



USESO 2026

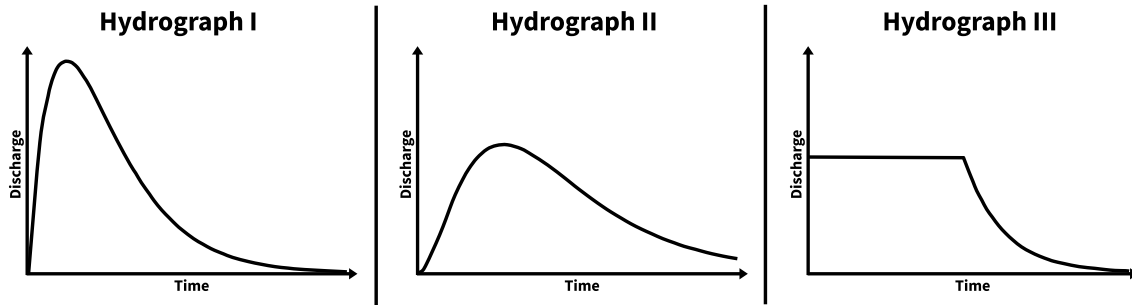
National Open Exam

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.

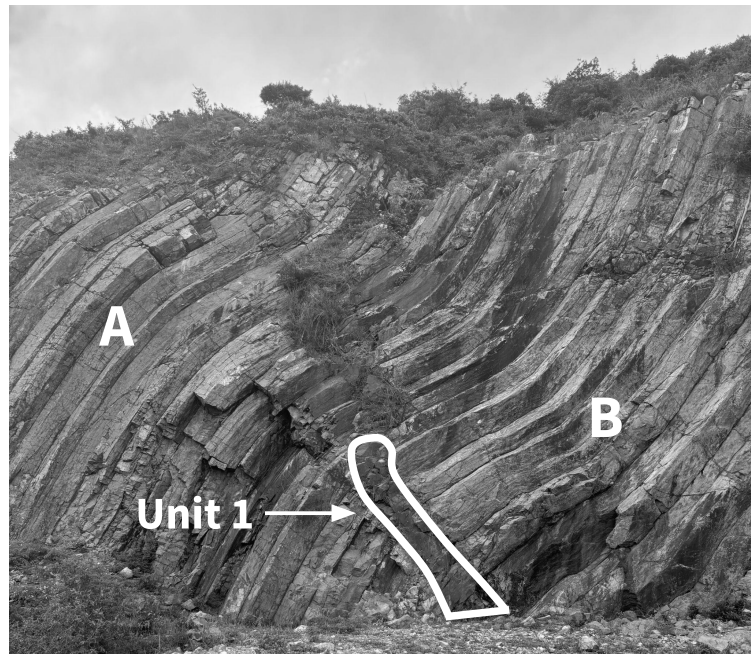
1. Vishnu is interested in how different types of urban developments influence flood duration and flood intensity. To do so, he models a precipitation event in three hypothetical watersheds. Which option correctly matches each hydrograph to its corresponding watershed type?



- A. I is a highly urbanized watershed; II is a forested rural watershed; III is a dam-controlled river reach
 B. I is a forested rural watershed; II is a highly urbanized watershed; III is a dam-controlled river reach
 C. I is a dam-controlled river reach, II is a highly urbanized watershed, III is a forested rural watershed
 D. I is a forested rural watershed, II is a dam-controlled river reach, III is a highly urbanized watershed
2. The P/E_p ratio is the ratio of precipitation to maximum evapotranspiration assuming an unlimited water supply. Suppose you were trying to calculate this ratio, but you accidentally substituted the actual evapotranspiration E_a instead of E_p . What would be the resulting error, and where would the largest percent errors be?
- A. An overestimate of the P/E_p ratio, mainly in dry climates
 B. An overestimate of the P/E_p ratio, mainly in wet climates
 C. An underestimate of the P/E_p ratio, mainly in dry climates
 D. An underestimate of the P/E_p ratio, mainly in wet climates
3. Of the terrestrial planets, only Earth and Mercury have appreciable global magnetic fields. However, Mercury's magnetic field is much weaker than Earth's (about 1/100th the strength of Earth's magnetic field). Which of the following choices correctly explains why?
- A. Mercury's larger core relative to its size results in stronger Coriolis forces upon core convection currents
 B. Mercury's slow rotation compared to Earth results in weaker convection columns within the core
 C. Mercury's large inner core temperature gradient results in stronger core convection currents
 D. Mercury has a thick outer core relative to its overall core size, resulting in weaker convection currents
4. Max is measuring the water discharge exiting a fully saturated aquifer composed primarily of sand. Which of the following changes would increase the discharge measured by Max?
- I) Replacing the sand in the aquifer with silt
 II) Increasing the discharge of streams feeding into the aquifer
- A. I only
 B. II only
 C. I and II
 D. None

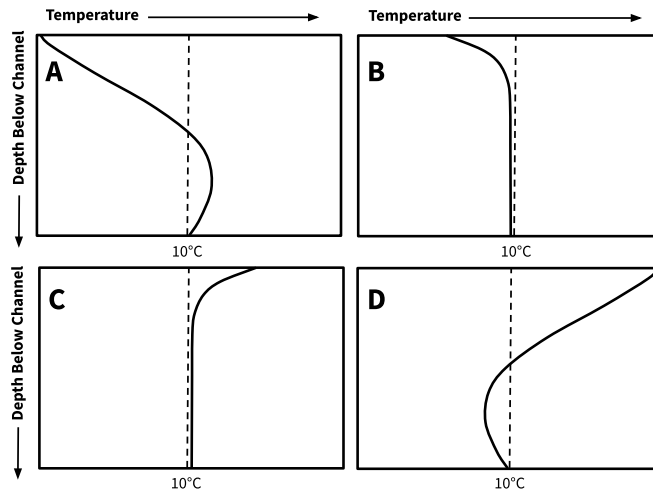
5. Sulfate aerosols are emitted into the troposphere by anthropogenic pollution. Which of the following climate impacts would you expect to observe following an increase in tropospheric sulfate aerosols?
- I) Increase in the absorbance of incoming sunlight, causing warming
 - II) Increase in low-level cloud formation rates, causing cooling
 - III) Decrease in the lifespan of low-level clouds by decreasing the average droplet mass, causing warming
- A. I and III B. II and III C. II only D. III only E. None

6. Consider the following outcrop of igneous rock with intruding rock Unit 1 denoted by the white outlines. Which of the following can be reasonably inferred from this photo?



- I) Unit 1 is younger than the surrounding rock
 - II) The rocks at location A are younger than those at location B
- A. I only B. II only C. I and II D. None
7. Blearth is a planet exactly identical to Earth except for the fact that it rotates around its axis in retrograde. Which of the following statements accurately describes patterns of ocean circulation on Blearth?
- I) Downwelling occurs at the center of gyres
 - II) Currents on the Western edge of ocean basins are slower and wider than their Eastern counterparts
 - III) Surface water at the latitude of the Antarctic Divergence on Earth **converges** on Blearth
- A. II only B. III only C. I and II D. II and III E. I, II, and III

8. The following diagram depicts the temperature profiles for gaining and losing streams at different times of the year. Which profile represents a gaining stream in winter?



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

9. The chemical index of alteration (CIA), a weathering index for rocks, is calculated as

$$CIA = \frac{[Al_2O_3]}{[Al_2O_3] + [CaO] + [Na_2O] + [K_2O]} \times 100,$$

where [CaO], [Na₂O], and [K₂O] are the concentrations of more easily leachable species than Al₂O₃. Soil samples X and Y are derived from the same parent rock but were taken from different locations. Sample X has CIA = 80 and Sample Y has CIA = 55. Which of the following offers the best explanation for the cause of this discrepancy?

- A. Sample Y is older than Sample X
- B. Sample X was sampled from the E horizon, while Sample Y was sampled from the B horizon
- C. Sample X was exposed to freeze-thaw cycles more often than Sample Y
- D. The precipitation at the location of Sample X was less acidic than the precipitation at Sample Y

10. Edlyn and Flora are studying water properties in the Atlantic Ocean. Edlyn is on a boat at the equator, while Flora is on a boat at 20 degrees north. Which of the following statements is/are true about the water they are studying?

- I) If Edlyn and Flora both begin vertically descending into the ocean below their boats, Flora will experience a greater change in temperature as she descends
- II) If Edlyn and Flora have identical boats, Flora's boat will have an easier time floating due to a difference in surface water density
- III) If the strength of the Hadley circulation cell were decreased, the difference in surface water salinity at the location of the two boats would also decrease

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

11. According to Kepler's laws of planetary motion, which of the following pairs of planets have the same orbital period?

Planet	Host Star Mass (M_{\odot})	Perihelion (AU)	Aphelion (AU)
I	1.0	1.0	1.0
II	2.0	0.5	2.0
III	4.0	1.0	4.0
IV	8.0	1.0	3.0

- A. I and II B. I and IV C. II and III D. II and IV E. III and IV

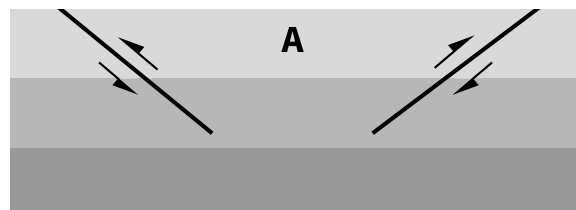
12. Scientists are investigating a sample of oceanic sediments known to be located near the equator during the start of its formation. From top to bottom, the layers are primarily composed of clay, then siliceous ooze, then calcareous ooze. Which of the following sets of events experienced by the sample is most likely to have caused the formation of this sequence?

- A. Retreat of continental glaciers, followed by movement away from the equator
 B. Movement away from the equator, followed by retreat of continental glaciers
 C. Seafloor subsidence, followed by strong ocean surface cooling
 D. Strong ocean surface cooling, followed by seafloor subsidence

13. A geologist wants to find rocks with strong schistosity and large mica flakes. From which of the following environments would they be most likely to find such rocks?

- A. An area of repeated marine transgressions and regressions C. A mountain range where accreted oceanic crust is found
 B. An area of continental rifting D. An isolated mountain where tuff and rhyolite are found

14. The cross-section below depicts a region *before* deformation occurred along with the faults that formed *during* deformation. What type of force resulted in the faults shown, and would you expect erosion or deposition to occur at the region labeled A?



- A. Compressional, erosion C. Extensional, erosion
 B. Compressional, deposition D. Extensional, deposition

15. Heat waves generally form when high-pressure zones stagnate, trapping hot air near the ground. Which of the following best explains how high soil moisture affects the severity of a heat wave?

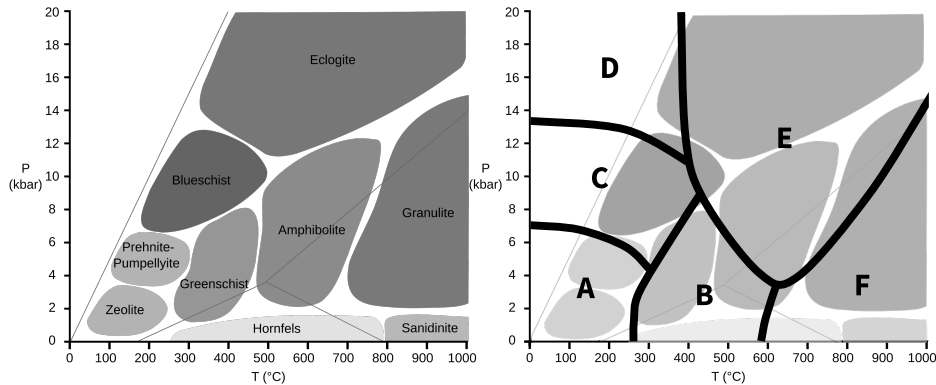
- A. Increases, because the high latent heat of evaporation releases energy to the atmosphere
- B. Decreases, because the high latent heat of evaporation absorbs heat energy from the atmosphere
- C. Increases, because the high specific heat of water releases energy to the atmosphere
- D. Decreases, because the high specific heat of water absorbs energy from the atmosphere

16. The velocity of a glacier can be affected by factors such as temperature, basal water pressure, and glacier mass. Which of the following conditions are associated with faster glacier flow?

- I) A glacier with an ice shelf rather than fully grounded termination
- II) A glacier that is thinner than average
- III) A glacier with a warmer base than average

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

17. Shown below is the pressure-temperature phase diagram for six polymorphic minerals, A, B, C, D, E, and F. For samples belonging to the same metamorphic facies, in which of the following facies would these minerals be least useful for distinguishing relative degrees of metamorphism?

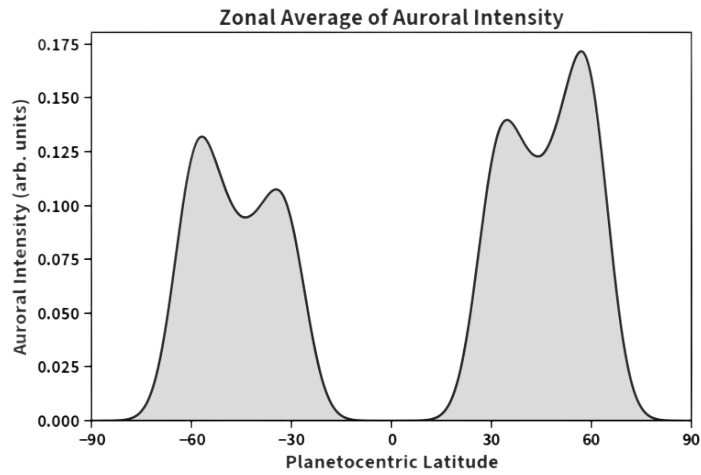


- A. Zeolite
- B. Blueschist
- C. Amphibolite
- D. Hornfels

18. Laboratory analysis of a stony-iron meteorite shows that it is composed of roughly equal parts Fe-Ni metal and olivine-pyroxene crystals, with textures suggesting slow cooling while solid-state metal and silicate were in contact. Which of the following parent-body settings best explains this composition and texture?

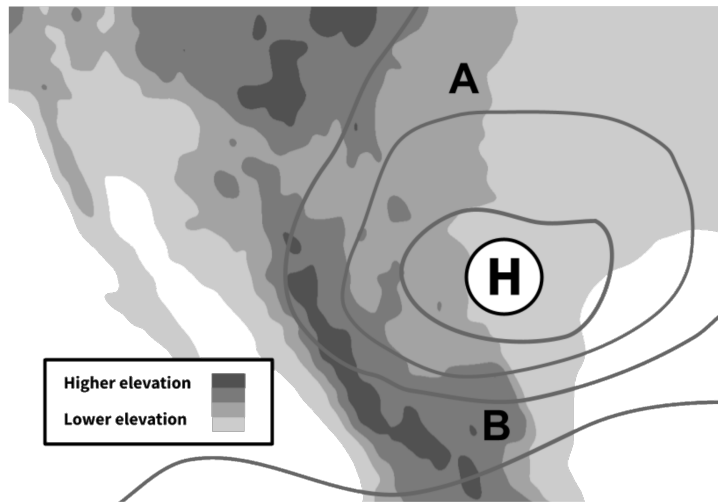
- A. Fragment of an undifferentiated chondritic asteroid that never experienced large-scale melting
- B. Regolith breccia formed in the upper crust of a small, airless body such as the Moon
- C. Metal-rich clasts mixed into silicate material within an undifferentiated asteroid's interior
- D. Mixed material from the boundary between the metallic core and silicate mantle of a differentiated asteroid

19. Shown in the figure is the zonal average of aurora intensity on an unknown planet (in a specific month) versus the latitude relative to the planet's rotational axis. Which of the following statements can be inferred about the planet imaged during this month?



- A. The planet's southern hemisphere is tilted toward the Sun
- B. The planet experiences retrograde rotation
- C. The planet's magnetic pole is offset from its rotational axis
- D. The planet exhibits a lower rotational axial tilt than Earth

20. The North American monsoon is a seasonal weather phenomenon which impacts the southwestern United States and Mexico. The following figure shows one phase of the monsoon, with surface-level isobars overlain on a topographic map of Mexico. Which of the following correctly describes the effect of this phase of the monsoon on precipitation levels at locations A and B, respectively?



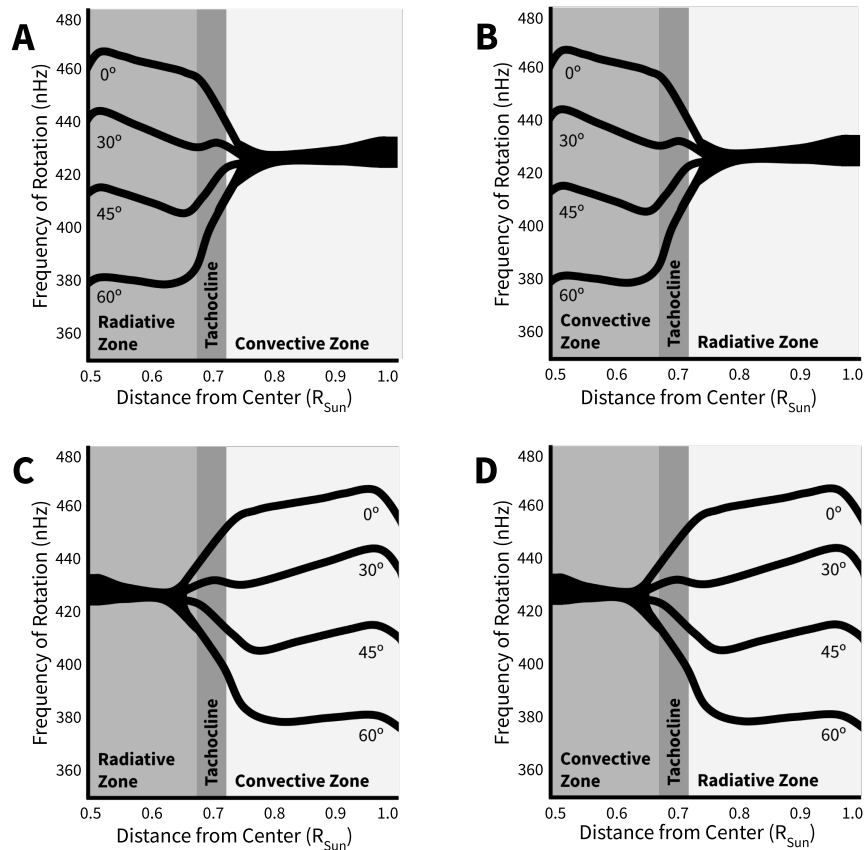
- A. Relatively high; relatively low
- B. Relatively high; relatively high
- C. Relatively low, relatively high
- D. Relatively low, relatively low

21. Winds subject to which of the following conditions would be expected to flow across isobars?

- I) Large pressure gradient aloft in the mid-latitudes
- II) Located within the planetary boundary layer in the Antarctic
- III) Located at the surface beneath a developing anticyclone in the mid-troposphere

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

22. The tachocline acts as the division between the Sun's radiative and convective zones. Which of the following four figures most accurately models the rotation of the Sun as a function of distance from the Sun's center?



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

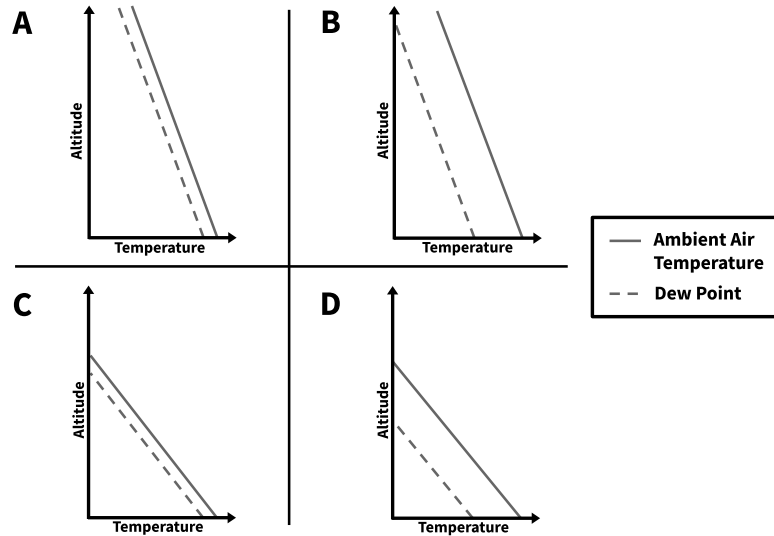
23. Which of the following best describes upper tropospheric energy transfer over the Western Pacific ocean during La Niña conditions?

- A. Net meridional heat movement towards the equator, net zonal heat movement eastward
- B. Net meridional heat movement towards the equator, net zonal heat movement westward
- C. Net meridional heat movement towards the poles, net zonal heat movement eastward
- D. Net meridional heat movement towards the poles, net zonal heat movement westward

24. Adakites are a rare class of silica- and sodium-rich igneous rock. Ratios of trace elements in adakites indicate that they are derived from partial melting of metamorphosed basalt. Which of the following is most likely to be the bulk composition of the material left behind by an adakite-forming partial melt?

- A. Alkali feldspar and chlorite
- B. Amphibole and garnet
- C. Muscovite and quartz
- D. Perovskite and bridgmanite

25. The following diagram shows four upper air soundings at different locations. At which location are thunderstorms most likely to occur?



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

26. Cold air damming occurs when cold air gets trapped by easterly winds along the windward side of a mountain range. Which of the following statements is/are true about cold air damming configurations in the Northern Hemisphere?

- I) Cold air damming configurations typically have high pressure to the south
- II) Cold air damming is associated with freezing rain

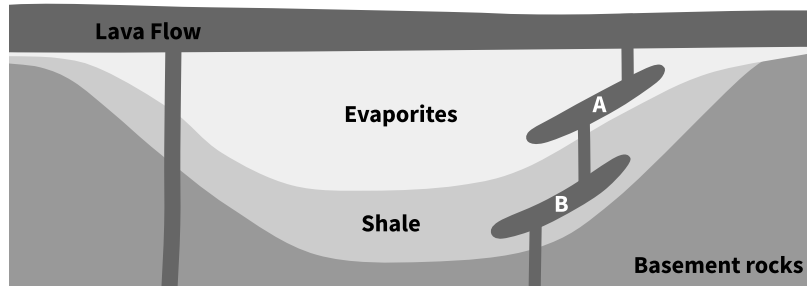
- A. I only
- B. II only
- C. I and II
- D. None

27. Which of the following regions are likely to display anomalously high seismic velocities in the lower lithosphere?

- I) Below the Canadian Shield
- II) Below Kilauea, Hawaii

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

28. The Siberian Traps are a large region of volcanic rock formed by mantle plume volcanism. These eruptions are often stated to be the primary cause of the Permian-Triassic mass extinction event. The image below shows a simplified cross-section of a portion of the Siberian Traps, including the underlying strata.

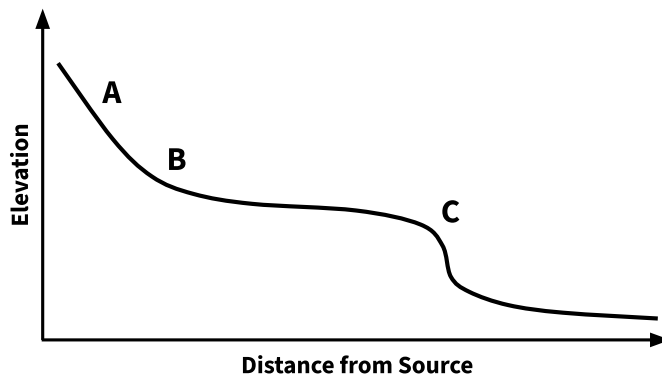


Identify all of the following statements that are true of the Siberian Traps:

- I) The mass extinction was partially caused by long-term global warming due to the eruption’s high greenhouse gas content
- II) A sample of the intrusion from location A would likely be more enriched in volatiles than a sample from location B

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

29. Shown in the figure is a simplified topographic profile of a river that originates in the mountains and flows out to the sea over uniform bedrock. Which of the following choices best identifies the points where the highest net erosion and deposition occur, respectively?



- A. A, C B. A, B C. C, A D. C, B

30. Rohit is studying a mysterious exoplanet—a perfect black body with no atmosphere—that has an average surface solar flux of 2100 W/m^2 . He measures its ratio of absorbed radiation to reflected radiation to be 1.75. Taking the Stefan Boltzmann constant to be $5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$, which of the following is closest to the equilibrium temperature of Rohit’s planet?

- A. 280 K B. 390 K C. 410 K D. 440 K E. 500 K

END OF SECTION I