



**Harvard Undergraduate Science Olympiad India
2025 Final Round
7th-8th Grade
Earth Science Section: Questions**

Instructions:

The Earth Science exam will be divided into 5 categories: Interior of the Earth, Minerals & Rocks, Astronomy & Astrophysics, Hydrosphere, and Atmosphere. Each category will contain 5 multiple-choice questions (with 1,2,3 or 4 correct answers) and one open-ended question.

You may spend 1 hour on the Earth Science exam. You are allowed a non-programmable, non-graphing calculator. No additional notes or electronics are allowed. Make sure you have received **all 8 pages of this exam**.

Grading:

Each multiple choice question is worth 1 point, and the open-ended question is worth 5 total points, with each sub-part worth equally (e.g: if there are 2 parts, each part is worth 2.5 points; alternatively, if there are 5 parts, each part is worth 1 point).

In case of a tie, the higher cumulative score on the open-ended questions will be the tie-breaker.

It is within your best interest to attempt all questions: **no points will be taken off for incorrect answers**.

Best of luck! You've got this!

Interior of the Earth Section:

Multiple Choice Questions (1,2,3 or 4 answers may be correct):

1. Which tectonic movements are responsible for mountain formation?
 A. Convergent boundaries
 B. Divergent boundaries
 C. Subduction zones
 D. Transform boundaries
2. Which layers of the Earth are made of solid rock?
 A. Crust
 B. Mantle
 C. Outer Core
 D. Inner Core
3. Which of the following soil types holds water the best?
 A. Sandy
 B. Clay
 C. Silt
 D. Gravel
4. Which layers make up the lithosphere?
 A. Outer Core
 B. Crust
 C. Mantle (upper part)
 D. Inner Core
5. Which seismic waves arrive at a seismic station second (after the first seismic waves)?
 A. P-waves
 B. S-waves
 C. Surface waves
 D. Tsunami waves

Open-ended Question:

1. Name 2 of the 7 major tectonic plates.
Any 2 of the following: Pacific, North American, Eurasian, African, Antarctic, Indo-Australian (can be split into Indian and Australian), and South American.
2. The Earth's radius is approximately 6,371 km. If the mantle extends from 35 km to 2,900 km depth, how much of the Earth's radius is made up of the mantle?
 $(2,900-35)/6,371*100=44.97\%$

Minerals & Rocks Section:

Multiple Choice Questions (1,2,3 or 4 answers may be correct):

1. Which of the following is NOT a property used to identify minerals?
 - A. Hardness
 - B. Crystal structure
 - C. Cleavage
 - D. Melting point**
2. Which type of sedimentary rock forms from compacted plant material?
 - A. Sandstone
 - B. Limestone
 - C. Coal**
 - D. Shale
3. Which of the following rocks are extrusive and igneous?
 - A. Granite
 - B. Basalt**
 - C. Gabbro
 - D. Diorite
4. Which 2 elements are the most abundant in the Earth's crust?
 - A. Iron
 - B. Oxygen**
 - C. Silicon**
 - D. Aluminum
5. Which features help geologists determine relative ages of rocks?
 - A. Unconformities**
 - B. Absolute isotopic ages
 - C. Mineral hardness
 - D. Fossil succession**

Open-ended Question:

1. A mineral scratches glass (5.5 on Mohs scale) but is scratched by a steel file (6.5 on Mohs scale). Estimate its hardness on Mohs scale. Justify your answer.
The mineral's hardness is roughly 6
2. Name one difference between intrusive and extrusive igneous rocks.
Intrusive → form below the surface + are coarse-grained + appear to have more luster, whereas Extrusive → form above the surface + are fine-grained + appear to have less luster

Astronomy & Astrophysics Section:

Multiple Choice Questions (1,2,3 or 4 answers may be correct):

- Which events occur due to the Earth's tilt?
 - Equinoxes
 - Solstices
 - Eclipses
 - Seasons
- The first launching of an object into orbit happened in 1957, with a satellite of about 83kg. What is the name of this mission?
 - Sputnik 1
 - Vostok 1
 - Voyager 1
 - Apollo 11
- Which stars are located in the constellation Orion?
 - Betelgeuse
 - Rigel
 - Sirius
 - Polaris
- If the Earth had another satellite of the same size as the Moon, but at twice the distance, what would be its sidereal period? The Moon's sidereal period is 27.3 days.
 - 55 days
 - 34 days
 - 77 days
 - 39 days
- Venus has orbital period $T_V = 224.7 \text{ days}$ and Earth has orbital period $T_E = 365.25 \text{ days}$.

Assuming they rotate around the Sun in the same plane, how long is the synodic period between Venus and Earth?

- 139 days
- 141 days
- 365 days
- 584 days

Open-ended question:

- Which constellation is Sirius located in?
Canis Major
- What is the difference between sidereal and synodic periods?
Sidereal is the measurement of time using distant stars (or vernal point) as a reference point, whereas synodic is the measurement of time using the Sun as a reference point.

3. What is the azimuth of the North Celestial pole for an observer at latitude $+27^\circ$?
 0° at any latitude since azimuth is measured from the north
4. What type of celestial object is Hercules (M13)?
Cluster
5. A star is observed equator-on, meaning its rotation axis is perpendicular to our line of sight. A line with rest wavelength $\lambda_0=500.0$ nm is measured to be shifted to 499.992 nm at one limb and 500.008 nm at the opposite limb. The star's radius is $R=6.0 \times 10^8$ m. Assuming $v \ll c$, where v is the equatorial rotation speed of the star, determine the star's rotation period P .

$$\Delta\lambda = \lambda_{\text{red}} - \lambda_{\text{blue}} = 500.008 - 499.992 = 0.016 \text{ nm.}$$

For opposite limbs viewed equator-on: $\Delta\lambda = 2 \lambda_0 (v/c)$, so

$$v = c \Delta\lambda / (2 \lambda_0) = c(0.016) / [2(500.0)] \approx 4.8 \times 10^3 \text{ m/s.}$$

$$P = 2\pi R / v = 2\pi(6.0 \times 10^8) / (4.8 \times 10^3) \approx 7.85 \times 10^5 \text{ s} \approx 9.1 \text{ days.}$$

Hydrosphere Section:

Multiple Choice Questions (1,2,3 or 4 answers may be correct):

1. If the water table drops 5 meters over 10 years, what is the average annual decline?
 - A. 0.2 m/year
 - B. 0.5 m/year**
 - C. 1 m/year
 - D. 2 m/year
2. Which force(s) primarily causes tides?
 - A. Wind
 - B. Earth's rotation
 - C. Ocean currents
 - D. Moon's gravity**
3. Which processes decrease seawater salinity?
 - A. Rainfall**
 - B. Ice melting**
 - C. Evaporation
 - D. Ocean currents
4. Which features are typical of mature river valleys?
 - A. Meanders**
 - B. Rapids
 - C. Oxbow lakes**
 - D. V-shaped valleys
5. Which factors increase groundwater recharge?
 - A. Impermeable rock
 - B. Urban pavement
 - C. Permeable soil**
 - D. None of the above

Open-ended question:

1. Name one erosional and one depositional feature of glaciers.
Erosional: U-shaped valley or cirque; Depositional: Moraines or drumlins or kame terraces
2. Describe the 3 major steps in the Water Cycle.
Evaporation/Vaporization: liquid to vapor, Condensation: vapor cool and form clouds, and Precipitation: water falling back to Earth.

Atmosphere Section:

Multiple Choice Questions (1,2,3 or 4 answers may be correct):

- Relative humidity measures:
 - The total amount of water in the air
 - The ratio of water vapor to the maximum possible at that temperature
 - Precipitation rate
 - Dew point
- What 2 layers of the atmosphere come immediately after the stratosphere (further away from Earth)?
 - Troposphere
 - Mesosphere
 - Thermosphere
 - Exosphere
- Low-pressure systems are usually associated with:
 - Clear skies
 - Cold, dry air
 - Stable weather
 - Cloud formation and precipitation
- Global winds are affected by:
 - Earth's rotation
 - Moon's gravity
 - Ocean salinity
 - Uneven heating of Earth
- The environmental lapse rate is:
 - The rate temperature increases with altitude
 - The rate temperature decreases with altitude
 - The rate of precipitation
 - The rate wind speed changes with height

Open-ended question:

- Name three common types of clouds and describe one characteristic of each (e.g: what they look like, altitude they are commonly found at, what weather those clouds are associated with etc).

Cumulus: Puffy, white clouds, often indicate fair weather; Stratus: Low, gray clouds that cover the sky like a blanket; Cirrus: Wispy, high-altitude clouds made of ice crystals
- Explain how seasonal wind shifts cause the monsoon rains in South Asia.
Hint: Start thinking about which one heats faster: the land or the ocean during each season.

Summer: Land heats faster than ocean → low pressure over land → moist ocean air blows inland → heavy rains, Winter: Land cools faster → high pressure over land → dry winds blow toward the ocean → dry season