

DE5

TOSSUP

1) Math *Short Answer* How many ways are there to reorder the letters in REDDER spelled R-E-D-D-E-R such that the word is a palindrome?

ANSWER: 6

BONUS

1) Math *Short Answer* Distinct digits between 0 and 9 satisfy the equation, *Read Slowly* D2M * 3 = M7C. What is D + M + C?

ANSWER: 16

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TOSSUP

2) Physics - *Short Answer* Rank the following 3 types of radiation by increasing deflection in a magnetic field:

1) Alpha
2) Beta
3) Gamma

ANSWER: 3, 1, 2

BONUS

2) Physics - *Short Answer* A resistor of 2.5 ohms and an inductor connected to a voltage source of 10 volts. At a certain moment, the current is 1 amp. Find the rate at which energy is stored in the inductor.

ANSWER: 7.5 Watts

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TOSSUP

3) Earth and Space - *Multiple Choice* Which of the following correctly describes the Hayashi track?

W) Convective Core, Radiative Envelope
X) Radiative core, Convective Envelope
Y) Convective Core, Convective Envelope
Z) Radiative Core, Radiative Envelope

ANSWER: Y) Convective Core, Convective Envelope

BONUS

3) Earth and Space - *Short Answer* Rank the following variable stars in term of increasing period:

1) Classical Cepheids
2) RR Lyrae
3) ZZ Ceti

ANSWER: 321

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TOSSUP

4) Biology - *Short Answer:* Arjun is studying natural rubber, which he discovers to be made up of repeating five carbon units. Rubber, the plant hormone gibberellin and carotenoids are all examples of terpenoids, which are all polymers of what five-carbon hydrocarbon?

ANSWER: isoprene [AD]

BONUS

4) Biology - *Short Answer:* Continuing his study of plant secondary metabolites, Arjun moves to looking at phenolics. Which of the following four plant secondary metabolites are phenolics?

1) Digoxin
2) Lignin
3) Flavonoids
4) Tannins

ANSWER: 2, 3, 4 [AD]

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TOSSUP

5) Math - *Short Answer* Order the following three geometries by increasing curvature:

1) Euclidean
2) Hyperbolic
3) Spherical

ANSWER: 2, 1, 3.

BONUS

5) Math - *Short Answer* A rectangular pyramid exists such that all of its edges are 2 cm long. What is its volume in centimeters cubed?

ANSWER: 4(sqrt2)/3

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TOSSUP

6) Chemistry - *Multiple Choice* When methyl magnesium bromide is reacted with a ketone, after acidic workup which of the following functional groups does the new compound contain?

W) Primary alcohol
X) Secondary alcohol
Y) Tertiary alcohol
Z) Quaternary alcohol

ANSWER: Y) Tertiary alcohol [SO]

BONUS

6) Chemistry- *Multiple Choice* Which of the following is closest to the pH of a solution of $H_2PO_4^-$ given that the pKa_1 of phosphoric acid is 2.15, the pKa_2 is 6.82 and the pKa_3 is 12.38?

W) 2.15
X) 4.49
Y) 5.56
Z) 9.60

ANSWER: X) 4.49 [SO]

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TOSSUP

7) Physics - *Short Answer* Color confinement refers to the binding of quarks by the strong force into color neutral particles. However, at extremely high temperatures, quarks can break free which is described by what property of the strong force?

ANSWER: Asymptotic Freedom

BONUS

7) Physics - *Short Answer* A rod has a linear mass density given by lambda(x) = x^2. If the rod is 1 meter long, and the left end is at the origin, find the coordinate of the center of mass.

ANSWER: ¾ meters

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TOSSUP

8) Biology- *Short Answer:* Identify all of the following three nitrogenous bases that are matched correctly with their product when deaminated: 1) cytosine, uracil 2) adenine, xanthine 3) guanine, hypoxanthine.

ANSWER: 1 only (ACCEPT: Cytosine, uracil) [HL]

BONUS

8) Biology - *Short Answer* In most cells, methionine serves as the initial amino acid. In bacteria, a separate tRNA is used for regular methionine, and a separate one as the initiator tRNA. What functional group is added to the methionine in this initiator tRNA, giving the amino acid the name f-met?

ANSWER: Formyl [HL]

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TOSSUP

9) Earth and Space - *Multiple Choice* Venus has a large isotopic ratio of deuterium to protium, roughly 100x that of Earth. Which of the following is a potential reason for this?

W) Venus formed closer to the Sun and thus accreted more refractory elements.
X) Venus experienced substantial water loss earlier in its history.
Y) Venus's thick atmosphere produces strong greenhouse warming through carbon dioxide.
Z) Venus's slow retrograde rotation leads to weak Coriolis forces and reduced global circulation.

ANSWER: X) Venus experience substantial water loss earlier in its history

BONUS

9) Earth and Space - *Multiple Choice* T Tauri stars classify as which of the following classes of protostars?

W) Class 0 Protostar
X) Class 1 Protostar
Y) Class 2 Protostar
Z) Class 3 Protostar

ANSWER: Y) Class 2 Protostar

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TOSSUP

11) Physics - *Short Answer* The electric flux of a region is proportional to r^2. Identify all of the following 4 charge distributions that could describe this situation.

1) Point Charge
2) Infinite line
3) Infinite charged sheet

ANSWER: 3 only

BONUS

11) Physics - *Short Answer* A special type of spring has a spring constant k that varies with displacement and has 0 rest length. This spring is placed at the origin and has a potential energy function of 7x^6 + 6x^7. Calculate its effective spring constant at x = 1 meter.

ANSWER: 652 N/m

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TOSSUP

12) Earth and Space - *Short Answer* Order the following four seismic discontinuities within the Earth from shallowest to deepest:

1) Repetti
2) Conrad
3) Moho
4) Gutenberg

ANSWER: 2, 3, 1, 4 [JY]

BONUS

12) Earth and Space - *Multiple Choice* The D'' ("d double prime") layer, situated just above the outer core, is characterized by complex but low seismic velocity gradients and is often considered a graveyard for subducted plates. Which of the following best characterizes the D'' layer?

W) Seismic isotropy, homogenous
X) Seismic anisotropy, heterogenous
Y) Seismic anisotropy, homogenous
Z) Seismic isotropy, heterogenous

ANSWER: X) Seismic anisotropy, heterogenous [JY]

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TOSSUP

13) Math - *Short Answer* To make his outfit, Likhith selects one hat, one shirt, and one set of pants every day. His hats, shirts and pants each come in one of 3 colors, red, green and yellow. However, he does not want to be mistaken for a traffic light so he will never wear all three at the same time. How many ways can he choose an outfit for the day under these conditions?

ANSWER: 21

BONUS

13) Math - *Short Answer* What is the Cosine of the acute angle between the lines, y = 4x and y = 2x?

ANSWER: 9sqrt(85)/85

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TOSSUP

14) Biology - *Multiple Choice:* Which of the following statements is incorrect about the Ramachandran plot?

W) Antiparallel beta sheets are found in the upper left quadrant
X) Glycine has the least possible locations on the Ramachandran plot
Y) The axes on the plot represent different dihedral angles
Z) Left handed alpha helices are found in the upper right quadrant

ANSWER: X) Glycine has the least possible locations on the Ramachandran plot [HL]

BONUS

14) Biology- *Multiple Choice:* A plant has a mutation in the PIN gene, which encodes for an auxin efflux carrier protein. Which of the following answer choices correctly identifies where you would expect the highest concentration of auxin and what the deviation from normal development would be, respectively?

W) Shoot Tip, Decreased Root Development
X) Shoot Tip, Decreased Shoot Development
Y) Root Tip, Decreased Root Development
Z) Root Tip, Decreased Shoot Development

ANSWER: W) Shoot Tip, Decreased Root Development [HL]

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TOSSUP

15) Physics - *Multiple Choice* Joel believes he is at the center of a flat Earth with an ice wall at its edge. He sends Aneesh to the ice wall to test his theory. If Joel is correct, how do Joel and Aneesh feel gravity respectively?

W) downward, toward the ice wall
X) downward, away from the ice wall
Y) toward the ice wall, downward
Z) away from the ice wall, downward

ANSWER: X) downward, away from the ice wall

BONUS

15) Physics - *Short Answer* Rank the following 3 types of scattering in terms of increasing wavelength dependance:

1) Mie
2) Rayleigh
3) Raman

ANSWER: 1, 2, 3

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TOSSUP

16) Chemistry- *Short Answer* Identify all of the following three acids which would display higher acidity in acetic acid than in water:

1) Sulfuric acid
2) Perchloric acid
3) Hydrochloric acid

ANSWER: NONE [SO]

BONUS

16) Chemistry - *Short Answer* In a sealed movable piston at constant pressure, propane gas is ignited under an oxygenated atmosphere. Identify all of the following three changes that will cause an increase in the amount of propane gas consumed:

1) Decreasing temperature
2) Increasing volume
3) Adding argon gas

ANSWER: ALL [SO]

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TOSSUP

17) Biology - *Short Answer* What is the term for the outer layer of living endosperm in cereal grains, which produces alpha amylase in response to gibberellic acid secretion during germination?

ANSWER: aleurone layer [AD]

BONUS

17) Biology - *Short Answer:* Arjun is studying frequency dependent selection in snakes. Select all of the following four traits that could exhibit negative frequency dependent selection:

1) A trait that allows a non-venomous species to display Batesian mimicry.
2) A trait that gives venomous snakes aposematic coloration.
3) A trait that causes two different snake species to display Mullerian mimicry.
4) A trait that gives non-venomous snake cryptic coloration.

ANSWER: 1, 4 [AD]
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TOSSUP

18) Math - *Short Answer* Let a,b,c,d,e be distinct positive integers and N = a+b+c+d+e. Find the minimum value of N given that N is even.

ANSWER: 16

BONUS

18) Math - *Short Answer* Given an inflection point for a certain cubic function, how many more points on the function's graph would you need to know to completely determine the cubic?

ANSWER: 2

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TOSSUP

19) Earth and Space - *Multiple Choice* Rock glaciers are mass flows that are composed predominantly of rock, typically formed by the cementing action of ice on colluvial deposits or when the proportion of rocks exceeds that of ice in an active glacier. Which of the following is the primary method of movement for rock glaciers?

W) Bed deformation
X) Basal sliding
Y) Internal deformation
Z) Regelation flow

ANSWER: Y) Internal deformation [JY]

BONUS

19) Earth and Space - *Short Answer* Identify all of the following that commonly involve BOTH orthogonal and hexagonal configurations:

1) Patterned ground
2) Trellis drainage
3) Mud cracks

ANSWER: 1 and 3 [JY]

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TOSSUP

#20) Chemistry - *Multiple Choice* Arjun has an unknown metal M. He notices that when he adds sodium chloride to a soluble salt of M in aqueous solution, a white precipitate is formed. However, when Arjun lightly heats this precipitate, it redissolves. Which of the following metals could be the identity of Arjun's unknown metal M?

W) Silver
X) Lead
Y) Mercury
Z) Zinc

ANSWER: X) Lead [SO]

BONUS

#20) Chemistry - *Multiple Choice* Which of the following molecules can NOT be used as a primary standard for a titration?

W) Oxalic acid
X) Potassium hydrogen phthalate
Y) Sodium carbonate
Z) Sodium hydroxide

ANSWER: Z) Sodium hydroxide [SO]