Science Bowl Discord Winter Tournament Tesla

TOSS-UP

1) Biology – *Short Answer* In noncyclic electron flow, what is the final electron acceptor of Photosystem 1?

ANSWER: $NADP^+$

BONUS

1) Biology – *Multiple Choice* Which of the following least accurately describes archaea?

W) Their cell membranes are phospholipid monolayers
X) Fatty acids in their cell membranes are linked with ester bonds
Y) They are more tolerant to high salinity than most eubacteria
Z) Their cell walls contain pseudopeptidoglycan

ANSWER: X) FATTY ACIDS IN THEIR CELL MEMBRANES ARE LINKED WITH ESTER BONDS

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TOSS-UP

2) Earth and Space – *Short Answer* Which of the following 3 statements is true about Antarctic Bottom Water, or AABW? 1) Temperatures range from -4 to -0.5 degrees C; 2) It is formed from surface water cooling in polynyas and near the ice shelf; 3) Recent climate change and consequent melting of the Antarctic ice sheet has slowed the formation of AABW.

ANSWER: 2, 3

BONUS

2) Earth and Space – *Short Answer* What is the primary mechanism that removes star forming gas from a galaxy when it moves towards the center of a galaxy cluster?

ANSWER: RAM PRESSURE STRIPPING (ACCEPT: RAM PRESSURE)
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TOSS-UP

3) Physics – *Short Answer* A 5 kg box moving at 4 m/s collides inelastically with a stationary 3 kg box. What is the final velocity of the boxes?

ANSWER: 2.5 m/s

BONUS

3) Physics – *Short Answer* A 3 cubic meter block is submerged half in oil and half in water, and is in static equilibrium. If the density of water is 1000 kg/m^3 and the density of oil is 800 kg/m^3, what is the mass of the block?

ANSWER: 2700 kg

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TOSS-UP

4) Math – *Short Answer* A string of 3 letters, each letter being A or B is randomly chosen. What is the probability of having more B's than A's in the string?

ANSWER: 1/2

BONUS

4) Math – *Multiple Choice* Which of the following best describes the Euclidean Algorithm for finding the greatest common divisor of two numbers?

W) Prime factorize each of the numbers and pick the primes out
X) Multiply both of the numbers and divide by the least common multiple
Y) Using remainders by dividing the larger by the smaller and repeating
Z) Multiply both the numbers and divide by their difference

ANSWER: Y) USING REMAINDERS BY DIVIDING THE LARGER BY THE SMALLING AND REPEATING
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TOSS-UP

5) Chemistry – *Short Answer* Which of the following is true about solid solutions? 1) The exsolution of solid solutions forms lamellae that are characterized by differing cation size; 2) The lowest melting of a solid solution is usually near an endmember; 3) The Hume-Rothery rules govern the formation of solid solutions based on similar electronegativities and atomic radii.

ANSWER: 1, 3

BONUS

5) Chemistry – *Short Answer* Which of the following is true about the addition of oxygen to a Grignard reagent? 1) radical intermediates are formed; 2) a magnesium organoperoxide is formed; 3) the halide is removed as an anion

ANSWER: 1, 2

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TOSS-UP

6) Biology – *Short Answer* What bond links the phosphates of an ATP molecule?

ANSWER: PHOSPHOANHYDRIDE BONDS

BONUS

6) Biology – *Short Answer* What class of noncoding RNAs are utilized in CRISPR systems to guide the endonuclease complex to the target sequence?

ANSWER: GUIDE RNA (ACCEPT: gRNA)
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TOSS-UP

7) Earth and Space – *Multiple Choice* Which of the following igneous structures is a small batholith-like discordant intrusion?

W) Laccolith
X) Stock
Y) Lopolith
Z) Sphere dike

ANSWER: X) STOCK

BONUS

7) Earth and Space – *Short Answer* Order the following minerals in terms of increasing relative stability at standard temperature and pressure: 1) vermiculite; 2) magnesiowustite; 3) sillimanite; 4) andalusite

ANSWER: 2, 3, 4, 1

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TOSS-UP

8) Physics – *Short Answer* Which fundamental force violates charge parity?

ANSWER: WEAK NUCLEAR FORCE

BONUS

8) Physics – *Short Answer* A hollow, air cored inductor coil consists of 200 turns of copper wire, which produces a magnetic flux of 6 milliwebers when passing a DC current of 10 amps. Calculate the self-inductance of the coil in milli-Henries.

ANSWER: 120 mH
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TOSS-UP

9) Math – *Short Answer* What is the period of the function $f(x) = sin^2(x) * cos^2(x)$?

ANSWER: π/2

BONUS

9) Math – *Short Answer* What is the area between the curves $y = x^3$ and $y = x + 2$ between $x = 0$ and $x = 1$?

ANSWER: 9/4 (ACCEPT: 2 ¼, 2.25)

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TOSS-UP

10) Chemistry – *Multiple Choice* Which of the following cations is the most stable?

W) Al^+
X) Ga^+
Y) In^+
Z) Tl^+

ANSWER: Z) Tl^+

BONUS

10) Chemistry – *Short Answer* What important metal oxide is used to oxidize alkenes into *vic* diols, also used as a staining agent in TEM to provide contrast to the image?

ANSWER: OSMIUM TETROXIDE (ACCEPT: OsO4, osmium (VIII) oxide)
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TOSS-UP

11) Biology – *Multiple Choice* PIN Proteins in plants are associated with the transport of what major plant hormone?

W) Auxins
X) Gibberellins
Y) Cytokinins
Z) Ethylene

ANSWER: W) AUXINS

BONUS

11) Biology – *Multiple Choice* The first step of the Calvin cycle, catalyzed by Rubisco, forms what molecule?

W) 1,5-Bisphosphate
X) 3-Phosphoglycerate
Y) 1,3-Bisphosphoglycerate
Z) Glyceraldehyde 3-Phosphate

ANSWER: X) 3-PHOSPHOGLYCERATE

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TOSS-UP

12) Earth and Space – *Multiple Choice* Which of the following minerals cannot be mined as a source of copper?

W) Chalcopyrite
X) Azurite
Y) Bornite
Z) Pentlandite

ANSWER: Z) PENTLANDITE

BONUS

12) Earth and Space – *Short Answer* Which of the following statements about important angles in structural geology is true? 1) true dip is always greater than apparent dip; 2) trend is equal to strike if the ground surface is parallel to the horizontal plane; 3) plunge is measured along the limb of a fold

ANSWER: 1, 2, 3 (ACCEPT: ALL)
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TOSS-UP

13) Physics – *Short Answer* When a free neutron decays into a proton via beta minus decay, what particle mediates the flavor change from the down quark into an up quark?

ANSWER: W^- BOSON

BONUS

13) Physics – *Short Answer* A particular planet has mass 7.0×10^{23} kg and a radius of $2.0 \times 10^{6}\ m$. What is the escape velocity, in meters per second, on this planet? Take G to be $7 \times 10^{-11}\ Nm^2kg^{-2}$ (Read as: Newton meters squared per kilogram squared)

ANSWER: 7,000 m/s

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TOSS-UP

14) Math – *Multiple Choice* Which of the following is equivalent to $cosh(2x)$?

W) $sinh^2(2x)$
X) $1 + 2sinh^2(x)$
Y) $2sinh(x)cosh(x)$
Z) $sinh^2(x)$

ANSWER: X) $1 + 2sinh^2(x)$

BONUS

13) Math – *Short Answer* What is the sum of the values in the matrix that results from the multiplication of a 2 by 3 matrix with all values being 6 and a 3 by 2 matrix with all values being 7?

ANSWER: 126
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TOSS-UP

15) Chemistry – *Short Answer* What quantity describes useful work obtained from a closed isothermal and isochoric system?

ANSWER: HELMHOLTZ FREE ENERGY

BONUS

15) Chemistry – *Short Answer* Even as aromatic rings are interrupted by an sp3 carbon atom, they can still maintain aromaticity through what mechanism, seen in molecules like $C_8H_9^+$?

ANSWER: HOMOAROMATICITY

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TOSS-UP

16) Biology – *Multiple Choice* Which of the following gives myelin its characteristic white color?

W) Water
X) Proteins
Y) Phospholipids
Z) Glycolipids

ANSWER: Z) GLYCOLIPIDS

(Fun fact: the main glycolipid of myelin is galactocerebroside!)

BONUS

16) Biology – *Short Answer* What oval-shaped mechanoreceptor is located in the Stratum basale of the skin and is essential for light touch sensation?

ANSWER: MERKEL CELLS (ACCEPT: MERKEL-RANVIER CELLS, TACTILE EPITHELIAL CELLS)
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TOSS-UP

17) Earth and Space – *Multiple Choice* The phase transition of spinel structured ringwoodite into the denser perovskite phases of magnesiowustite and bridgmanite occurs at which of the following depths?

W) 100 km
X) 220 km
Y) 410 km
Z) 660 km

ANSWER: Z) 660 km

BONUS

17) Earth and Space – *Multiple Choice* In stars above 0.3 solar masses, what is the transition layer between the radiative zone and convective zone, representing significant rotational shear between the two layers?

ANSWER: TACHOCLINE

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TOSS-UP

18) Physics – *Short Answer* An ideal refrigerator is operating between temperatures of 27 degrees celsius and 77 degrees celsius. What is the coefficient of performance of this refrigerator?

ANSWER: 7

BONUS

18) Physics – Short Answer A ball with moment of inertia (2/5)mr^2 rolls down a 30 degree inclined plane. What is its acceleration?

ANSWER: 3.5 m/s^2
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TOSS-UP

19) Math – *Short Answer* 5 students are sitting at a round table. How many seatings are possible if rotations are indistinct?

ANSWER: 24

BONUS

19) Math – *Short Answer* What is the area of a triangle with side lengths of 13, 14, and 15?

ANSWER: 84

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TOSS-UP

20) Chemistry – *Multiple Choice* Which of the following solids has a zincblende structure?

W) Sodium fluoride
X) Gallium arsenide
Y) Caesium chloride
Z) Silver chloride

ANSWER: X) GALLIUM ARSENIDE

BONUS

20) Chemistry – *Short Answer* Assuming there are no rings or triple bonds, how many double bonds are present in the molecule $C_{12}H_{15}O_2Cl$?

ANSWER: 5
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