SSBT Playoffs Round 5

TOSS-UP

1) Earth and Space – *Short Answer* A sandy desert loses its source of deposition, causing the wind to remove lighter material from the surface without replacement. This erosion leaves behind a layer of large sediment and pebbles, which is typically given what name?

ANSWER: DESERT PAVEMENT

BONUS

1) Earth and Space – *Short Answer* Stars in the instability strip pulsate due to the double ionization of what element?

ANSWER: HELIUM

TOSS-UP

2) Biology – *Multiple Choice* Which of the following terms is used to describe a prey or harmless species which imitates a more dangerous species which it is not closely related to?

W) Batesian mimicry

X) Mullerian mimicry

Y) Cryptic coloration

Z) Aposematic coloration

ANSWER: W) BATESIAN MIMICRY

BONUS

2) Biology – *Multiple Choice* Which of the following statements is NOT TRUE about the central dogma of biology?

W) The spliceosome is made up of an RNA-protein complex which mediates the removal of introns

X) Wobble base pairing is generally found at the first nucleotide of a codon in mRNA

Y) rRNAs are thought to form the core structure of the ribosome

Z) tRNAs contain non-canonical nitrogenous bases not commonly found in other RNAs

ANSWER: X) WOBBLE BASE PAIRING IS GENERALLY FOUND AT THE FIRST NUCLEOTIDE OF A CODON IN MRNA

TOSS-UP

3) Math – *Short Answer* Two regular hexagons are drawn such that the vertices of one are the midpoints of the other. What is the ratio of the area of the smaller hexagon to that of the larger hexagon?

ANSWER: 3/4

BONUS

3) Math – *Short Answer* A cube is inscribed inside a sphere which is inscribed inside a cube with side length 12. What is the side length of the smaller cube?

ANSWER: $4\sqrt{3}$

TOSS-UP

4) Chemistry – *Short Answer* Order the following three solvents in terms of increasing rate of ionization of an alkyl halide in solution: 1) Acetone; 2) Water; 3) Dimethyl ether.

ANSWER: 3, 1, 2

BONUS

4) Chemistry – *Short Answer* Identify all of the following three statements are true regarding ionization of alkyl halides: 1) Alkyl fluorides undergo ionization more readily than alkyl chlorides; 2) Polar aprotic solvents are more suitable than polar protic solvents for ionizing an alkyl halide; 3) Methyl alkyl halides produce the most stable carbocations of the alkyl halides.

ANSWER: NONE

TOSS-UP

5) Physics – *Multiple Choice* Which of the following materials has the greatest conductivity?

W) Aluminum

X) Gold

Y) Nickel

Z) Calcium

ANSWER: X) GOLD

BONUS

5) Physics – *Short Answer* A 25kg mass attached to a spring is moving linearly in simple harmonic motion on a frictionless surface. If the maximum displacement from rest is 4m and the spring constant is 9 N/m, what is the maximum velocity the mass can reach in meters per second?

ANSWER: 2.4 (ACCEPT: 12/5)

TOSS-UP

6) Earth and Space – *Short Answer* Around a small volcano, the ash released from eruptions may deposit and compact to form what relatively soft, porous rock?

ANSWER: TUFF

BONUS

6) Earth and Space – *Multiple Choice* In coastal California, the accretion of sediment during subduction has led to the formation of various parallel ridges formed from folded sedimentary rock. Which of the following drainage patterns would you expect to see in this region?

W) Dendritic

X) Trellis

Y) Rectangular

Z) Radial

ANSWER: X) TRELLIS

TOSS-UP

7) Biology – *Short Answer* What structure located in the epithalamus plays a crucial role in circadian rhythm by secreting melatonin?

ANSWER: PINEAL GLAND

BONUS

7) Biology - *Short Answer* As the postganglionic autonomic neuron enters smooth muscle, it splits into branches with each branch containing a swollen region containing vesicles filled with neurotransmitters. What is the name of these swollen regions?

ANSWER: VARICOSITIES

TOSS-UP

8) Math – *Short Answer* A man bikes a 4 mile path from his house to the store at an average speed of 12 mph and bikes back at an average speed of 16 mph. What is the man's average speed in mph for his round trip?

ANSWER: 96/7

BONUS

8) Math – *Short Answer* How many 7-digit palindromes are there such that at least two adjacent digits are the same?

ANSWER: 2439

TOSS-UP

9) Chemistry – *Short Answer* Rank the following molecules in order of increasing heat of combustion: 1) Cyclopropane; 2) Trans-2-Butene; 3) Cis-2-Butene.

ANSWER: 2, 3, 1

BONUS

9) Chemistry – *Short Answer* How many double bonds are in a molecule of biphenyl?

ANSWER: 6

TOSS-UP

10) Physics – *Short Answer* A wave is produced at a point source and travels in all directions. How many times larger is the intensity of the wave at a point 3 meters from the source compared to a point 8 meters from the source?

ANSWER: 64/9

BONUS

10) Physics – *Short Answer* A car rides along a banked curve of radius 10 m making an angle of 45 degrees to the ground. Assuming g is 10 m/s^2, what velocity in m/s must the car move in order to not slide up or down?

ANSWER: 10

TOSS-UP

11) Energy – *Short Answer* Researchers from around the world are studying Saccorhytus, a group of organisms with a large mouth surrounded by spines but with no developed anus. They recently concluded that Saccorhytus do not belong to what group of animals, known to develop their anus before their mouths during embryonic development?

ANSWER: DEUTEROSTOMES

BONUS

11) Energy – *Short Answer* A recent study discovered that a group of cells donate their mitochondria to damaged neurons after a brain hemorrhage in order to stimulate production of manganese superoxide dismutase, neutralizing free radicals. What is the name of this group of brain support cells?

ANSWER: ASTROCYTES

TOSS-UP

12) Earth and Space – *Multiple Choice* In igneous rocks, magnesium often substitutes for which of the following ions?

W) K^+

X) Cu^+

Y) Fe^{2+}

Z) Fe^{3+}

ANSWER: Y) FE^{2+}

BONUS

12) Earth and Space – *Short Answer* Identify all of the following three regions of the atmosphere that are always convectively stable: 1) Troposphere; 2) Stratosphere; 3) Mesosphere.

ANSWER: 2 ONLY

TOSS-UP

13) Biology – *Multiple Choice* What class of plant hormones is sprayed on produce to keep it ripe?

W) Auxins

X) Gibberellins

Y) Cytokines

Z) Ethylene

ANSWER: Z) ETHYLENE

BONUS

13) Biology- *Short Answer* What is the name of the mechanoreceptors which are phasic and detect gross pressure changes and vibrations in the skin?

ANSWER: PACINIAN CORPUSCLE (ACCEPT: LAMELLAR CORPUSCLE, VATER-PACINI CORPUSCLE)

TOSS-UP

14) Math – *Short Answer* A biker bikes at a constant speed of 8 m/s uphill and 16 m/s downhill. If the biker spends 6 seconds biking uphill and 10 seconds biking downhill on a trail, how long in seconds will the biker spend on hills if he bikes the whole way back to where he started?

ANSWER: 23

BONUS

14) Math – *Short Answer* If a, b, c, and d are the roots of the polynomial $4x^4 + 5x^2 + 5x - 13$, what is the value of $a^2 + b^2 + c^2 + d^2$?

ANSWER: -5/2 (ACCEPT: -2.5)

TOSS-UP

15) Chemistry - *Short Answer* What is the hybridization of iodine in iodine trichloride?

ANSWER: SP^3D

BONUS

15) Chemistry – *Multiple Choice* Which of the following is not true regarding a racemic mixture?

W) Racemic mixtures are optically active

X) The percent enantiomeric excess of a racemic mixture is 0%

Y) Racemic mixtures are identical to their pure enantiomer components in physical properties

Z) Racemic mixtures are composed of equal amounts of enantiomers

ANSWER: W) RACEMIC MIXTURES ARE OPTICALLY ACTIVE

TOSS UP

16) Physics – *Short Answer* Identify all of the following 3 color charges that a quark may have: 1) Red; 2) Yellow; 3) Green.

ANSWER: 1 AND 3

BONUS

16) Physics – *Multiple Choice* Which of the following bosons can exist in two oppositely charged states?

W) Gluon

X) W Boson

Y) Higgs Boson

Z) Z Boson

ANSWER: X) W BOSON

TOSS-UP

17) Energy – *Short Answer* Researchers at Brookhaven National Lab are developing new drugs to slow the replication of COVID-19 by preventing the cleaving of bonds in protein chains produced by infected cells. What group of enzymes are these researchers targeting?

ANSWER: PROTEASES

BONUS

17) Energy – *Short Answer* Researchers at Argonne National Lab are using new imaging techniques to observe ultrafast phase transitions at a 25 nanometer resolution. Identify all of the following three regions of the electromagnetic spectrum that would be appropriate for this imaging: 1) Visible; 2) Ultraviolet; 3) X-ray.

ANSWER: 3 ONLY

TOSS-UP

18) Earth and Space – *Short Answer* Identify all of the following three types of plate boundaries that a Wadati-Benioff zone would be present in: 1) Convergent; 2) Divergent; 3) Transform.

ANSWER: 1 ONLY

BONUS

18) Earth and Space – *Short Answer* Identify all of the following three types of variable stars that are considered intrinsic variables: 1) Eclipsing binaries; 2) Rotating variables; 3) Eruptive variables.

ANSWER: 3 ONLY

TOSS-UP

19) Biology – *Multiple Choice* Which of the following is NOT a characteristic of r-selected species?

W) Quick reproduction

X) Low survival rate of newborns

Y) Intensive parental care

Z) Large number of offspring per birth

ANSWER: Y) INTENSIVE PARENTAL CARE

BONUS

19) Biology – *Short Answer* Identify all of the following three enzymes that are involved in protein folding: 1) Hsp70 family proteins; 2) Protein disulfide isomerase; 3) Peptide prolyl cis-trans isomerase.

ANSWER: ALL

TOSS-UP

20) Math – *Short Answer* What is the partial derivative of $24x^2y^5$ with respect to x?

ANSWER: $48xy^5$

BONUS

20) Math – *Multiple Choice* Positive real numbers x and y exist such that log base x of y is equal to log base y of x. Which of the following best describes the graph plotting all solutions for x and y?

W) A straight line

X) Two straight lines perpendicular to each other

Y) A straight line and a hyperbola

Z) A hyperbola

ANSWER: Y) A STRAIGHT LINE AND A HYPERBOLA

TOSS-UP

21) Chemistry – *Short Answer* What radioactive isotope remains following electron capture in Beryllium 7?

ANSWER: BORON-7

BONUS

21) Chemistry - *Multiple Choice* Which of the following is the reaction that occurs in the first elementary step of the reaction between 2-bromo-2-methyl-butane and sodium cyanide?

W) Nucleophilic attack

X) Hydride shift

Y) Loss of a leaving group

Z) Proton transfer

ANSWER: Y) LOSS OF A LEAVING GROUP

TOSS UP

22) Physics – *Multiple Choice* Which of the following is the most accurate description of the subatomic particle known as a meson?

W) Mesons consist of a quark-antiquark pair interacting with the strong force

X) Pentaquarks are examples of mesons

Y) The meson is a heavier cousin of the electron

Z) Mesons only interact via the strong force

ANSWER: W) MESONS CONSIST OF A QUARK-ANTIQUARK PAIR INTERACTING WITH THE STRONG FORCE

BONUS

22) Physics – *Short Answer* How many up quarks can be found in an atom of Lithium-6?

ANSWER: 9

TOSS-UP

23) Energy – *Multiple Choice* Researchers at Brookhaven National Lab are testing the decomposition of methanol with various catalysts due to its potential viability as a method of storing hydrogen in a liquid form. Which of the following is closest to the mass percent of hydrogen in methanol?

W) 13%

X) 25%

Y) 40%

Z) 67%

ANSWER: W) 13%

BONUS

23) Energy – *Short Answer* Researchers at Oak Ridge National Lab are studying the conductive properties of perovskite materials. Which of the following is NOT a compound these researchers are studying?

W) $SrCoO_3$

X) $SrFeO_3$

Y) $LaNiO_3$

Z) $RbNO_3$

ANSWER: Z) $RbNO_3$