid outer core, (b) The existence of an inner core, (c) Tectonic plate movement, (d) The composition of the crust
9. What is the relationship between the Earth's rotation and oceanic gyres? (a) Coriolis effect, (b) Tidal force, (c) Temperature differences, (d) Wind speed
10. The "Goldilocks zone" for life is determined by: (a) Magnetic field, (b) Distance from the sun (liquid water), (c) Atmospheric density, (d) Tectonic activity
11. Which phenomenon is responsible for the formation of monsoons? (a) Coriolis effect, (b) Differential heating of land and sea, (c) Plate tectonics, (d) Solar flares
12. The Milankovitch cycles refer to: (a) Long-term variations in Earth's orbit, (b) Solar spot cycles, (c) Tidal cycles, (d) Carbon cycle fluctuations
13. How do volcanic eruptions influence Earth's climate on a short timescale? (a) Global warming, (b) Global cooling, (c) No effect, (d) Ozone depletion
14. The Earth's albedo is primarily determined by: (a) Atmospheric gases, (b) Cloud cover and ice caps, (c) Soil color, (d) Vegetation
15. What is the primary factor limiting primary productivity in the deep ocean? (a) Sunlight, (b) Nutrients, (c) CO₂, (d) Temperature
16. The "Hadley cell" is a pattern of: (a) Ocean circulation, (b) Atmospheric circulation, (c) Plate movement, (d) Energy flow in cells
17. Which isotope is used to date geological samples? (a) Carbon-14, (b) Uranium-Lead, (c) Nitrogen-15, (d) Oxygen-18
18. The "K-Pg extinction" event is linked to: (a) Climate change, (b) Asteroid impact, (c) Volcanic activity, (d) Disease
19. Which of the following is a "sink" for carbon? (a) Atmosphere, (b) Deep ocean, (c) Combustion, (d) Respiration
20. How do atmospheric aerosols affect climate? (a) Always warm, (b) Always cool, (c) Can

reflect or absorb radiation, (d) No effect

Answer Key: 1-b, 2-b, 3-a, 4-a, 5-b, 6-b, 7-b, 8-a, 9-a, 10-b, 11-b, 12-a, 13-b, 14-b, 15-a, 16-b, 17-b, 18-b, 19-b, 20-c

Part B: 20 Subjective Questions (Difficult)

1. Discuss the Gaia hypothesis and its implications for Earth system stability.
2. Explain the ice-albedo positive feedback loop.
3. How do plate tectonics influence the Earth's long-term carbon cycle?
4. Differentiate between internal and external energy sources in the Earth system.
5. Describe the significance of the Earth's magnetic field for life.
6. How do Milankovitch cycles explain glacial-interglacial transitions?
7. Explain the "biological pump" and its role in oceanic carbon sequestration.
8. What is the Coriolis effect and how does it drive global wind patterns?
9. Discuss the impact of large-scale volcanic eruptions on global radiation balance.
10. How do aerosols interact with cloud formation and Earth's radiative balance?
11. Explain the thermal structure of the atmosphere and its influence on weather.
12. What are the geochemical cycles and how do they couple with biological life?
13. Discuss the limitations of carbon dating versus uranium-lead dating.
14. How does deep ocean circulation (thermohaline circulation) regulate climate?
15. Explain the "shadow zone" evidence for the Earth's internal structure.
16. How does vegetation cover modify the local radiative and hydrological balance?
17. Discuss the concept of a "tipping point" in the Earth system.
18. How does seafloor spreading provide evidence for tectonic theory?
19. Explain the role of phosphorus in limiting primary productivity.
20. How do orbital variations drive long-term climatic shifts?

Segment 4: Olympiad Level

Part A: 20 Multiple Choice Questions (Olympiad)

1. The "Redfield Ratio" for phytoplankton is 106:16:1 for C:N:P. What is the stoichiometric implication of this ratio? (a) P is always in excess, (b) N is always in excess, (c) P is often a limiting nutrient, (d) C is always limiting
2. Which mechanism primarily accounts for the Earth's excess heat in the tropics being transported to the poles? (a) Thermohaline circulation, (b) Hadley cell circulation, (c) Jet streams, (d) All of the above
3. If the Earth's tilt were 0 degrees, which of the following would be true? (a) No seasons, (b) Extreme seasons, (c) The same seasons as now, (d) Reverse seasons
4. What is the impact of the "Solubility Pump" in the ocean? (a) Regulates ocean acidity, (b) Transports CO₂ to the deep ocean, (c) Produces methane, (d) Has no impact on CO₂
5. The "Faint Young Sun Paradox" is solved by: (a) Increased greenhouse effect in early Earth, (b) Reduced solar activity, (c) More clouds, (d) A different Earth orbit
6. What happens to the Earth's moment of inertia during a major tectonic reorganization? (a) Increases, (b) Decreases, (c) Changes slightly, (d) Unchanged
7. Which of the following is an example of an "emergent property" of the Earth system? (a) Chemical properties of water, (b) Planetary climate, (c) Atomic structure of carbon, (d) Orbital mechanics

8. The "Great Oxidation Event" was primarily driven by: (a) Volcanoes, (b) Cyanobacteria, (c) Meteors, (d) Plate tectonics
9. What governs the intensity of the "Coriolis force"? (a) Latitude and velocity, (b) Only latitude, (c) Only velocity, (d) Atmospheric pressure
10. Which of these describes the "chemical weathering" of silicate rocks as a CO₂ sink? (a) Urey reaction, (b) Haber process, (c) Krebs cycle, (d) Calvin cycle
11. The Earth's core cooling affects: (a) Plate tectonics, (b) Magnetosphere, (c) Both a and b, (d) Neither
12. What is the primary factor affecting the depth of the "Thermocline"? (a) Salinity, (b) Solar energy at the surface, (c) Pressure, (d) Gravity
13. The "Clausius-Clapeyron" relation relates temperature to: (a) Pressure, (b) Saturation vapor pressure, (c) Density, (d) Specific heat
14. What defines a "Stochastic" process in Earth systems? (a) Predictability, (b) Randomness, (c) Linear change, (d) Cyclic change
15. Which of the following is a major feedback during deglaciation? (a) CO₂ release, (b) Methane release, (c) Both a and b, (d) Neither
16. The Earth's mantle behaves as a: (a) Brittle solid, (b) Fluid (on geological timescales), (c) Gas, (d) Liquid
17. What influences the Earth's rotational speed? (a) Moon's tidal friction, (b) Earth's shape changes, (c) Both a and b, (d) Neither
18. The "Wilson Cycle" describes: (a) Ocean basin formation and closure, (b) Carbon cycle, (c) Solar cycle, (d) Nitrogen cycle
19. Which of these is a measure of Earth's total energy budget? (a) Net radiation, (b) Latent heat, (c) Sensible heat, (d) All of the above
20. What is the "Anthropocene"? (a) A geological epoch defined by human impact, (b) A past era, (c) A solar cycle, (d) A plate boundary type

Answer Key: 1-c, 2-d, 3-a, 4-b, 5-a, 6-c, 7-b, 8-b, 9-a, 10-a, 11-c, 12-b, 13-b, 14-b, 15-c, 16-b, 17-c, 18-a, 19-d, 20-a

Part B: 20 Subjective Questions (Olympiad)

1. Critically analyze the stoichiometric limitations imposed by the Redfield Ratio on ocean productivity.
2. Explain the mathematical dependency of the Coriolis force on latitude and object velocity.
3. Discuss the role of the Urey reaction in the long-term stabilization of Earth's climate.
4. How do Milankovitch cycles interact with non-linear feedback loops to trigger glaciation?
5. Evaluate the Earth's energy budget in the context of net radiative forcing.
6. Explain the mechanism of the biological pump and its sensitivity to oceanic stratification.
7. How does the Earth's rotational speed interact with mantle convection patterns?
8. Analyze the "Faint Young Sun Paradox" and the necessity of a dense greenhouse atmosphere in early Earth.
9. Discuss the chemical and geological evidence for the Great Oxidation Event.
10. What are the implications of the "Wilson Cycle" for current continental configurations?
11. Explain how the Clausius-Clapeyron relation dictates the moisture-holding capacity of the atmosphere under warming.
12. How does the magnetosphere modulate the interaction between the solar wind and the upper atmosphere?
13. Discuss the impact of stochasticity in Earth system modeling.
14. How do tectonic reorganizations drive changes in the Earth's moment of inertia?
15. Explain the coupling between atmospheric greenhouse gases and the solubility of CO₂ in the oceans.

16. Discuss the concept of the Anthropocene and its geologically recognizable markers.
17. How do feedback loops (ice-albedo, water vapor) create non-linear responses in Earth's temperature?
18. Analyze the limitations of isotope dating in high-temperature or geologically active zones.
19. Explain the importance of the thermocline in oceanic heat distribution.
20. Discuss the interplay between plate tectonics and the Earth's long-term thermal regime.