2024 SMH Invitational Cup - ROUND ROBIN 3

TOSSUP

1) Biology – *Multiple Choice* In humans, what process removes unnecessary neuronal connections in early development in order to lead to proper brain function?
W) neuronal revision
X) synaptic pruning
Y) foundational reduction
Z) deneuralation

ANSWER: X) SYNAPTIC PRUNING [SO]

BONUS

1) Biology – *Short Answer* Identify all of the following three animals which are r-selected: 1) humans, 2) mice, 3) salmon.

ANSWER: 2 and 3 [SO]

TOSSUP

2) Chemistry – *Multiple Choice* An unknown element A can form the ion AO4-. Which of the following elements could A be?
W) Phosphorus
X) Sulfur
Y) Chlorine
Z) Nitrogen

ANSWER: Y) Chlorine [CZ]

BONUS

2) Chemistry – *Short Answer* Besides iron, what element is most abundant by mass in stainless steel?

ANSWER: chromium [CZ]

TOSSUP

3) Physics – *Short Answer* A ball is placed on an inclined plane and begins to roll without slipping. In order for the ball to roll, what force must be present to exert a torque?

ANSWER: FRICTION (DO NOT ACCEPT: KINETIC FRICTION) [SO]

BONUS

3) Physics – *Short Answer* What thermodynamic constant is used in the definitions of statistical entropy and the kelvin?

ANSWER: Boltzmann's constant [SO]

TOSSUP

4) Earth and Space – *Multiple Choice* What compound makes up the majority of Mars' ice caps?
W) Water
X) Ammonia
Y) Carbon dioxide
Z) Hydrogen

ANSWER: Y) Carbon dioxide [SO]

BONUS

4) Earth and Space – *Short Answer* Identify all of the following three conditions which are risk factors for mass wasting: 1) heavy rain seasons, 2) deforestation, 3) located near a passive fault.

ANSWER: 1 and 2 [SO]

TOSSUP

5) Math – *Short Answer* 5 fair coins are flipped one by one. What is the probability that no two consecutive flips are the same?

ANSWER: 1/16 [RG]

BONUS

5) Math – *Short Answer* Dan is inputting real numbers into the arctan function. Identify all of the following values that are in the principal range of the arctan function:
1) 0
2) pi/2
3) pi

ANSWER: 1 only [RG]

TOSSUP

6) Biology – *Multiple Choice* Individuals with a dominant allele for the spineless gene display red dorsal coloration, while those without the dominant allele display white coloration. In a population in Hardy-Weinburg equilibrium where 81% of the population is white, what is the allele frequency of the recessive allele?

W) 0.1

X) 0.3

Y) 0.7

Z) 0.9

ANSWER: Z) 0.9 [SO]

BONUS

6) Biology – *Short Answer* Identify all of the following three situations which involve active transport: 1) creation of a membrane potential by a proton pump, 2) diffusion of hydrogen gas out of an archaean, 3) pinocytosis of fats by an adipose cell.

ANSWER: 1 and 3 [SO]

TOSSUP

7) Chemistry – *Short Answer* What term describes compounds that are capable of behaving both as an acid and a base?

ANSWER: amphoteric [CZ]

BONUS

7) Chemistry – *Multiple Choice* Which of the following statements is not true about the phase diagram of water?

W) More evaporation occurs at higher pressure

X) The solid-liquid boundary has negative slope

Y) The solid, liquid, and gas forms of water can coexist
Z) Water boils faster at lower pressure

ANSWER: W) More evaporation occurs at higher pressure [CZ]

TOSSUP

8) Physics – *Multiple Choice* In what type of thermodynamic process is no work done by the system?
W) isobaric
X) isochoric
Y) isothermal
Z) adiabatic

ANSWER: X) isochoric [SO]

BONUS

8) Physics – *Short Answer* Mo is subject to a force that varies with time as F(t) = t^2 + 2t + 1. What is the impulse on Mo from time t = 0 to time t = 2?

ANSWER: 26/3 [DL]

TOSSUP

9) Earth and Space – *Short Answer* Identify all of the following three ores that are ores of aluminum: 1) hematite, 2) corundum, 3) bauxite.

ANSWER: 2 and 3 [SO]

BONUS

9) Earth and Space – *Short Answer* What name is given to asteroids that collect near the stable Lagrange points ahead and behind a planet along its orbit?

ANSWER: Trojans [PB]

TOSSUP

10) Math – *Short Answer* A student has a 60% in the class before the final. If the final is worth 20% of the class grade, and this is the only remaining assignment to be graded, what is the minimum score the student needs to increase his grade by 5%?

ANSWER: 85% [RG]

BONUS

10) Math – *Short Answer* If sine of theta is equal to 1/3, then compute cosine to the fourth power of theta..

ANSWER: 64/81 [RG]

TOSSUP

11) Biology – *Multiple Choice* Which of the following animal phyla does not display bilateral symmetry?
W) Porifera
X) Mollusca
Y) Chordata
Z) Annelida

ANSWER: W) Porifera [SO]

BONUS

11) Biology – *Short Answer* Euna is studying the differences between DNA and RNA. Identify all of the following three parts of a nucleic acid that Euna could use to distinguish between DNA and RNA: 1) nucleobase, 2) phosphate, 3) sugar.

ANSWER: 13 [SO]

TOSSUP

12) Chemistry – *Short Answer* Dry ice and table sugar are examples of what type of solid, composed of individual molecules held together by intermolecular interactions?

ANSWER: molecular [SO]

BONUS

12) Chemistry – *Short Answer* What general organic functional group is found inside carboxylic acids, aldehydes, and ketones?

ANSWER: carbonyl [CZ]

TOSSUP

13) Physics – *Multiple Choice* A planet orbits around a star with a mass much greater than its own mass. Which of the following explains why the angular momentum of the planet around the star is conserved, but not the planet's linear momentum?
W) gravity is a nonconservative force

X) gravity does not exert torque, as it is directed towards the center of mass
Y) the planet's angular velocity must be constant
Z) Newton's third law does not apply in vacuum

ANSWER: X) gravity does not exert torque, as it is directed towards the center of mass [SO]

BONUS

13) Physics – *Short Answer* Identify all of the following three laws which are corollaries of the principle of conservation of energy: 1) Bernoulli's principle, 2) Kepler's second law, 3) Newton's third law.

ANSWER: 1 ONLY [SO]

TOSSUP

14) Earth and Space – *Short Answer* Select all of the following three types of type I supernovae that contain hydrogen spectral lines:

1. Type Ia
2. Type Ib
3. Type Ic

ANSWER: None [DL]

BONUS

14) Earth and Space – *Short Answer* The Montreal Protocol was primarily signed to phase out the use of what group of ozone-depleting substances?

ANSWER: Chlorofluorocarbons (ACCEPT: CFCs) [PB]

TOSSUP

15) Math – *Short Answer* The piecewise function f is defined such that f(x) = 3x for x less than k and f(x) = 6x - 18 for x greater than or equal to k, where k is a fixed constant. If the function is continuous everywhere, what is the value of k?

ANSWER: 6 [RG]

BONUS

15) Math – *Short Answer* A quadratic equation f(x) satisfies f(3) = 4, f(5) = 6, and f(7) = 10. What is the value of f(1)?

ANSWER: 4 [RG]

TOSSUP

16) Biology – *Multiple Choice* Most plants today are classified as C3 plants. However, many plant species have evolved adaptations of photosynthesis in order to increase efficiency. Which of the following most accurately describes the separation of the two phases of photosynthesis in C4 and CAM plants, respectively?

W. Temporally separated in C4 plants, spatially separated in CAM plants
X. Spatially separated in C4 plants, temporally separated in CAM plants
Y. Spatially separated in both C4 and CAM plants
Z. Temporally separated in both C4 and CAM plants

ANSWER: X. Spatially separated in C4 plants, temporally separated in CAM plants [SO]

BONUS

16) Biology – *Short Answer* Identify all of the following three structures which can be found in bacterial chromosomes: 1) origins of replication, 2) telomeres, 3) centromeres.

ANSWER: 1 only [SO]

TOSSUP

17) Chemistry – *Multiple Choice* Cindy graphs an isobar by drawing a straight line on a temperature-volume diagram. Which of the following laws describes movement along this line?
W) Boyle's Law
X) Charles's Law
Y) Gay-Lussac's Law
Z) Avogadro's Law

ANSWER: X) Charles's Law [CZ]

BONUS

17) Chemistry – *Short Answer* What is the electron pair geometry of the sulfite ion, which has formula SO3 2-?

ANSWER: Tetrahedral [CZ]

TOSSUP

18) Physics – *Multiple Choice* Giving your answer to the nearest percent, what is the efficiency of a Carnot heat pump running between two reservoirs of temperature 500 Kelvin and 800 Kelvin?
W) 13%
X) 38%
Y) 63%

Z) 88%

ANSWER: X) 38% [SO]

BONUS

18) Physics – *Short Answer* Connor is observing a particle whose position and velocity he knows exactly. What quantum mechanical principle prevents him from knowing the particle's mass?

ANSWER: HEISENBURG UNCERTAINTY PRINCIPLE [SO]

TOSSUP

19) Earth and Space – *Short Answer* Identify all of the following three spectral classes that are described as red dwarfs: 1) A; 2) G; 3) M.

ANSWER: 3 only [PB]

BONUS

19) Earth and Space – *Multiple Choice* A hurricane approaches a coastline in the northern hemisphere from the east. Where along the hurricane will the storm surge be strongest?

W) Just north of the eye
X) On the northern edge of the storm
Y) Just south of the eye
Z) On the southern edge of the storm

ANSWER: W) Just north of the eye [PB]

TOSSUP

20) Math – *Short Answer* A ball is dropped from a height of 4 meters. On each bounce, it bounces up to 1/3 of the previous height it bounced up to. How many times has it bounced when the ball first fails to bounce to a height of 0.1 meters?

ANSWER: 4 [RG]

BONUS

20) Math – *Short Answer* Define the piecewise function f of x such that if x = 0, f of x = 0, and if x is nonzero, then f(x) = |x|/x [read: absolute value of x divided by x]. What is the integral from -14 to 34 of f(x) dx?

ANSWER: 20 [RG]
