



**Harvard Undergraduate Science Olympiad Dubai
2026 Final Round
9th-10th Grade
Earth and Space Science Section: Exam**

NAME: _____

Student ID: _____

Instructions:

The HUSO-Middle East Final Round Earth and Space Science exam consists of 4 problems with several parts each. You should have 5 pages of problems – 1 for each problem and a tiebreaker/feedback page at the end. You will have 1 hour for the exam.

All answers must be written on the designated answer sheet. Any writing on the exam booklet outside the answer sheets will not be graded. You may write in this booklet, but NO WRITING IN THIS BOOKLET WILL BE GRADED. Feel free to use this booklet as extra scratch paper.

The exam consists of mostly true/false statements – for those questions, the scoring is as follows: You will receive 1 point for a correct answer, 0 points for an incorrect answer, and 0.5 points if you choose to leave the question blank. Unless noted otherwise, all questions are worth 1 point.

For this exam, you are allowed to bring a non-programmable, non-graphing calculator and a wrist-watch. You are not allowed to bring a smart watch, textbooks, notes, or any other electronic devices.

Best of luck!

Problem 1: Rock'in around the Christmas Tree (9pts total)

In this problem, we will explore the geology of Oman, starting with the Semail Ophiolite, one of the most complete ophiolites on Earth. (An ophiolite is a section of Earth's oceanic crust and upper mantle that has been uplifted and exposed.)

1. True/False: The majority of the Semail Ophiolite is mafic/ultramafic.
2. True/False: The presence of pillow basalts indicates that some of the rock formed underwater.

Next, we turn to the Hajar Mountains—a mountain range shared between Oman and the UAE.

3. True/False: The Hajar Mountains is a great place to view fragments of the Mohorovičić discontinuity, the boundary between the mantle and the outer core of Earth.
4. True/False: The Hajar Mountains were created on a transform boundary.

The strategy of apatite fission tracking can be used to date some rock formations – apatite crystals record damage tracks created by the spontaneous fission of uranium-238. These tracks shorten or disappear when the rock is heated and are preserved once the rock cools below ~120 °C.

5. True/False: Apatite fission tracking would be useful for the exhumation (rocks coming to the surface) of the Hajar Mountains.
6. Apatite fission tracking is quite complex, so let's try a simpler example involving carbon dating. Carbon-14 has a half-life of 5,730 years, and the fraction of carbon-14 remaining in a sample can be used to estimate its age. A piece of ancient wood is found to contain 25% of its original carbon-14. Using the half-life of carbon-14, estimate the age of the wood in years. (2pts)

The exhumation event mentioned earlier created possibly the largest megasheath fold on Earth, the Wadi Mayh megasheath fold. The rare metamorphic rock, eclogite, can be found in the megasheath fold.

7. True/False: Rocks that fold are typically more ductile than rocks that fault.
8. True/False: The eclogite was most likely created during the folding process.

Problem 2: The Sky is Not The Limit (9pts total)

The star Altair is the twelfth-brightest star in the night sky – its name comes from the ancient Arabic Al-Nasr Al-Ta'ir meaning “the flying eagle”.

1. True/False: Altair is part of the constellation Orion.
2. Altair has a radius $R = 2.007 R_{\odot}$ (equatorial) and an effective temperature $T = 8000 \text{ K}$. The Sun has $R = 6.96 \times 10^8 \text{ m}$ and $T = 5778 \text{ K}$. σ is a constant $= 5.67 \times 10^{-8} \text{ W} \cdot \text{m}^{-2} \cdot \text{K}^{-4}$. Using the Stefan-Boltzmann law: $L = 4\pi R^2 \sigma T^4$, compute the luminosity of Altair relative to the Sun. (2pts)
Round your answer to the nearest tenth.

Heading a little closer to the present day, an asteroid weighing 2,045 kilograms is orbiting the Sun with a semi-major axis of 2.5 AU.

3. Using Kepler's Third Law, calculate the orbital period of the asteroid in Earth years. Kepler's Third Law states that the square of a planet's orbital period is proportional to the cube of the length of the semi-major axis of its orbit. (2pts)
4. True/False: If the asteroid belt disappeared, there would be a noticeable effect on the orbit of the Earth.

Oh no! The asteroid is hurtling towards Earth (it is now a meteorite!) and lands in Saudi Arabia, creating one of the famed Wabar craters.

5. True/False: Melted sand around the craters indicates that the impact was low-energy.

Looking to the future, the “solar eclipse of the century” occurs in August 2027! Jeddah and other parts of Southern Saudi Arabia will get a full 6-minute view, as well as various parts of Europe and Northern Africa.

6. The path of totality is wider when the Moon is closer to Earth in its orbit.
7. A solar eclipse occurs when the Earth comes directly between the Sun and the Moon.

Problem 3: Weather You Like It Or Not (9pts total)

On December 18th, 2025, the Burj Khalifa was struck by lightning amidst a thunderstorm due to the Al-Bashayer system passing through the UAE.

1. True/False: The Al-Bashayer storm system is a low-pressure system.
2. True/False: High-pressure weather systems are inherently unstable.

Looking ahead to summer, the UAE is very dry! It implements cloud seeding (injecting particles into clouds) to promote precipitation.

3. True/False: The particles are much colder than the air around them, causing the water vapor inside the cloud to condense into liquid water droplets.
4. True/False: The particles' main purpose is to provide a nucleus for supercooled water vapor to condense.

During a hot summer day in the Dubai desert, the surface temperature is 42°C and the temperature 3 km above is 6°C.

5. What is the environmental lapse rate in °C/km? Your answer should be a positive integer. (2pts)
6. True/False: This is an unstable lapse rate.

Oh no! A dust storm has started, a common phenomenon in Middle Eastern deserts.

7. True/False: Dust storms negatively affect the soil fertility of the deposit (where the storm ends).
8. True/False: Dust storms can cause increased precipitation.

Problem 4: Water We Doing Here (9pts total)

Last question! We are almost there – just a little bit more about bodies of water in/around Jordan.

Jordan is actually considered one of the four most water scarce countries in the world, with a severe lack of renewable water sources.

1. True/False: Aquifers in Jordan are primarily recharged by rivers and lakes in the desert regions, so water availability is relatively constant throughout the year.
2. True/False: The decreasing water table could lead to saltwater intrusions – saltwater entering the aquifers.

At least we still have the Jordan River and Rift Valley... for now.

3. True/False: The Dead Sea's main source of water, the Jordan River is primarily losing flow due to global warming.
4. True/False: The Jordan Rift Valley, the location of vital aquifers in the region, is formed with rocks of low porosity.

Jordan is salty! It contains sabkhas, salt flats that form in arid coastal or inland regions, and of course the iconic Dead Sea.

5. True/False: Sabkhas indicate high evaporation rates relative to precipitation.
6. True/False: The Dead Sea's salinity is higher than that of typical ocean water, making the water less dense and therefore easier to float in.

We now turn westward to the Red Sea, a sea inlet of the Indian Ocean lying between Africa and Asia.

7. True/False: The Gulf of Aqaba (Jordan's only coastline on the Red Sea) experiences relatively small tidal ranges due to the shape of the Red Sea.
8. True/False: The Red Sea is relatively oligotrophic (nutrient-poor) because it lacks the strong seasonal upwelling that characterizes the Arabian Sea.
9. True/False: The Coriolis effect causes surface water in the Red Sea to move to the left of the wind direction.

Problem 5: Feedback

1. What was your favorite problem (1, 2, 3, or 4)?
2. What was your least favorite problem (1, 2, 3, or 4)?
3. Which was the easiest problem (1, 2, 3, or 4)?
4. What was the hardest problem (1, 2, 3, or 4)?

If you have further feedback, please feel free to write in this booklet – but it will not be graded.

Problem 6: Tiebreaker

This problem will only be graded if you end up tying with another participant. In the event of a tie, this question will be used to determine placements.

Pick a “sphere” from the following list: atmosphere, geosphere, hydrosphere.

A forest fire occurs. Explain in as many ways as possible how your chosen sphere is impacted.