

**2024 Earth and Space Scrimmage**

# **Single Elimination 3**

**August 17th, 1:30 - 2:00 PT**

### TOSS-UP

1) Earth science – *Short Answer* Generally speaking, at what ratio of wave height to wavelength does an ocean wave begin to break?

ANSWER: 1:7

### BONUS

1) Earth science – *Short Answer* The apparent dip of a bed is found to be 20 degrees. Identify all of the following three values that could be the true dip of the bed: 1) 10 degrees; 2) 20 degrees; 3) 30 degrees.

ANSWER: 2 and 3

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### TOSS-UP

2) Space science – *Multiple Choice* Numerous matter-antimatter annihilation events were thought to have occurred during the Big Bang. In a reference frame where the system's net momentum is zero, which of the following describes the most probable result of electron-positron annihilation?

- W) Two low-energy photons going in opposite directions
- X) Two high-energy photons going in opposite directions
- Y) Two low-energy photons going in the same direction
- Z) Two high-energy photons going in the same direction

ANSWER: X) Two high-energy photons going in opposite directions

### BONUS

2) Space science – *Short Answer* Identify all of the following three statements that are true of pulsating neutron stars: 1) They are modeled by the double-exhaust model; 2) Their beams of radiation come from electron-positron pairs created by strong electric fields; 3) They have an average age of less than ten million years.

ANSWER: 2 and 3

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**TOSS-UP**

3) Earth science – *Multiple Choice* Which of the following statements is FALSE regarding lightning?

- W) The return stroke creates the bright flash in lightning
- X) Nearly all lightning is the result of a positively charged cloud and negatively charged surface object
- Y) Dry air acts as a good insulator and is unfavorable for lightning formation
- Z) The dart leader is the leading charge for each stepped ladder

ANSWER: X

**BONUS**

3) Earth science – *Short Answer* Identify all of the following three minerals that would likely be found in close association with topaz: 1) Ulexite [*yoo-LEX-ight*]; 2) Fluorite; 3) Aragonite.

ANSWER: 2 only

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**TOSS-UP**

4) Earth science – *Multiple Choice* Which of the following most accurately describes the optical properties of cirrus clouds with respect to visible and infrared light, respectively?

- W) Transparent, reflective
- X) Reflective, transparent
- Y) Transparent, opaque
- Z) Opaque, transparent

ANSWER: Y) Transparent, opaque

**BONUS**

4) Earth science – *Multiple Choice* Which of the following conditions would NOT likely favor the formation of a copper ore deposit?

- W) Underlying magma intrusion
- X) Deposition of poorly sorted sediment
- Y) Presence of extensional faulting
- Z) High subsurface water content

ANSWER: X) Deposition of poorly sorted sediment

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**TOSS-UP**

5) Space science – *Multiple Choice* A planet travels in a circular orbit around a star. If the star's mass is suddenly halved, which of the following best describes the new path of the planet?

- W) Circular
- X) Elliptical
- Y) Parabolic
- Z) Hyperbolic

ANSWER: Y) Parabolic

**BONUS**

5) Space science – *Short Answer* Large asteroid collisions are thought to have created what families of asteroids, which are grouped together because they share similar proper orbital elements like their eccentricity and semimajor axis?

ANSWER: Hirayama families

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**TOSS-UP**

6) Earth science – *Short Answer* Mafic sills and dikes near Earth's surface often contain what type of igneous rock with a texture intermediate between basalt and gabbro?

ANSWER: Diabase [*DAI-uh-bayz*]

**BONUS**

6) Earth science – *Multiple Choice* Dropstones are isolated fragments of rock that are often found within fine-grained, water-deposited sedimentary rocks. At which of the following locations are dropstones LEAST likely to be found?

- W) Along a continental rise
- X) Along an ice tongue
- Y) Along a stratovolcano
- Z) Along a river floodplain

ANSWER: Z) Along a river floodplain

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**TOSS-UP**

7) Earth science – *Multiple Choice* Carl the frog hops into a gossan [**GAW-sen**] deposit. When mining out this deposit, he encounters a pyrite layer above the water table. Which of the following minerals should Carl NOT expect to find below the water table of this gossan deposit?

- W) Goethite [**GER-tite**]
- X) Bornite
- Y) Chalcopyrite
- Z) Marcasite

ANSWER: W) Goethite

**BONUS**

7) Earth science – *Short Answer* Rank the following three soil orders in terms of increasing average amount of weathering: 1) Oxisols; 2) Mollisols; 3) Entisols.

ANSWER: 3, 2, 1

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**TOSS-UP**

8) Space science – *Short Answer* Order the following three layers of Jupiter's atmosphere from highest to lowest elevation: 1) Ammonium ice; 2) Ammonium hydrosulfide ice; 3) Water ice.

ANSWER: 1, 2, 3

**BONUS**

8) Space science – *Short Answer* A spacecraft travels 4 light-years at 0.8 times the speed of light from Earth to Alpha Centauri. How long, in years, would the journey appear to take to someone onboard the spacecraft?

ANSWER: 3

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**TOSS-UP**

9) Earth science – *Multiple Choice* A coastal mountain range has a uniform height of 5 kilometers. If an air parcel passing over the mountain range is measured to have an initial temperature of 20 degrees Celsius, which of the following is closest to its maximum possible temperature, in degrees Celsius, at the same elevation after crossing the mountain range?

- W) 5
- X) 20
- Y) 35
- Z) 50

ANSWER: Z) 50

**BONUS**

9) Earth science – *Short Answer* Titus observes an exposed sequence of ophiolitic rock in California. Assuming there has been no overturning or faulting following the initial obduction of the rock, order the following four features that Titus would see from top to bottom: 1) Mélange [*meh-LANJ*]; 2) Layered gabbros; 3) Sheeted dikes; 4) Massive gabbros.

ANSWER: 3, 4, 2, 1

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**TOSS-UP**

10) Earth science – *Multiple Choice* Peter is exploring a nearby lake when he discovers a large accumulation of stishovite along the lake bed. Based on this information, which of the following is the most likely formation mechanism of the lake?

- W) Glacial meltwater
- X) Cut-off meander
- Y) Meteorite crater
- Z) Volcanic crater

ANSWER: Y) Meteorite crater

### BONUS

10) Earth science – *Multiple Choice* Shreyas explores a beach and finds a sedimentary structure with vertically-layered bands, from top to bottom, of sandstone, shale, and limestone. The sandstone layer extends outwards towards the sea while the limestone layer extends inwards towards the land. Which of the following best describes this outcrop?

- W) Progradational transgression
- X) Retrogradational transgression
- Y) Progradational regression
- Z) Retrogradational regression

ANSWER: Y) Progradational regression

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### TOSS-UP

11) Space science – *Multiple Choice* Which of the following statements is INCORRECT regarding Martian terrain?

- W) The Martian surface is primarily composed of tholeiitic [*toe-LEH-ih-tik*] basalt
- X) Dark streaks are common along steep crater slopes
- Y) The dark southern plains are likely the remnants of a large impact crater
- Z) Valles Marineris formed due to the thickening of the Tharsis Bulge

ANSWER: Y) The dark southern plains are likely the remnants of a large impact crater

### BONUS

11) Space science – *Multiple Choice* Which of the following statements is INCORRECT regarding gamma-ray bursts?

- W) The majority of gamma-ray bursts are classified as long gamma-ray bursts
- X) Collapse along a star's equatorial region due to differential rotation can create gamma-ray bursts
- Y) Long gamma-ray bursts are most commonly formed by star collapse or star formation
- Z) Short gamma-ray bursts produce the strongest radiation afterglows

ANSWER: Z) Short gamma-ray bursts produce the strongest radiation afterglows

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**TOSS-UP**

12) Earth science – *Short Answer* In metamorphic assemblages, what term describes large mineral crystals, often made of garnet or staurolite, that are embedded within a finer matrix?

ANSWER: Porphyroblasts

**BONUS**

12) Earth Science – *Multiple Choice* Which of the following statements is FALSE regarding seismic waves?

- W) The preferred orientation of olivine can influence seismic wave velocity in the mantle
- X) Seismic waves approaching a boundary non-perpendicularly travel along the boundary
- Y) Seismic waves approaching a boundary non-perpendicularly reflect into the original medium
- Z) No secondary P waves can be detected at an earthquake epicenter's antipode

ANSWER: Z) No secondary P waves can be detected at an earthquake epicenter's antipode

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**TOSS-UP**

13) Space science – *Short Answer* Due to their high neutron density, supernovae are thought to create neutron-rich heavy elements through what process that involves rapid neutron capture?

ANSWER: R-process

**BONUS**

13) Space science – *Short Answer* Order the following four components of the interstellar medium in terms of increasing average density: 1) Intercloud medium; 2) Coronal gas; 3) Molecular clouds; 4) H I **[h-one]** clouds.

ANSWER: 2, 1, 4, 3



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**TOSS-UP**

14) Earth science – *Multiple Choice* Which of the following choices does NOT correctly match the silicate mineral with the group of silicates it falls under?

- W) Hornblende, inosilicate
- X) Epidote, sorosilicate
- Y) Augite, tectosilicate
- Z) Beryl, cyclosilicate

ANSWER: Y) Augite, tectosilicate

**BONUS**

14) Earth science – *Multiple Choice* Given that the average celerity of a tsunami in the Arctic Ocean is around 98 meters per second, to two significant figures, what is the minimum wavelength of a wave in the Arctic Ocean that can be considered a shallow water wave at the average depth of the Arctic Ocean?

- W) 980 meters
- X) 2,000 meters
- Y) 9,800 meters
- Z) 20,000 meters

Answer: Z) 20,000 meters

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**TOSS-UP**

15) Space science – *Short Answer* To measure the magnetic field strength of sunspots, astronomers often take advantage of what effect, which causes the splitting of spectral lines in a powerful magnetic field?

ANSWER: Zeeman effect

### **BONUS**

15) Space science – *Multiple Choice* A star with a surface temperature of 10,000 Kelvin and a radius of 1,000 kilometers is orbited by a spherical planet at a distance of 50,000 kilometers. Assuming the system is in thermal equilibrium, which of the following is closest to the surface temperature of the planet?

W) 100 Kelvin

X) 500 Kelvin

Y) 1000 Kelvin

Z) 2000 Kelvin

ANSWER: Y) 1000 Kelvin