Harvard Undergraduate Science Olympiad India
2026 Final Round
9-10th Grade
Earth Science Section: Exam

Instructions:
The Earth Science exam will be divided into 5 sections: 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, as well as 1 Bubble Sheet (for the multiple-choice questions) and 5 Answer Sheets (for the open-ended questions)**.

For the multiple-choice questions:
All answers must be marked on the provided Bubble Sheet. Any writing on the exam booklet outside the designated boxes in the Bubble Sheets will not be graded. You may write in this booklet, but *NO WRITING IN THIS BOOKLET WILL BE GRADED.*

For answers to be graded, you must fully darken in the corresponding bubbles on the Bubble Sheet. Your bubble must have no white remaining to be properly scored. Poor bubbling will lead to your exam not being scored. Please write your full name, school name, and HUSO ID on the Bubble Sheet.

For the open-ended questions:
All explanations and relevant calculations must be written in the boxes provided on the separate Answer Sheet. Any writing on the exam booklet outside the designated boxes in the answer sheets will not be graded. You may write in this booklet, but *NO WRITING IN THIS BOOKLET WILL BE GRADED.*

On each page of the Answer Sheet, please write down your full name, school name, HUSO ID and Section name (either Interior of the Earth, Minerals & Rocks, Astronomy & Astrophysics, Hydrosphere, or Atmosphere). 5 Answer Sheets will be initially provided to each student, each corresponding to a different Section of the exam. Additional Answer Sheets are available upon request.

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 of the following statements about the Earth's interior are correct?
   A. The crust is the thinnest layer of the Earth
   B. The mantle is composed mainly of molten iron and nickel
   C. The outer core is in a liquid state
   D. The inner core has extremely high temperature and pressure

2. At which type of plate boundary do plates slide past each other without creating or destroying crust?
   A. Convergent boundary
   B. Divergent boundary
   C. Transform boundary
   D. Subduction zone

3. Which seismic waves can travel through the Earth's interior?
   A. P-waves
   B. S-waves
   C. Love waves
   D. Rayleigh waves

4. Which properties are typical of sandy soils?
   A. High water-holding capacity
   B. High nutrient retention
   C. Large particle size
   D. Good drainage

5. Which statements about the Earth's crust are correct?
   A. The crust forms the Earth's outermost layer
   B. Continental crust is thicker than oceanic crust
   C. The crust is composed mainly of iron and nickel
   D. Oceanic crust is denser than continental crust

Open-ended Question:

1. What is the name of the boundary between the mantle and the crust of the Earth?
2. What is subduction?
3. Name 3 of the 7 major tectonic plates.
4. What is the name of the initial supercontinent of the world?
5. Name one of the four driving forces behind plate motion.

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

1. Which one(s) of the following igneous rocks is fine-grained?
    A. Granite
    B. Basalt
    C. Diorite
    D. Andesite

2. Which of the following are sedimentary rocks?
    A. Sandstone
    B. Limestone
    C. Chalk
    D. Gypsum

3. Which of the following is true about metamorphic rocks?
    A. Metamorphic rocks are the products of preexisting rocks that suffered high pressure/temperatures
    B. Some examples of metamorphic rocks are gneiss and schists
    C. Magmas that erupt on the Earth's surface produce extrusive metamorphic rocks
    D. Carbon dioxide can act as an agent for turning sedimentary rocks into metamorphic rocks

4. Which of the following are part of Bowen's Reaction Series?
    A. Olivine
    B. Quartz
    C. Calcite
    D. Pyroxene

5. Which of the following are physical or optical properties used to identify minerals?
    A. Opacity
    B. Luster
    C. Density (specific gravity)
    D. Latitude of formation

Open-ended Question:
1. What are the 4 types of igneous rocks based on their composition (proportion of light and dark minerals)?

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

1. The Doppler effect causes light from a star moving away from Earth to:
    A. Shift toward red wavelengths
    B. Increase in brightness
    C. Shift toward blue wavelengths
    D. Change frequency

2. Which star-constellation pairs are correct?
    A. Polaris - Ursa Major
    B. Vega - Lyra
    C. Sirius - Canis Major
    D. Arcturus - Boötis

3. Planet A has an albedo of 0.1, and Planet B has an albedo of 0.6. Which statements are correct?
    A. Planet A absorbs more sunlight
    B. Planet B reflects more sunlight
    C. Planet A absorbs 90% of incoming light
    D. Planet B absorbs 60% of incoming light

4. Star A has an apparent magnitude of $m_A = -1.5^m$ and star B has $m_B = 1^m$. Which statements are always correct?
    A. Star B appears 10 times brighter than star A
    B. Star A has a bigger luminosity than Star B
    C. Star A appears 10 times brighter than star B
    D. Star B is further away from the observer than star A

5. An observer is at 60° N latitude. Which declinations correspond to stars that are circumpolar for this observer?
    A. +20°
    B. +25°
    C. +35°
    D. +60°

Open-ended Question:
For this part, you are given the following constant:

Constant name:	Value:	Unit:
Wien's displacement constant	2.898×10^{-3}	$m \times K$

1. A star has a parallax angle of 0.2 arcseconds. Find its distance in parsecs.

2. The peak wavelength of Star A's emission is 400 nm and the peak wavelength of Star B's emission is 800 nm. Both can be modeled as black bodies. Determine which star has the larger surface temperature and compute the ratio T_A/T_B.

3. A geostationary satellite remains fixed above one point on Earth's equator, so its orbit is circular in the equatorial plane and its orbital period equals Earth's rotation period. Assume Earth is spherical with radius R_E = 6.37 × 10^6 m and surface gravity g = 9.81 m/s². Take Earth's rotation period to be T = 23 h 56 min. Calculate the satellite's altitude h above Earth's surface.

4. Two stars A and B orbit their common center of mass in a circular, edge-on binary with period P=30 days. The center of mass of the system moves away from Earth with speed v_sys = 20.0 km/s. Relative to the center of mass, star A has line-of-sight speed v_A = 30.0 km/s and star B has line-of-sight speed v_B = 60.0 km/s (these are the maximum speeds over an orbit). A spectral line from star A has a rest wavelength λ0 = 500.0 nm. Assume $v \ll c$.

   Find the mass ratio M_B/M_A, the orbital radii a_A and a_B, the total separation a, and the individual masses M_A and M_B. What is the maximum wavelength displacement |Δλ| from λ0 that an observer on Earth can measure for star A over one full orbit?

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

1. Which of the following is true about the hydrosphere?
    A. Most of the world's freshwater is represented by glaciers
    B. Glaciers form from compacted snow
    C. Aquifers represent permeable rock strata or sediments that transmit groundwater freely
    D. Areas that have been shaped by the dissolving power of groundwater are said to exhibit "karst topography"

2. Which of the following are important steps of the Hydrologic Cycle?
    A. Precipitation
    B. Evaporation
    C. Volcanic eruption
    D. Decalcification

3. Which of the following are types of wetlands?
    A. Marsh
    B. Swamp
    C. Bog
    D. Desert

4. Which statements are correct?
    A. Most ocean waves are caused by wind
    B. Tides are influenced by the Moon's gravity
    C. Tsunamis are the same as normal waves
    D. Tsunamis are caused by underwater earthquakes

5. Which of the following are types of ocean sediments?
    A. Sand and mud from land
    B. Shells of marine organisms
    C. Lava flows
    D. Sediment formed from chemicals in seawater

Open-ended Question:

1. What is the freshwater discharge (Q) if the Cross-Sectional Area (A) of a river is 10 m^2 and the Average Velocity (V) of the river is 20 m/s? Make sure to show your work and write down the units of your answer.

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

1. Which layer of the atmosphere contains the ozone layer?
    A. Troposphere
    B. Stratosphere
    C. Mesosphere
    D. Thermosphere

2. What type of front is formed when a warm air mass moves over a cold air mass?
    A. Cold front
    B. Stationary front
    C. Warm front
    D. Occluded front

3. Which winds are caused by differences in temperature between land and sea?
    A. Trade winds
    B. Sea breezes
    C. Westerlies
    D. Land breezes

4. What factors influence the formation of precipitation?
    A. Humidity
    B. Temperature
    C. Cloud type
    D. Air pressure

5. Which statements about El Niño and La Niña are true?
    A. El Niño warms the Pacific Ocean
    B. La Niña cools the Pacific Ocean
    C. Both affect global weather patterns
    D. Only occur in the Atlantic Ocean

Open-ended Question:

1. What is the term for a large system of rotating low pressure?
2. Which cloud type is thin, wispy, and found at high altitudes?
3. What do we call a sudden reversal of normal temperature with height in the atmosphere? By normal we mean that warm air sits below cooler air.
4. Name 2 layers of the atmosphere in which the phenomenon from open-ended question part 3 occurs.