2024 Earth and Space Scrimmage

Single Elimination 4

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

TOSS-UP

1) Earth science – *Multiple Choice* Which of the following is the expected dip for a normal fault according to Anderson fault theory?

W) 30 degrees
X) 45 degrees
Y) 60 degrees
Z) 75 degrees

ANSWER: Y) 60 degrees

BONUS

1) Earth science – *Short Answer* What is the term for the smallest type of condensation nuclei, which typically do not induce condensation except in highly supersaturated conditions?

ANSWER: Aitken ***[ATE-ken]*** nuclei

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TOSS-UP

2) Earth science – *Multiple Choice* Which of the following is typically the source of aluminum that allows for the formation of lateritic bauxites?

W) Felsic igneous rock
X) Mafic igneous rock
Y) Detrital ***[deh-TRY-tahl]*** sedimentary rock
Z) Chemical sedimentary rock

ANSWER: W) Felsic igneous rock

BONUS

2) Earth science – *Short Answer* Identify all of the following three statements concerning stress and strain that are true: 1) Strain has the same units as pressure; 2) In three dimensions, there are 27 independent components of stress; 3) Young's modulus relates stress and strain for linearly elastic materials.

ANSWER: 3 only
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TOSS-UP

3) Space science – *Short Answer* Identify all of the following three stellar phenomena that are spiral tracers: 1) RR Lyrae ***[LIE-rah]*** variables; 2) H II ***[h-two]*** regions; 3) OB associations.

ANSWER: 2 and 3

BONUS

3) Space science – *Multiple Choice* A G-type star behind a dense nebula undergoes interstellar extinction. Which of the following sets of values could plausibly represent the star's intrinsic B-V ***[b minus v]*** color index and observed B-V color index, respectively?

W) 0.5, 0.9
X) 0.5, 0.1
Y) -0.5, -0.9
Z) -0.5, -0.1

ANSWER: W) 0.5, 0.9

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TOSS-UP

4) Space science – *Short Answer* What set of cosmological equations, derived from the principles of general relativity, first predicted the expansion of a homogenous, isotropic universe?

ANSWER: Friedmann equations

BONUS

4) Space science – *Short Answer* A galaxy exhibits a cosmological redshift of $z = 0.01$. Assuming Hubble's constant is 70 kilometers per second per megaparsec, then to one significant figure, estimate the distance to the galaxy in megaparsecs.

ANSWER: 40

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TOSS-UP

5) Earth science – *Multiple Choice* A Rossby wave in the Northern Hemisphere has positive curvature vorticity and positive shear vorticity. At which of the following locations would its wind speed likely be highest?

W) At the northern edge of the jet stream
X) At the southern edge of the jet stream
Y) At the western edge of the wave
Z) At the eastern edge of the wave

ANSWER: X) At the southern edge of the jet stream

BONUS

5) Earth science – *Short Answer* During Heinrich events in the Pleistocene, large groups of icebergs broke off from the Laurentide Ice Sheet and entered the northern Atlantic. Identify all of the following three phenomena that would likely be observed during Heinrich events: 1) Strengthening of AMOC; 2) Increase in ocean stratification; 3) Shrinking of the North Atlantic Gyre.

ANSWER: 2 and 3

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TOSS-UP

6) Earth science – *Short Answer* AM radio stations increase their power output at sunrise due to the daytime reappearance of which innermost layer of the ionosphere that attenuates radio waves?

ANSWER: D layer

BONUS

6) Earth science – *Short Answer* Identify all of the following three statements that are true regarding mid-latitude cyclones in the Northern Hemisphere: 1) Mid-latitude cyclones often form to the left of polar jet stream troughs; 2) During the open wave stage, the area between the cold and warm front is known as the cold sector; 3) Mid-latitude cyclones gradually dissipate when they leave the jet core.

ANSWER: 3 only

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TOSS-UP

7) Space science – *Multiple Choice* Which of the following statements is INCORRECT regarding the formation of the Jovian planets?

W) The Nice model suggests that the Jovian planets moved inwards after forming
X) The Jovian planets likely formed by direct collapse instead of slow accretion
Y) Hydrogen and helium were captured by the Jovian planets' strong gravity
Z) Migration of the Jovian planets formed the Kirkwood gaps

ANSWER: W) The Nice model suggests that the Jovian planets moved inwards after forming

BONUS

7) Space science – *Short Answer* Star A and Star B follow circular orbits in a binary star system. It is observed that Star A has a distance of 2 AU from the barycenter while Star B has a distance of 6 AU from the barycenter. Given that the orbital period of this binary star system is 4 years, what are the masses of Star A and Star B in solar masses, respectively?

ANSWER: 24 and 8

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TOSS-UP

8) Earth science – *Short Answer* What is the term for an isolated remnant of a thrust sheet that has been detached from the main body of allochthonous ***[uh-LAHK-thuh-nuhs]*** material through erosion?

ANSWER: Klippe

BONUS

8) Earth science – *Short Answer* A hypothetical river forms the shape of the letter "Z" when viewed from above. If both interior angles of this shape are 45 degrees, then to two significant figures, what is the river's sinuosity?

ANSWER: 2.4

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TOSS-UP

9) Earth science – *Short Answer* What term describes the process by which atoms of a protolith diffuse through solid crystals during metamorphism and react to form crystals of minerals different from those of the protolith?

ANSWER: Neocrystallization

BONUS

9) Earth science – *Short Answer* On Earth, the dew point lapse rate is 2 degrees Celsius per kilometer and the dry adiabatic lapse rate is 10 degrees Celsius per kilometer. If a scientist were to estimate the lifting condensation level, or LCL, without considering the dew point lapse rate, what would be the ratio of the actual LCL height to their estimated LCL height?

ANSWER: 1.25

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TOSS-UP

10) Space science – Short Answer What theorem states that all black hole solutions of the Einstein-Maxwell equations can be defined solely by their mass, charge, and angular momentum?

ANSWER: No-hair theorem

BONUS

10) Space science – *Short Answer* Identify all of the following three statements that are TRUE regarding stellar types: 1) O-type stars have the lowest average temperature; 2) A-type stars typically have the strongest Balmer lines; 3) G-type stars typically have strong ionized calcium lines.

ANSWER: 2 and 3

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TOSS-UP

11) Earth science – *Multiple Choice* A geologist notices a star-shaped pattern of light reflecting off the surface of a spinel ***[spuh-NEL]*** gemstone. Which of the following compounds is most likely included within this gemstone?

W) SnO_2
X) TiO_2
Y) Cu_2O
Z) Fe_3O_4

ANSWER: X) TiO_2

BONUS

11) Earth science – *Short Answer* Order the following three layers of the Bouma ***[BOO-mah]*** sequence in terms of increasing depth from the surface: 1) Planar-laminated sandstone; 2) Ungraded mudstone 3) Ripple-laminated sandstone.

ANSWER: 2, 3, 1

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TOSS-UP

12) Space science – *Short Answe*r What class of organic polymer-like molecules, formed from various atmospheric reactions, are responsible for the reddish coloring of Titan's atmosphere and the surfaces of Europa and Pluto?

ANSWER: Tholins

BONUS

12) Space science – *Short Answer* In hexahedrite iron meteorites, shock-induced deformation of kamacite ***[CAM-uh-sight]*** crystals can create what characteristic surface features?

ANSWER: Neumann lines (ACCEPT: Neumann bands)

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TOSS-UP

13) Earth science – *Short Answer* Although banded iron formations are generally confined to the early Proterozoic, their formation rate increased around 700 million years ago during what event, which prevented ocean-atmosphere gas exchange by covering much of Earth in ice?

ANSWER: Snowball Earth

BONUS

13) Earth science – *Short Answer* Water flow through glaciers is thought to be primarily achieved through steady-state water channels at the bed known as Röthlisberger ***[RAWTH-lis-bur-gur]*** channels. Identify all of the following three statements that are true concerning these channels: 1) Röthlisberger channels can be fed by moulins; 2) Water flow in Röthlisberger channels is approximately laminar; 3) Röthlisberger channels decrease in size when net accumulation occurs.

ANSWER: 1 and 3

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TOSS-UP

14) Earth science – *Multiple Choice* Which of the following must be true of a dip-slip fault where the fault plane has a true dip of 45 degrees?

W) Throw is greater than heave
X) Throw is less than heave
Y) Throw is equal to heave
Z) Throw and heave are undefined

ANSWER: Y) Throw is equal to heave

BONUS

14) Earth science – *Multiple Choice* Along the western coast of Australia, the Indian Ocean gyre is partially blocked by the Leeuwin ***[LOO-win]*** current, a warm southward current fed by equatorial waters. Researchers studying the Australian sediment record observed several events with a weakened Leeuwin current. Which of the following sets of conditions likely occurred in the Indian Ocean during these events?

W) Strong Indonesian Throughflow and strong Indian Summer Monsoon
X) Strong Indonesian Throughflow and weak Indian Summer Monsoon
Y) Weak Indonesian Throughflow and strong Indian Summer Monsoon
Z) Weak Indonesian Throughflow and weak Indian Summer Monsoon

ANSWER: Y) Weak Indonesian Throughflow and strong Indian Summer Monsoon

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TOSS-UP

15) Earth science – *Multiple Choice* Which of the following best describes the conditions in which pegmatites typically form?

W) Dry early-stage cooling
X) Dry late-stage cooling
Y) Wet early-stage cooling
Z) Wet late-stage cooling

ANSWER: Z) Wet late-stage cooling

BONUS

15) Earth science – *Multiple Choice* David finds a rock with an excess of Al_2O_3 and correctly classifies it as peraluminous. Which of the following minerals is most likely to be present in the lowest concentration within David's rock?

W) Corundum
X) Muscovite
Y) Nepheline ***[NEH-feh-leen]***
Z) Sillimanite

ANSWER: Y) Nepheline
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