2024 SMH Invitational Cup - ROUND ROBIN 2

TOSSUP

1) Biology – *Short Answer* What class of plant hormones, responsible for foolish seedling disease, stimulates stem elongation through both cell division and cell elongation?

ANSWER: gibberellins [SO]

BONUS

1) Biology – *Multiple Choice* Lily and James' son, Harry, has the X-linked disorder hemophilia, despite both parents being unaffected. What is the probability that Lily and James' next child is a daughter with hemophilia?
W) 0
X) 1/4
Y) 1/2
Z) 3/4

ANSWER: W) 0 [SO]

TOSSUP

2) Chemistry – *Multiple Choice* Which of the following techniques would a burette most likely be used for?
W) distillation
X) titration
Y) chromatography
Z) calorimetry

ANSWER: X) titration [SO]

BONUS

2) Chemistry – *Short Answer* The reaction A yields 2B + C has a standard enthalpy of reaction of -400 kilojoules per mole and the reaction 2D yields 3A has a standard enthalpy of reaction of -500 kilojoules per mole. What is the enthalpy change of the reaction: 4B + 2C + 4D yields 8A?

ANSWER: -200 [CZ]

TOSSUP

3) Physics – *Multiple Choice* A pressure sensor is slowly lowered into a container filled with an incompressible fluid. When the measured pressure is plotted against depth, which of the following graphs results?
W) logarithmic
X) exponential
Y) linear
Z) quadratic

ANSWER: Y) linear [SO]

BONUS

3) Physics – *Short Answer* A circuit consists of two resistors in parallel connected to a battery. If the two resistors have different resistances, identify all of the following three quantities that are the same across both resistors: 1) current, 2) voltage, 3) power dissipated.

ANSWER: 2 ONLY [SO]

TOSSUP

4) Earth and Space – *Short Answer* Order the following three minerals by increasing hardness: 1) calcite, 2) quartz, 3) orthoclase.

ANSWER: 132 [SO]

BONUS

4) Earth and Space – *Short Answer* Earth's Van Allen belts form when the magnetosphere captures charged particles from what solar system phenomenon?

ANSWER: Solar wind [PB]

TOSSUP

5) Math – *Short Answer* Chords AB and CD intersect inside a circle at point X. If AX = BX, CX = 2, and DX = 32, then what is the length of chord AB?

ANSWER: 16 [RG]

BONUS

5) Math – *Short Answer* Giving your answer in standard form, what is the equation of the line perpendicular to x - 2y = 7, given that the two lines intersect at (9,1)?

ANSWER: 2x + y = 19 [RG]

TOSSUP

6) Biology – *Multiple Choice* Carcinomas are tumors that form in what type of tissue?
W) connective
X) epithelial
Y) nervous
Z) muscle

ANSWER: X) EPITHELIAL [SO]

BONUS

6) Biology – *Short Answer* Order the following three blood vessel types by increasing velocity of the blood flowing through them: 1) arteries, 2) veins, 3) capillaries.

ANSWER: 321 [SO]

TOSSUP

7) Chemistry – *Multiple Choice* Which of the following ions is the most effective reducing agent?
W) Mn^{7+}
X) Mn^{5+}
Y) Mn^{4+}
Z) Mn^{2+}

ANSWER: Z) Mn^{2+} [CZ]

BONUS

7) Chemistry – *Multiple Choice* Which of the following compounds has the highest specific heat?
W) aluminum
X) liquid water
Y) graphite
Z) granite

ANSWER: X) liquid water [SO]

TOSSUP

8) Physics – *Multiple Choice* Naomi has attached a rock of mass m to a massless string, which she holds in her hand. Assuming the rock is acted upon only by tension and gravity, if Naomi lowers her hand at constant velocity, which of the following is most accurate regarding the magnitude of the tension in the string?
W) equal to 0
X) greater than 0 and less than mg
Y) equal to mg
Z) greater than mg

ANSWER: Y) equal to mg [SO]

BONUS

8) Physics – *Short Answer* Peter has obtained a 6-farad air capacitor with square parallel plates. If the air is replaced by a dielectric with kappa equals 1.5, and the side lengths of the plates are all doubled, what is the new capacitance of his capacitor?

ANSWER: 36 [SO]

TOSSUP

9) Earth and Space – *Multiple Choice* As sea ice forms, salts are excluded and dissolve in the remaining water, and the newly dense water mass flows down. A new, less saline water mass rises up, which is more conducive to sea ice formation. This is an example of which of the following?

W) Negative feedback
X) Positive feedback
Y) Negative feedforward
Z) Positive feedforward

ANSWER: X) Positive feedback [SO]

BONUS

9) Earth and Space – *Short Answer* What element typically makes up the core of a star just before it undergoes a type 2 supernova?

ANSWER: Iron [PB]

TOSSUP

10) Math – *Short Answer* In a pile of red, blue, and green socks, the probability of picking a red sock is 1/3 and the probability of picking a blue sock is 1/2. If there are 12 green socks in the pile, how many total socks are there in the pile?

ANSWER: 72 [RG]

BONUS

10) Math – *Multiple Choice* If a convex polygon has perimeter 12, then which of the following inequalities best represents the possible values for the area A of the polygon?
W) 0 is less than A which is less than 36
X) 0 is less than A which is less than or equal to 36
Y) 0 is less than A which is less than 36/pi
Z) 0 is less than A which is less than or equal to 36/pi

ANSWER: Y) 0 is less than A which is less than 36/pi [RG]

TOSSUP

11) Biology – *Short Answer* Identify all of the following 3 structures which serve to increase membrane surface area: 1) mitochondrial cristae (READ: KRIS-TEE), 2) gastric microvilli, 3) bacterial flagella.

ANSWER: 1 and 2 [SO]

BONUS

11) Biology – *Multiple Choice* Why are red algae in deeper waters more red than those in shallower waters?
W) red light penetrates deeper into water
X) green light penetrates deeper into water
Y) red light carries more energy
Z) green light is more efficient at splitting water

ANSWER: X) GREEN LIGHT PENETRATES DEEPER INTO WATER [SO]

TOSSUP

12) Chemistry – *Short Answer* What quantum mechanical principle explains why the valence electron in lithium fills the 2s subshell instead of the 2p subshell?

ANSWER: Aufbau principle [CZ]

BONUS

12) Chemistry – *Multiple Choice* Which of the following VSEPR geometries has a steric number of 4?

W) trigonal pyramidal

X) seesaw

Y) square planar

Z) trigonal bipyramidal

ANSWER: W) trigonal pyramidal [CZ]

TOSSUP

13) Physics – *Short Answer* Daniel is a sneaky man who stands behind corners and eavesdrops on others' conversations. What phenomenon of wave dispersion allows him to hear the sound waves coming from behind the corner?

ANSWER: Diffraction [DL]

BONUS

13) Physics – *Short Answer* A light ray with a frequency of 20 hertz and a wavelength of W travels through vacuum. If another light ray with a frequency of 60 hertz travels through a medium with an index of refraction of 2, then in terms of W, what is its wavelength?

ANSWER: W/6 [SO]

TOSSUP

14) Earth and Space – *Short Answer* Novae are small outbursts caused by mass transfer onto what type of star?

ANSWER: White dwarf [PB]

BONUS

14) Earth and Space – *Multiple Choice* Which of the following quantities increases as waves encounter shallow water?
W) Wave speed
X) Wavelength
Y) Wave height
Z) Water viscosity

ANSWER: Y) Wave height [SO]

TOSSUP

15) Math – *Multiple Choice* A twice-differentiable function f of x has f of 0 equals 20 and f of 20 equals 220. Which of the following values must f prime of x take in the interval from 0 to 20?
W) 2
X) 10
Y) 20
Z) 40

ANSWER: X) 10 [RG]

BONUS

15) Math – *Short Answer* A point is randomly picked inside a unit square. What is the probability the distance to the closest side is less than 1/3?

ANSWER: 8/9 [RG]

TOSSUP

16) Biology – *Multiple Choice* Boheng is investigating oxidative phosphorylation. They design a proton pump inhibitor and target it towards complex 1 of the electron transport chain. Which of the following would happen to ATP production in this cell?
W) increase
X) decrease
Y) stay the same
Z) stop completely

ANSWER: X) decrease [SO]

BONUS

16) Biology – *Short Answer* Botulism exerts its paralytic effects by preventing the release of what neurotransmitter?

ANSWER: ACETYLCHOLINE [SO]

TOSSUP

17) Chemistry – *Short Answer* When a solution with an oxidizing reagent is connected to a solution with a reducing agent, no electrons can flow and charge builds up. In galvanic cells, this is remedied by what electrolyte-filled connector?

ANSWER: salt bridge [CZ]

BONUS

17) Chemistry – *Short Answer* Nitrogen dioxide dimerizes to dinitrogen tetroxide in an exothermic reaction. Name all of the following three changes that will result in higher nitrogen dioxide concentration at equilibrium:
1) Increase in temperature
2) Addition of neon gas
3) Decrease in volume

ANSWER: 1 only [CZ]

TOSSUP

18) Physics – *Multiple Choice* Which of the following functions of position is characteristic of simple harmonic motion?
W. x of t = A
X. x of t = At + B
Y. x of t = At squared + Bt + C
Z. x of t = A cosine of Bt

ANSWER: Z. x of t = A cosine of Bt [DL]

BONUS

18) Physics – *Short Answer* A ball with mass 4 kilograms lies at rest on a frictionless plane. A constant force with magnitude 6 N acts on the ball. In meters per second, what is the speed of the ball after the force pushes the ball over a distance of 5 meters?

ANSWER: sqrt(15) [SO]

TOSSUP

19) Earth and Space – *Short Answer* What term describes the rapid ignition of the triple alpha process in the helium core of a large red giant?

ANSWER: Helium flash [PB]

BONUS

19) Earth and Space – *Short Answer* What property, often measured at various points in a stream, describes the volume of water that flows past a point per unit time?

ANSWER: Discharge [SO]

TOSSUP

20) Math – *Short Answer* Identify all of the following 3 positive integers which have exactly 6 positive integer factors.
1) 12
2) 16
3) 20

ANSWER: 1 and 3 [RG]

BONUS

20) Math – *Short Answer* Consider the graph of y = xe^x [read: x times e to the power of x]. What is the slope of the line tangent to the graph at x = 3?

ANSWER: 4e^3 [RG]
