2024 SMH Invitational Cup - ROUND ROBIN 4

TOSSUP

1) Biology – *Short Answer* Identify all of the following three living organisms which can carry out glycolysis.

I. Gallus gallus

II. Washingtonia filifera

III. Amanita muscaria

ANSWER: ALL [SO]

BONUS

1) Biology – *Short Answer* Lydia is trying to count the number of geese in an isolated population. She first captures 20 geese and marks them, then waits for a month. She recaptures 30 geese and notices that 4 of them are marked. What is the estimated number of geese in this population?

ANSWER: 150 [SO]

TOSSUP

2) Chemistry – *Multiple Choice* Which of the following is an intensive property?

W) Concentration

X) Mass

Y) Entropy

Z) Energy

ANSWER: W) Concentration [CZ]

BONUS

2) Chemistry – *Short Answer* What is the differential rate law for the forward reaction with the single elementary step (read 2NOBr yields 2NO + Br2)?

ANSWER: Rate = k[NOBr]^2 [CZ] (Note: also accept only k[NOBr]^2)

TOSSUP

3) Physics – *Multiple Choice* RLC circuits are often used in analog electronics as filters. In these applications, which of the following components of the circuits act as the dampener?
W. Inductor
X. Resistor
Y. Capacitor
Z. Load profiler

ANSWER: X. resistor [DL]

BONUS

3) Physics – *Short Answer* Given that g is equal to 10 meters per second squared, and in meters to two significant figures, what is the range of a particle with mass 3 kilograms shot at an initial velocity of 12 meters per second at an angle of 15 degrees above the horizontal?

ANSWER: 7.2 [SO]

TOSSUP

4) Earth and Space – *Short Answer* Order the following three regions of the solar system by increasing distance from the sun:

1. Kuiper belt
2. Asteroid belt
3. Oort cloud

ANSWER: 213 [DL]

BONUS

4) Earth and Space – *Multiple Choice* The luminosity of a star is proportional to the distance from the star raised to what power?
W) -1
X) -2
Y) -3
Z) -4

ANSWER: X) -2 [PB]

TOSSUP

5) Math – *Multiple Choice* Which of the following is the positive difference between the sum of the roots and the product of the roots of the quadratic polynomial y = x^2 + 3x + 7?
W) 4
X) 6
Y) 8
Z) 10

ANSWER: Z) 10 [RG]

BONUS

5) Math – *Short Answer* Set A contains the positive integers less than or equal to 4 and set B contains the positive integers less than or equal to 5. How many functions exist from set A to set B?

ANSWER: 625 [RG]

TOSSUP

6) Biology – *Multiple Choice* Which of the following primary meristems gives rise to the epiderm?
W) procambium
X) ground meristem
Y) vascular cambium
Z) protoderm

ANSWER: Z) protoderm [SO]

BONUS

6) Biology – *Short Answer* Identify all of the following three neurotransmitters which are excitatory in humans: 1) glycine, 2) GABA, 3) glutamate.

ANSWER: 3 only [SO]

TOSSUP

7) Chemistry – *Multiple Choice* Suzuko is using a graduated cylinder to measure mercury. At which of the following points on the meniscus should Suzuko take the measurement in order to get an accurate value for volume?
W) at the top of the meniscus
X) between the top and the bottom of the meniscus
Y) at the bottom of the meniscus
Z) graduated cylinders do not give accurate measurements

ANSWER: W) at the top of the meniscus [SO]

BONUS

7) Chemistry – *Short Answer* What gas is generated when heavy alkali earth metals, such as barium, react with water?

ANSWER: H2 (accept: hydrogen) [CZ]

TOSSUP

8) Physics – *Short Answer* What particle is involved in beta-plus decay and is the antiparticle of the electron?

ANSWER: POSITRON [SO]

BONUS

8) Physics – *Short Answer* Identify all of the following three combinations of a system and a force for which the conservation of momentum holds: 1) system of two stars and the gravitational force between them, 2) system of two ice skaters and an applied force by one skater upon the other, 3) system of a hydrogen atom and the electromagnetic force exerted on the electron by the nucleus.

ANSWER: ALL [SO]

TOSSUP

9) Earth and Space – *Multiple Choice* Characterized by water cutting across resistant ridges, what drainage system is commonly found in regions with many parallel valleys?
W) dendritic

X) trellis
Y) rectangular
Z) radial

ANSWER: X) Trellis [SO]

BONUS

9) Earth and Space – *Short Answer* Identify all of the following components which are part of the suspended load of a meandering stream: 1) ions, 2) cobbles, 3) silt.

ANSWER: 3 only [SO]

TOSSUP

10) Math – *Short Answer* How many positive integers less than 200 are divisible by 5 but not divisible by 2?

ANSWER: 20 [RG]

BONUS

10) Math – *Short Answer* Rohan uniformly and at random picks a 3 digit positive integer n. What is the probability that both 2n and n/2 are 3-digit positive integers?

ANSWER: 151/900 [RG]

TOSSUP

11) Biology – *Multiple Choice* Which of the following statements is true about respiration in humans?
W) humans have two trachea
X) the majority of gas exchange occurs in the alveoli
Y) the net movement of CO2 is into cells
Z) gas exchange is an example of cotransport

ANSWER: X) the majority of gas exchange occurs in the alveoli [SO]

BONUS

11) Biology – *Short Answer* What substance, produced by the liver and stored in the gallbladder, aids in the digestion of fats?

ANSWER: BILE [SO]

TOSSUP

12) Chemistry – *Multiple Choice* Which currently known element on the periodic table has the largest atomic radius?
W) Helium
X) Oganesson
Y) Cesium
Z) Francium

ANSWER: Z) Francium [DL]

BONUS

12) Chemistry – *Short Answer* Rank the following three elements from least to most unpaired electrons in the ground state:
1) Phosphorus

2) Oxygen
3) Barium

ANSWER: 321 [CZ]

TOSSUP

13) Physics – *Multiple Choice* A 1-ohm resistor, a 2-ohm resistor, and a 3-ohm resistor are placed in series with an ideal 12-volt battery. In volts, what is the voltage across the 2-ohm resistor?
W) 2
X) 4
Y) 6
Z) 8

ANSWER: X) 4 [SO]

BONUS

13) Physics – *Short Answer* A block is completely submerged in water. Identify all of the following three quantities that the buoyant force on the block is dependent on: 1) mass of the block, 2) gravitational acceleration, 3) volume of block that is submerged.

ANSWER: 23 [SO]

TOSSUP

14) Earth and Space – *Short Answer* Higher coal grades such as bituminous and anthracite are characterized by a higher purity of what element?

ANSWER: Carbon [PB]

BONUS

14) Earth and Space – *Short Answer* What type of star cluster is typically made up of old Population II stars strongly bound by gravity in a spheroidal shape?

ANSWER: Globular cluster [PB]

TOSSUP

15) Math – *Multiple Choice* A certain row of Pascal's triangle has 7 elements. Which of the following is the sum of these 7 elements?
W) 49
X) 64
Y) 98
Z) 128

ANSWER: X) 64 [RG]

BONUS

15) Math – *Short Answer* A drawer contains an equal even number of blue and red socks. Given that each sock is equally likely to be chosen, if half of the red socks are removed, what is the ratio of the probability of picking a blue sock after the removal to the probability of picking a blue sock before the removal?

ANSWER: 4/3 [RG]

TOSSUP

16) Biology – *Multiple Choice* Which of the following signallers is released by the adrenal medulla and acts as a vasodilator?
W) cortisol
X) thyroxine
Y) renin
Z) epinephrine

ANSWER: Z) epinephrine [SO]

BONUS

16) Biology – *Short Answer* Neurons produce less ATP per glucose molecule than liver cells. This is because neurons use what less efficient electron carrier to shuttle electrons from glycolysis to the electron transport chain?

ANSWER: FADH2 (DO NOT ACCEPT: FADH) [SO]

TOSSUP

17) Chemistry – *Short Answer* To one significant figure, by what factor is the initial half-life of a zeroth-order reaction multiplied if the original concentration is multiplied by 7?

ANSWER: 7 [CZ]

BONUS

17) Chemistry – *Short Answer* Name all of the following functional groups that can form hydrogen bonds:
1) Alcohol
2) Amine
3) Thiol

ANSWER: 1 and 2 [CZ]

TOSSUP

18) Physics – *Multiple Choice* Which of the following best describes the forces on an object moving in a circular path at a constant speed away from any gravitational interaction?

W. there are no forces since speed is constant
X. there is a centrifugal force and a centripetal force that cancel each other out
Y. there is a centripetal force that provides inwards acceleration
Z. there is a centrifugal force that provides inwards acceleration

ANSWER: Y. there is a centripetal force that provides inwards acceleration [DL]

BONUS

18) Physics – *Short Answer* Identify all of the following three results that support the particle nature of light: 1) photoelectric effect, 2) Young's double slit experiment, 3) Compton scattering.

ANSWER: 1 and 3 [SO]

TOSSUP

19) Earth and Space – *Multiple Choice* Which of the following terms describes the relationship between calcite and aragonite, which share the same chemical formula but different crystal structures?

W) Allotropes
X) Isomers
Y) Isotopes

Z) Polymorphs

ANSWER: Z) Polymorphs [PB]

BONUS

19) Earth and Space – *Short Answer* What phenomenon, occurring in refracting telescopes, creates imperfect images due to the uneven alignment of rays at the focus?

ANSWER: Spherical aberration [CC]

TOSSUP

20) Math – *Short Answer* Alice, Bob, Charles, David, and Euna are standing in a line. How many ways can they stand if Bob, Charles, and David all refuse to stand next to each other?

ANSWER: 12 [SO, CZ]

BONUS

20) Math – *Short Answer* Among all integers x and y, what is the minimum positive integer value that 9x + 24y can take?

ANSWER: 3 [RG]
