USESO 2025

National Open Exam

Section I

Instructions:

- Section I consists of 30 multiple choice questions. Each question is worth 2 points.
- Questions are **not** ordered by difficulty.
- Print your **USESO Student ID** on the ZipGrade answer sheet.
- Bubble your answers clearly on the ZipGrade answer sheet. Pencil or pen is fine; if you use pencil, push down as you write to make the scan easier to read.
- You have **2 hours** to complete both sections in any order, and you may flip back and forth between sections.

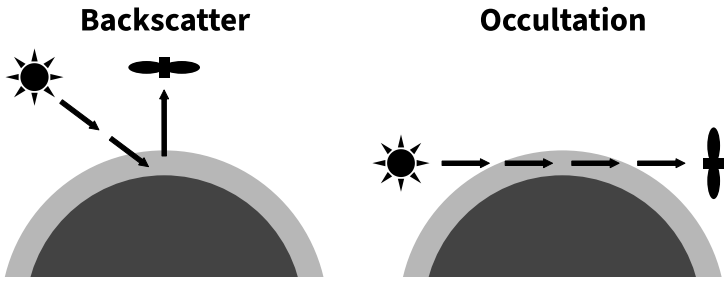
1. A geologist is studying a hand sample of schist in the lab. They determine that the rock formed in a region of compacted sediment adjacent to a subduction zone known as an accretionary wedge. Which of the following is likely true regarding the rock?

   I) The rock formed in a relatively low-temperature, high-pressure environment

   II) The rock contains well-preserved fossils of ancient marine organisms

   A. I only B. II only C. I and II D. None

2. Satellites can analyze backscattered light (the "backscatter method") or light passed directly through the atmosphere (the "occultation method") to gather meteorological data. The image below shows how these methods are used to collect data.



   Identify all of the following statements that are true of these methods:

   I) Use of the occultation method to measure stratospheric air is generally not affected by weather

   II) A satellite orbiting Earth using the occultation method cannot collect data during all 24 hours of the day

   III) The backscatter method would be more useful for measuring the vertical profile of aerosol concentrations

   A. I only B. II only C. I and II D. II and III E. I, II, and III

3. Identify all of the following three events that would likely increase the volatile content of a magma chamber:

   I) An earthquake occurs nearby

   II) The magma intrudes into limestone

   III) The magma chamber contacts an aquifer

   A. II only B. III only C. I and II D. I and III E. II and III

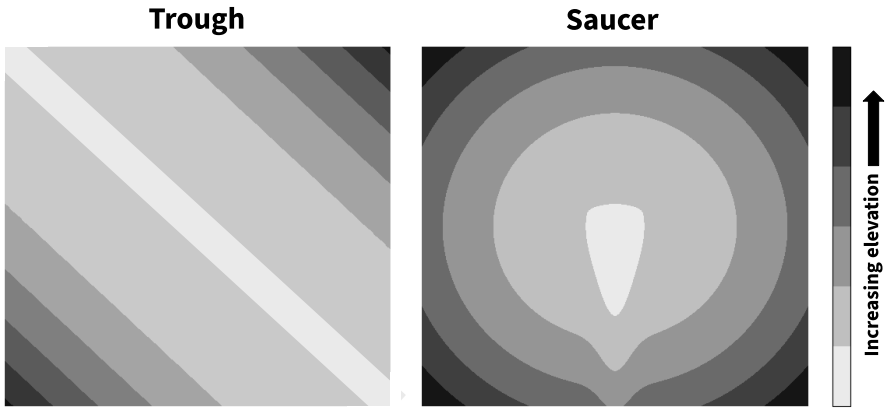
4. Shown below is a map of part of the Pacific Ocean with two locations labeled A and B. Which of the following combinations of location and atmospheric phenomenon would produce a thermocline with the greatest depth?

   A. A, El Niño B. A, La Niña C. B, El Niño D. B, La Niña

5. A meteorologist predicts that a warm front will pass through Norman, Oklahoma. Which of the following gives the chronological order of clouds an observer in Norman should expect to see as the front passes?

A. Cirrus, nimbostratus, altostratus
B. Cirrus, altostratus, nimbostratus
C. Nimbostratus, altostratus, cirrus
D. Altostratus, nimbostratus, cirrus

6. While exploring a coastal dune system, a geologist observes two distinct types of blowout depressions. They create topographical representations of an example of each type as shown.



Which of the following most plausibly describes how wind interacts with each blowout type?

A. Trough-shaped blowouts: winds are deflected outward and erosion is reduced; saucer-shaped blowouts: winds disperse more evenly and erosion is slower but more widespread
B. Trough-shaped blowouts: winds are deflected outward and erosion is reduced; saucer-shaped blowouts: winds are faster due to cyclonic rotation and erosion is increased
C. Trough-shaped blowouts: winds are funneled along the depression and erosion deepens the trough; saucer-shaped blowouts: winds disperse more evenly and erosion is slower but more widespread
D. Trough-shaped blowouts: winds are funneled along the depression and erosion deepens the trough; saucer-shaped blowouts: winds are faster due to cyclonic rotation and erosion is increased

7. Which of the following statements regarding flooding is/are true?

I) Flash flood risk increases directly after a wildfire
II) A 100-year flood has a 1% chance of occurring in any given year

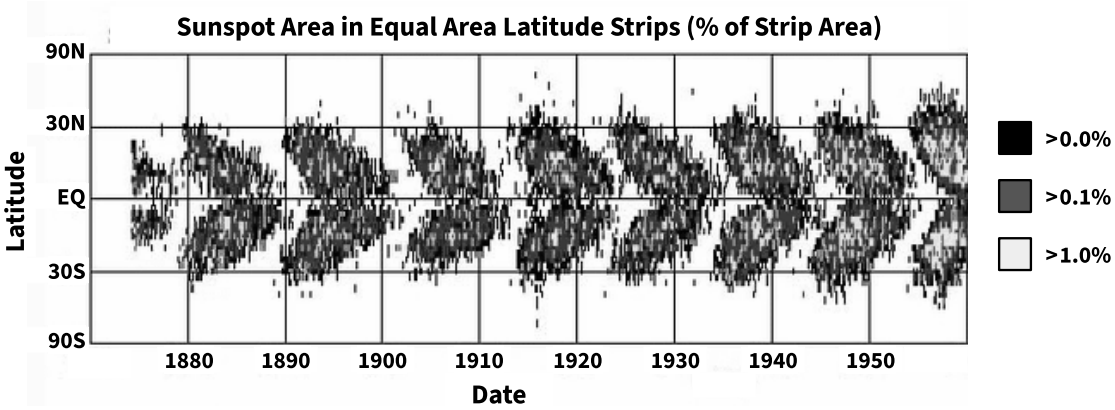
A. I only
B. II only
C. I and II
D. None

8. Identify all of the following changes that would likely increase the rate of meltwater production at the bed of a moving glacier:

I) Increase in the roughness of underlying rock
II) Increase in the thickness of the glacier
III) Decrease in the salinity of basal ice

A. I only
B. II only
C. I and II
D. I and III
E. I, II, and III

9. Flora invents a time machine and decides that she wants to see the Northern Lights during a time period with less light pollution. Using the graph below, which of the following years should she travel to if she wants to maximize her chances of seeing an aurora?



A. 1875 B. 1912 C. 1930 D. 1957

10. Two soils sampled several miles apart are found overlaying the same limestone bedrock.

Soil A	**Soil B**
Hematite	Quartz
Goethite	Calcite
Pyrite	Dolomite

Given that the significant minerals in each of the soils are shown in the table above, which of the following is the most likely explanation for their difference in compositions?

A. Differences in regional weathering led to the formation of different minerals in Soil A versus Soil B

B. The sediment composing Soil A was eroded from an ancient reef and was transported onto the limestone bedrock, while Soil B was weathered directly from the limestone

C. Soil A is older than Soil B and thus consists of minerals that are oxidation products of the minerals in Soil B

D. The sediment in Soil A eroded from a mafic batholith and was transported onto the limestone bedrock, while Soil B was weathered directly from the limestone

11. After analyzing a layer of limestone, an oceanographer notices that it has a higher $^{18}O/^{16}O$ ratio than the surrounding strata. Which of the following statements best characterizes the conditions of the ocean when the layer of limestone was deposited?

A. The surrounding ocean was warmer when the layer was deposited

B. The surrounding ocean was colder when the layer was deposited

C. The surrounding ocean had a higher pH when the layer was deposited

D. The surrounding ocean had a lower pH when the layer was deposited

12. During a certain period in Earth's geologic past, the planet experienced a prolonged hothouse climate. Which one of the following statements is most likely **not** true regarding this period?

A. Rates of feldspar weathering decreased

B. Large, equatorial biogenic calcareous deposits formed

C. Rates of glacial ablation increased

D. Atmospheric CO_2 concentrations were anomalously high

13. Comet Encke is notable for having the shortest orbital period of any reasonably bright comet, at 3.3 years. At its closest, Encke is a distance of 0.34 AU away from the Sun. In which of the following ranges does Encke's aphelion fall?

A. 1 to 2 AU B. 2 to 3 AU C. 3 to 4 AU D. More than 4 AU

14. In late summer, the influx of nutrient-rich freshwater from the Mississippi and Atchafalaya River Basins contributes to the formation of a seasonal hypoxic zone in the Gulf of Mexico known as the "Gulf Dead Zone". Which of the following conditions would be conducive to the continued existence of this dead zone?

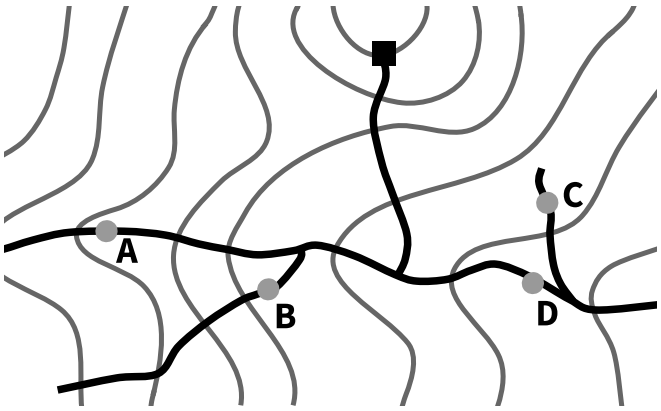
I) Increased precipitation over the river basins

II) Increased sea surface temperatures in the Gulf of Mexico

III) More intense tropical storms in the Gulf of Mexico

A. I only B. II only C. I and II D. I and III E. I, II, and III

15. Katherine surveys the course of a river. She produces the topographic map shown below, where the square represents the origin of a natural spring that runs through quartz and gold-rich veins.



Which point in the river should Katherine go to if she wants to maximize her chance of finding flakes of gold?

A. A B. B C. C D. D

16. A desert composed predominantly of which of the following types of sediment would result in the formation of the largest dunes?

A. Rounded silt B. Rounded sand C. Angular silt D. Angular sand

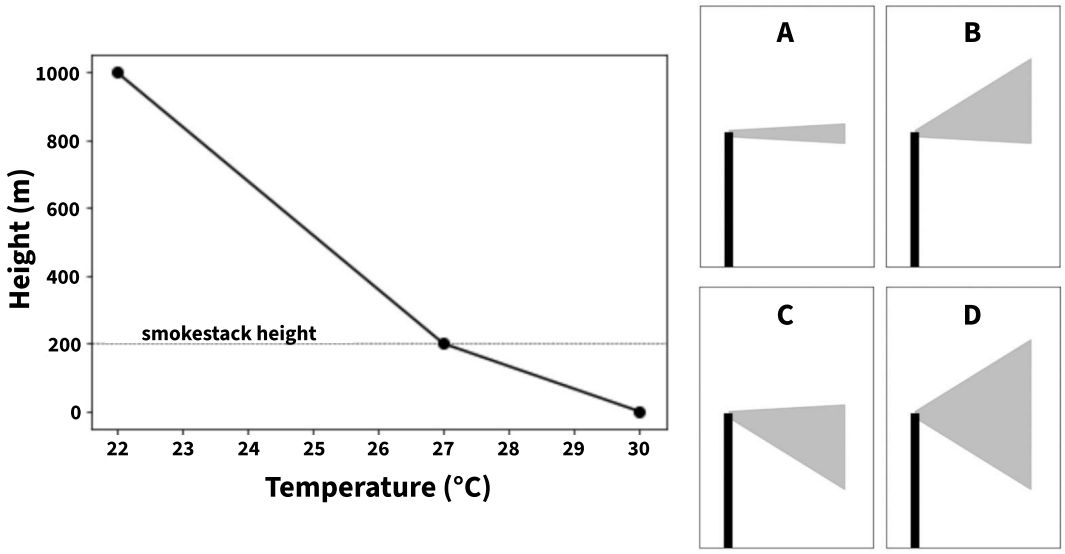
17. Mercury possesses a 3:2 spin-orbit resonance (i.e. Mercury rotates three times for every two times it orbits the Sun) that is unique among the terrestrial planets. Which of the following can be inferred from this resonance pattern?

I) Mercury's period of rotation about its axis is longer than its solar day

II) Mercury exhibits a relatively large zonal (east-west) temperature gradient

A. I only B. II only C. I and II D. None

18. Consider the following temperature profile. Smoke initially leaves a 200-meter tall smokestack at the same temperature as the environment and with zero **average** vertical velocity, although it is subject to both upward and downward perturbations. Assume a dry atmosphere and treat the smoke as dry air parcels.



Given that the dry adiabatic lapse rate is approximately 9.8°C/km, which of the figures above best depicts the shape of the smoke plume?

A. A B. B C. C D. D

19. Alex is given two pure, cubically-cut crystals and is told that one is halite while the other is calcite. They want to identify the two samples by conducting a series of tests. Which of the following tests would be the **least** effective for their investigation?

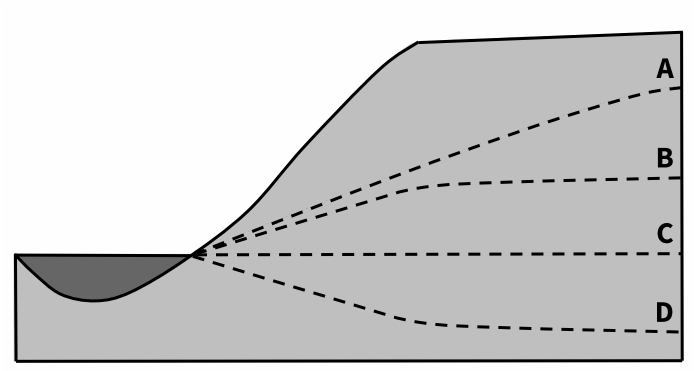
A. Applying dilute hydrochloric acid to the surface of each sample

B. Shining a laser through each sample and observing how the light refracts

C. Trying to scratch a glass plate with a corner of each sample

D. Examining the cleavage planes of each sample after breaking them with a rock hammer

20. The diagram below shows a cross-section of a river and the surrounding soil.



Given that the soil is uniform and the cross-section is taken in a relatively humid and temperate climate, which of the dashed lines most likely corresponds to the water table in the region?

A. A B. B C. C D. D

21. Max wants to study wet-season thunderstorms in La Paz, Bolivia, located at 16.5°S latitude. Based on the movement of the Intertropical Convergence Zone (ITCZ), which month should he choose to study and why?

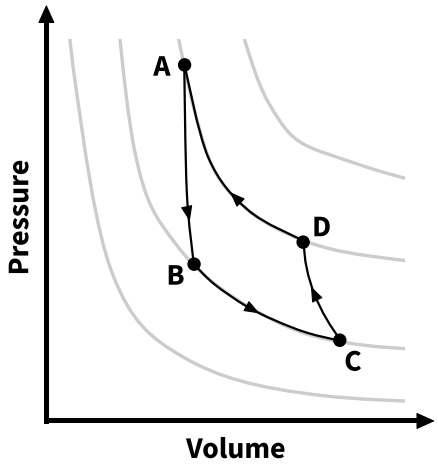
A. December, due to a northward shift of the ITCZ

B. June, due to a northward shift of the ITCZ

C. December, due to a southward shift of the ITCZ

D. June, due to a southward shift of the ITCZ

22. Katabatic winds carry dense air downslope under the force of gravity. Which of the following pathways on the pressure-volume diagram below best represents the transformation these winds experience as they descend? (Note that the gray lines represent isotherms.)



A. AB B. BC C. CD D. DA

23. Astronomers observing a terrestrial planet are investigating its magnetic properties. Which of the following pieces of evidence would support the hypothesis that the planet can generate and sustain its own magnetic field?

A. The planet has half the mass of Earth

B. The planet does not experience significant tidal forces from its host star

C. The planet's atmosphere is primarily composed of carbon dioxide

D. The planet has a high geothermal gradient

24. Dimictic lakes experience overturning twice per year. Which of the following types of lakes would most likely exhibit dimictic behavior?

A. A shallow, mid-latitude lake

B. A deep, mid-latitude lake

C. A shallow, high-latitude lake

D. A deep, high-latitude lake

25. Milankovitch cycles play an important role in the regulation of glacial and interglacial periods. Assuming each cycle occurs independently, which of the following modulations would increase seasonal variations of temperature in the Northern Hemisphere?

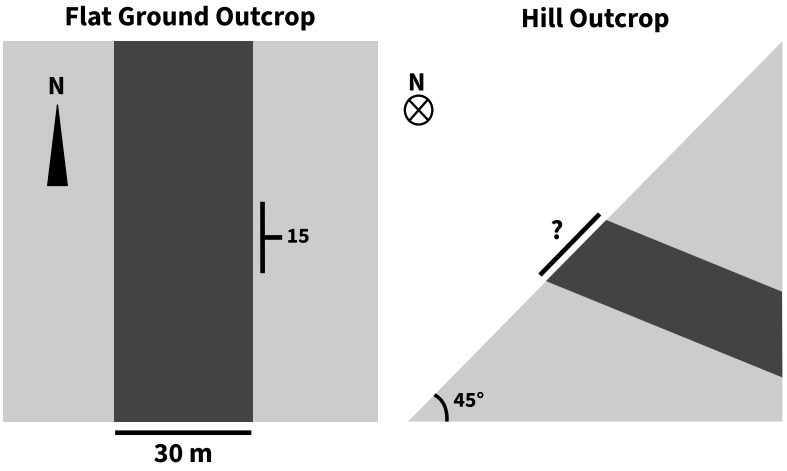
I) A slight increase in Earth's axial tilt

II) A slight increase in Earth's orbital eccentricity

III) Axial precession 180° away from its current state

A. I only B. II only C. I and III D. II and III E. I, II, and III

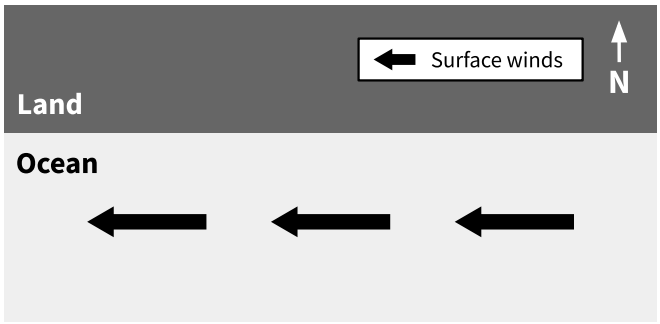
26. A geologist comes across a 30-meter wide outcrop of a planar coal seam on horizontal ground, depicted on the left of the image below. They find that the coal seam outcrops again on a hill directly to the west of the first outcrop, depicted on the right of the image below. They measure the slope of the hill to be 45°.



Assuming no tectonic uplift or subsidence occurred after the formation of the coal seam, what should the geologist measure the apparent thickness of the outcrop on the hill to be?

A. 7.76 meters B. 8.97 meters C. 10.97 meters D. 15.53 meters

27. In a region of the Northern Hemisphere shown below, the winds are the dominant driver of ocean circulation.



Given the depicted surface wind pattern, which of the following best describes the expected sea-surface temperature (SST) anomaly in waters along the coast?

A. A warm SST anomaly due to downwelling
B. A warm SST anomaly due to upwelling
C. A cold SST anomaly due to downwelling
D. A cold SST anomaly due to upwelling

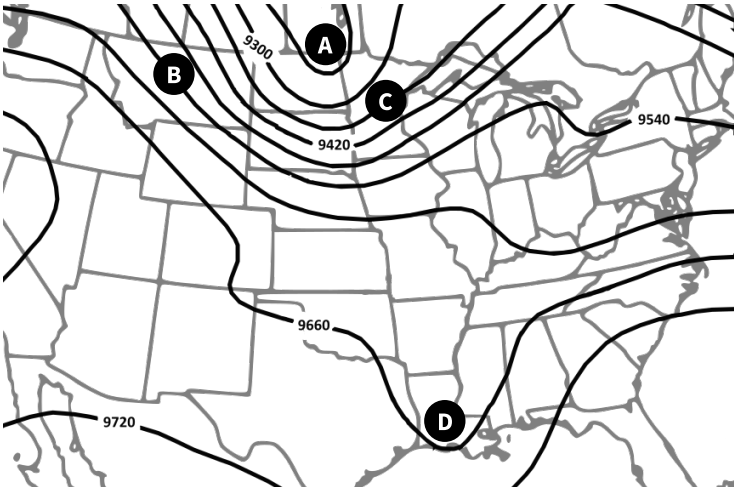
28. Though Titan's atmosphere contains 5% methane, which on Earth acts as a greenhouse gas, the surface of Titan is quite cold at 94 K. Malachi argues that if Titan was moved to a distance of 1 AU from the Sun, its average surface temperature would be greater than that of Earth. Which of the following observations would support Malachi's claim?

I) At higher temperatures, more methane evaporates into the atmosphere

II) Titan's haze dissipates due to photochemical reactions, which decreases planetary albedo

A. I only B. II only C. I and II D. None

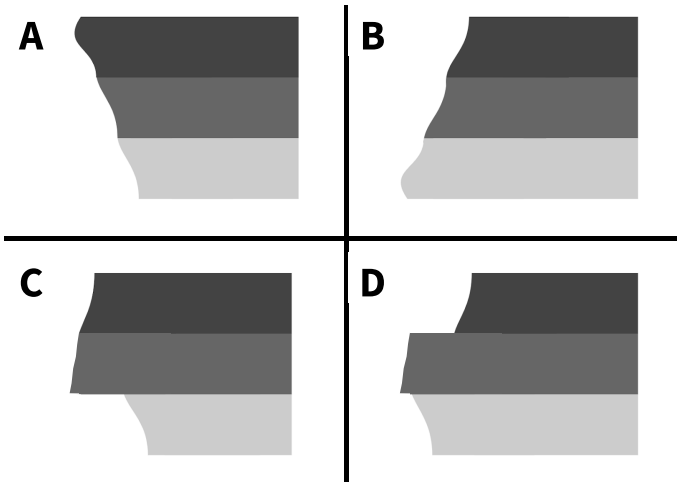
29. The following image depicts a 300 mb constant pressure chart over the United States.



Which of the locations depicted is most likely to exhibit surface-level convergence?

A. A B. B C. C D. D

30. A geologist observes a section of a roadcut in a temperate region. They know that from top to bottom, the cut contains a layer of limestone, then basalt, and then sandstone. Based only on this information, which of the following most likely depicts the weathering profile of the roadcut?



A. A B. B C. C D. D

END OF SECTION I