2024 SMH Invitational Cup - DOUBLE ELIMINATION 2

TOSSUP

1) Biology – *Multiple Choice* What form of selection actively maintains multiple alleles for a gene?

W) stabilizing

X) balancing

Y) directional

Z) intrasexual

ANSWER: X) balancing [SO]

BONUS

1) Biology – *Short Answer* Identify all of the following three statements which are true regarding erythropoietin: 1) it is secreted by the kidneys, 2) it is released when high blood O2 concentrations are sensed, 3) inhibition of its release can lead to anemia.

ANSWER: 1 and 3 [SO]

TOSSUP

2) Chemistry – *Short Answer* In x-ray crystallography, what law describes the relationship between the spacing of crystal layers and the angle of constructive interference for a specific wavelength?

ANSWER: Bragg's Law [CZ]

BONUS

2) Chemistry – *Multiple Choice* Which of the following group 16 elements would have the greatest pi bond overlap and form the strongest double bonds?

W) Oxygen
X) Sulfur
Y) Selenium
Z) Tellurium

ANSWER: W) Oxygen [CZ]

TOSSUP

3) Physics – *Multiple Choice* Daniel is using a hydraulic press to crush his car. Which of the following options best describes why hydraulic presses do not violate the conservation of energy?
W) the larger exerted force acts over a shorter distance
X) fluid compression is a reversible process
Y) the force a hydraulic press produces is inversely proportional to area
Z) hydraulic presses require the input of large amounts of heat to function

ANSWER: W) the larger exerted force acts over a shorter distance [SO]

BONUS

3) Physics – *Short Answer* Identify all of the following three types of scattering that involve a photon as the incident particle.
1. Mie scattering
2. Compton scattering
3. Raman scattering

ANSWER: all [DL]

TOSSUP

4) Earth and Space – *Multiple Choice* Herbig-Haro objects are generally associated with stars in which of the following stages of their evolution?
W) Protostar
X) Main sequence
Y) Red giant
Z) White dwarf

ANSWER: W) Protostar [PB]

BONUS

4) Earth and Space – *Short Answer* Order the following three convective systems in a tornado-forming storm from smallest to largest: 1) Mesocyclone; 2) Supercell; 3) Suction vortices.

ANSWER: 312 [PB]

TOSSUP

5) Math – *Short Answer* The integral from 2 to 6 of f(x) dx is 16. What is the integral from 1 to 3 of 3 + f(2x) dx?

ANSWER: 14 [RG]

BONUS

5) Math – *Short Answer* A rectangle has sides of length 6 and 8. It is divided into unit squares. How many distinct unit squares does the diagonal of the rectangle pass through?

ANSWER: 12 [RG]

TOSSUP

6) Biology – *Multiple Choice* Which of the following fruits is an example of a simple fruit?
W) plum
X) pineapple
Y) strawberry
Z) apple

ANSWER: W) plum [SO]

BONUS

6) Biology – *Short Answer* What cells line the ventricles of the brain and use cilia to move the cerebrospinal fluid?

ANSWER: EPENDYMAL CELLS [SO]

TOSSUP

7) Chemistry – *Short Answer* Rank the following three subshells with principal quantum number 3 in order of increasing orbital penetration:
1) 3p
2) 3s
3) 3d

ANSWER: 312 [CZ]

BONUS

7) Chemistry – *Multiple Choice* Which of the following pure elements has the greatest electrical conductivity?
W) zinc

X) silver
Y) gold
Z) copper

ANSWER: X) silver [CZ]

TOSSUP

8) Physics – *Multiple Choice* Sophia has two different prisms with different indices of refraction. She passes white light through the first prism and monocolor green light through the second, and notices that the monocolor green ray bends at a greater angle than the red part of the dispersed white light ray. Which of the following is an accurate conclusion that she can make about the indices of refraction of the two prisms for a given wavelength of light?

W. The first prism has a higher index of refraction
X. The second prism has a higher index of refraction
Y. The two prisms have an equal index of refraction
Z. No conclusion can be made

ANSWER: Z. No conclusion can be made. [DL]

BONUS

8) Physics – *Short Answer* Dan graphs an ohmic material's I-V characteristic by plotting current on the y-axis and voltage on the x-axis. What physical quantity is the slope of this graph?

ANSWER: Electrical Conductance (ACCEPT: conductance) [DL]

TOSSUP

9) Earth and Space – *Multiple Choice* Accretionary wedges can be found at which of the following plate boundaries?
W) continental continental divergent
X) oceanic continental divergent
Y) oceanic continental convergent
Z) continental continental transform

ANSWER: Y) oceanic continental convergent [SO]

BONUS

9) Earth and Space – *Multiple Choice* Bok globules are examples of which of the following types of nebulae?
W) Dark
X) Emission
Y) Planetary
Z) Reflection

ANSWER: W) Dark [PB]

TOSSUP

10) Math – *Short Answer* If a bracelet of 26 beads contains 2 red beads and 24 green beads, and rotations and reflections are indistinguishable, how many ways are there to place the beats on the bracelet?

ANSWER: 13 [RG]

BONUS

10) Math – *Short Answer* If 3 fair dice are rolled, each labeled from 1 through 6 inclusive, then what is the probability that the product of the numbers on the top face is prime?

ANSWER: 1/24 [RG]

TOSSUP

11) Biology – *Short Answer* Bisphosphonates treat osteoporosis by inhibiting what cells, which break down bone tissue to release calcium ions into the blood?

ANSWER: osteoclasts [SO]

BONUS

11) Biology – *Short Answer* On what chromosome are the genes coding for the red and green opsins located?

ANSWER: X chromosome [SO]

TOSSUP

12) Chemistry – *Multiple Choice* How many p electrons does the element bromine have?
W) 8
X) 10
Y) 15
Z) 17

ANSWER: Z) 17 [CZ]

BONUS

12) Chemistry – *Multiple Choice* Which of the following gasses will effuse the slowest?

W) Xenon
X) Butane
Y) Sulfur dioxide
Z) Helium

ANSWER: W) Xenon [CZ]

TOSSUP

13) Physics – *Short Answer* The Eightfold Way was devised to describe what class of subatomic particles, composed of quarks held together by gluons?

ANSWER: hadron [CZ]

BONUS

13) Physics – *Short Answer* A 4-meter-long wire has a cross-sectional area of 1 square meter and a resistance of 16 ohms. In SI units, what is the conductivity of this wire?

ANSWER: 0.25 [DL]

TOSSUP

14) Earth and Space – *Multiple Choice* Which of the following spectral classes is primarily characterized by ionized helium absorption lines?
W) O
X) A
Y) G
Z) M

ANSWER: W) O [PB]

BONUS

14) Earth and Space – *Short Answer* Saturn's second outermost ring, the E Ring, consists mostly of microscopic particles of water ice. Its origins are best attributed to cryovolcanic ejections as part of what moon's south polar jets?

ANSWER: Enceladus [DL]

TOSSUP

15) Math – *Multiple Choice* What is the limit as x approaches 0 of the fraction with numerator e^x - x - 1 and denominator 3x^2?
W) 0
X) 1/6
Y) 1/3
Z) Does not exist

ANSWER: X) 1/6 [RG]

BONUS

15) Math – *Short Answer* Connor repeatedly rolls a fair four-sided die labeled 1 through 4 until all of the numbers have shown up at least once. What is the expected number of times he must roll the die?

ANSWER: 25/3 [RG]

TOSSUP

16) Biology – *Short Answer* The density of fishes is close to the density of water because fish possess what organ, evolutionarily derived from lungs?

ANSWER: SWIM BLADDER [SO]

BONUS

16) Biology – *Short Answer* Identify all of the following three plant transport routes which involve transport through the cytoplasm.
I. symplastic
II. apoplastic
III. transmembrane

ANSWER: I AND III [SO]

TOSSUP

17) Chemistry – *Short Answer* Connor uses a bomb calorimeter to do calorimetry. The heat of this reaction represents the change in what thermodynamic quantity of the system?

ANSWER: internal energy [CZ]

BONUS

17) Chemistry – *Short Answer* What is the average bond order of the nitronium ion, which has formula NO_2^+?

ANSWER: 2 [CZ]

TOSSUP

18) Physics – *Short Answer* A string that is free at both ends has a standing wave induced at its third harmonic frequency. How many antinodes are present?

ANSWER: 4 [DL]

BONUS

18) Physics – *Short Answer* *Short Answer* A force given by the vector 9i plus 5j minus 6k moves a particle along the displacement vector 4i minus j minus 3k. What is the work done by the force on the particle?

ANSWER: 49 [SO]

TOSSUP

19) Earth and Space – *Multiple Choice* Which of the following terrestrial planets has a spin axis that makes the smallest acute angle with the ecliptic?

W. Mercury
X. Venus
Y. Earth
Z. Mars

ANSWER: Z. Mars [DL]

BONUS

19) Earth and Space – *Multiple Choice* Which of the following best describes how the salinity of seawater near the poles changes as depth increases?
W) increases

X) decreases
Y) stays the same
Z) increases, then decreases

ANSWER: W) increases [SO]

TOSSUP

20) Math – *Multiple Choice* The 4 distinct roots of the polynomial x^4 - 3x^3 + 2x^2 - 7x + 2 are a, b, c, and d. What is quantity a-1 times quantity b-1 times quantity c-1 quantity d-1?
W) -10
X) -5
Y) 4
Z) 8

ANSWER: X) -5 [RG]

BONUS

20) Math – *Short Answer* The circumcenter of an equilateral triangle is at the origin, and one of its vertices is at the point (6,8). What is the area of this equilateral triangle?

ANSWER: 75sqrt3 [DL]
