BSB ROUND 8

TOSS-UP

1) Physics – *Multiple Choice* Which of the following types of mirrors will not suffer from spherical aberration or chromatic aberration?

W) Spherical
X) Linear
Y) Parabolic
Z) All mirrors suffer from chromatic aberration

ANSWER: Y) PARABOLIC

BONUS

1) Physics – *Short Answer* Order the following three materials in order of increasing Young's modulus: 1) Aluminum; 2) Bone; 3) Steel.

ANSWER: 2, 1, 3

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TOSS-UP

2) Earth and Space – *Multiple Choice* Which of the following correctly describes the tectonic plate combination needed in the formation of island arcs?

W) Oceanic and continental divergence
X) Continental and continental divergence
Y) Oceanic and continental convergence
Z) Oceanic and oceanic convergence

ANSWER: Z) OCEANIC AND OCEANIC CONVERGENCE

BONUS

2) Earth and Space – *Short Answer* Which layer of the atmosphere is the highest altitude at which you would expect to find a weather balloon?

ANSWER: STRATOSPHERE
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TOSS-UP

3) Chemistry – *Short Answer* Identify all of the following three silver salts that are soluble in water: 1) Silver nitrate; 2) Silver fluoride; 3) Silver iodide.

ANSWER: 1 AND 2

BONUS

3) Chemistry – *Short Answer* A monolayer of nitrogen atoms at a pressure of 1 atmosphere adsorbs to a catalyst surface with an area of 5 centimeters squared. The nitrogen monolayer covers an area of 1 centimeter squared. If the standard pressure is 1 atmosphere, what is the equilibrium constant for nitrogen adsorption to this surface?

ANSWER: 0.25

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TOSS-UP

4) Biology – *Short Answer* What muscle tissue is found in the walls of the digestive tract, urinary bladder, arteries, and other internal organs?

ANSWER: SMOOTH

BONUS

4) Biology – *Short Answer* Carbamoyl-phosphate, arginine, and ornithine, are all molecules involved in what biochemical cycle?

ANSWER: UREA CYCLE
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TOSS-UP

5) Energy – *Multiple Choice* Scientists in the DuPage Lab at UC Berkeley are studying a new strategy to reprogram regulatory T cells from an immunosuppressive to pro-inflammatory state within the tumor microenvironment. Which of the following cells is considered a part of the innate immune response and does not require activation by specific antigens?

W) CD4+ T cells
X) CD8+ T cells
Y) Natural killer cells
Z) B cells

ANSWER: Y) NATURAL KILLER CELLS

BONUS

5) Energy – *Multiple Choice* Researchers in the Kuriyan Lab at UC Berkeley have synthesized and characterized proteins involved in the clamp-loading process of DNA replication. One of the most common structural motifs in these proteins is the alpha helix, which is most likely to contain which of the following amino acids?

W) Histidine
X) Glycine
Y) Proline
Z) Alanine

ANSWER: Z) ALANINE

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TOSS-UP

6) Math – *Short Answer* What is 7 factorial divided by 5?

ANSWER: 1,008

BONUS

6) Math – *Short Answer* What is the population standard deviation for the following list of 5 numbers: 11, 2, 3, 5, and 4?

ANSWER: SQUARE ROOT OF 10
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TOSS-UP

7) Energy – *Short Answer* Scientists in the Brooks Lab at UC Berkeley are studying isomerases involved in the transformation between aldoses and ketoses in biochemical pathways. Identify all of the following three sugars that are ketoses: 1) Glucose; 2) Ribose; 3) Fructose.

ANSWER: 3 ONLY

BONUS

7) Energy – *Short Answer* Scientists in the Neumark Group at UC Berkeley study how molecular beams scatter off liquid jets. The density function for the proportion of the species that scatters at a given angle from the jet is equal to the cosine of theta times what factor?

ANSWER: 1/2

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TOSS-UP

8) Biology – *Multiple Choice* Which of the following statements describes the difference between competitive and noncompetitive inhibition in enzyme-catalyzed reactions?

W) Competitive inhibitors bind irreversibly to the active site of an enzyme, while noncompetitive inhibitors bind reversibly to a regulatory site
X) Competitive inhibitors increase the K_m value of an enzyme, while noncompetitive inhibitors decrease the V_{max} value
Y) Competitive inhibitors decrease the turnover number of an enzyme, while noncompetitive inhibitors increase the rate of product formation
Z) Competitive inhibitors bind to an allosteric site, while noncompetitive inhibitors bind directly to the substrate of an enzyme

ANSWER: X) COMPETITIVE INHIBITION INCREASE THE K_m VALUE OF AN ENZYME, WHILE NONCOMPETITIVE INHIBITORS DECREASE THE V_{max} VALUE

BONUS

8) Biology – *Short Answer* A patient whose blood calcium levels are low is most likely having issues with what gland?

ANSWER: PARATHYROID
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TOSS-UP

9) Chemistry – *Short Answer* When approximating the lattice energy of a salt, what constant accounts for the spatial arrangement of ions?

ANSWER: MADELUNG CONSTANT

BONUS

9) Chemistry – *Short Answer* During a board game, a four-sided die is replaced with a thirty six-sided die. To the nearest factor of Boltzmann's constant, what is the positive difference in entropy between the dice?

ANSWER: 2

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TOSS-UP

10) Physics – *Short Answer* Two lenses are placed in sequence. An object is placed a certain distance away from the system, and the image produced by the first lens has a magnification of 0.25, while the image produced by the second lens has a magnification of 0.50. To two significant figures, what is the net magnification of the system?

ANSWER: 0.13

BONUS

10) Physics – *Multiple Choice* For which of the following systems would the use of Fermi–Dirac statistics be most appropriate?

W) Sodium metal
X) Photon gas
Y) Liquid helium
Z) Neon plasma

ANSWER: W) SODIUM METAL
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TOSS-UP

11) Earth and Space – *Multiple Choice* Dune formations usually follow patterns that are surprisingly consistent. Which of the following types of dunes are expected to form under steady winds, plentiful sand, and sparse or absent vegetation?

W) Barchan
X) Longitudinal
Y) Parabolic
Z) Transverse

ANSWER: Z) TRANSVERSE

BONUS

11) Earth and Space – *Multiple Choice* If a wind is blowing at 20 miles per hour and the air temperature is 20 degrees Fahrenheit, then to what temperature will a dry object cool when placed outside if the wind–chill index is –10 degrees Fahrenheit?

W) –20 degrees Fahrenheit
X) –10 degrees Fahrenheit
Y) 10 degrees Fahrenheit
Z) 20 degrees Fahrenheit

ANSWER: Z) 20 DEGREES FAHRENHEIT

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TOSS-UP

12) Math – *Short Answer* The number 12 is one-eighth of a percent of what number?

ANSWER: 9600

BONUS

12) Math – *Short Answer* If in a particular non-leap year, February 4th lands on a Thursday, then on what day does November 29th land on?

ANSWER: MONDAY
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TOSS-UP

13) Energy – *Short Answer* Scientists in the Schepartz Lab at UC Berkeley use the bacterial translation apparatus to create new chemical polymers. Which organelle is most directly involved in creating these polymers?

ANSWER: RIBOSOME

BONUS

13) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab are investigating different pigments for their potential uses in photovoltaic cells. These pigments often consist of long, conjugated hydrocarbons. Rank the following three conjugated hydrocarbons in terms of decreasing maximum absorption wavelength: 1) Beta-carotene; 2) Benzene; 3) Ethylene.

ANSWER: 1, 2, 3

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TOSS-UP

14) Earth and Space – *Short Answer* What is the name given to the term that defines the proportion of incident solar radiation which is diffusely radiated from the atmosphere and surface of a planet and back into outer space?

ANSWER: ALBEDO

BONUS

14) Earth and Space – *Multiple Choice* Which of the following is the principal gas that is released during a volcanic eruption, by percent composition?

W) Nitrogen dioxide
X) Sulfur dioxide
Y) Water vapor
Z) Carbon dioxide

ANSWER: Y) WATER VAPOR
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TOSS-UP

15) Chemistry – *Multiple Choice* Which of the following statements explains why chlorine is a gas at room temperature while bromine is a liquid?

W) Bromine ions are held together by ionic bonds
X) Chlorine molecules are smaller and will pack tighter in their physical orientation
Y) Bromine atoms are larger which results in stronger London dispersion forces
Z) Chlorine atoms are smaller which results in stronger London dispersion forces

ANSWER: Y) BROMINE ATOMS ARE LARGER WHICH RESULTS IN STRONGER LONDON DISPERSION FORCES

BONUS

15) Chemistry – *Short Answer* What is the simplification in quantum mechanics that allows for the separability of the nuclear and electronic wave functions?

ANSWER: BORN-OPPENHEIMER APPROXIMATION

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TOSS-UP

16) Biology – *Short Answer* What is the name of the phenomenon in which newborn animals form an immediate and irreversible attachment to the first moving object they encounter, usually their mother or a caregiver, during a critical period after hatching or birth?

ANSWER: IMPRINTING

BONUS

16) Biology – *Multiple Choice* Which of the following differentiated cell types would most likely arise from the ectoderm of a developing embryo?

W) Mucosal cells within the stomach
X) Glial cells within the central nervous system
Y) Epithelial cells lining the small intestine
Z) Red blood cells circulating through the body

ANSWER: X) GLIAL CELLS WITHIN THE CENTRAL NERVOUS SYSTEM
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TOSS-UP

17) Math – *Short Answer* What is the partial derivative with respect to x of the expression $4x^3 + xy$?

ANSWER: $12x^2 + y$

BONUS

17) Math – *Multiple Choice* What is the sum of the reciprocals of the prime factors of 654?

W) 453/654
X) 513/ 654
Y) 551/654
Z) 603/654

ANSWER: Y) 551/654

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TOSS-UP

18) Physics – *Short Answer* What constant is used for expressing the magnetic moment of an electron?

ANSWER: BOHR MAGNETON

BONUS

18) Physics – *Short Answer* A projectile is fired horizontally at a velocity of 20 meters per second from a 180-meter tall building. Assuming the acceleration due to gravity is 10 meters per second squared, at what horizontal distance in meters from the firing point does the projectile strike the ground?

ANSWER: 120
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TOSS-UP

19) Biology – *Multiple Choice* Which of the following diseases is caused by a lethal dominant allele?

W) Cystic fibrosis
X) Huntington's disease
Y) Sickle cell disease
Z) Achondroplasia

ANSWER: X) HUNTINGTON'S DISEASE

BONUS

19) Biology – *Short Answer* Identify all of the following three statements that are true regarding red blood cells: 1) Red blood cells are biconcave disks, which minimizes surface area to volume ratio; 2) Red blood cells lack mitochondria and nuclei; 3) Each hemoglobin molecule in a red blood cell can only bind up to 2 molecules of oxygen.

ANSWER: 2 ONLY

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TOSS-UP

20) Chemistry – *Multiple Choice* In a solution of 0.1-molar sodium acetate, which of the following ions has the lowest concentration?

W) Sodium
X) Acetate
Y) Hydronium
Z) Hydroxide

ANSWER: Y) HYDRONIUM

BONUS

20) Chemistry – *Short Answer* Identify all of the following three statements that are true regarding the most stable isomer of the compound C_2N_2: 1) It contains two triple bonds; 2) It is susceptible to radical formation; 3) It is linear in structure.

ANSWER: ALL
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TOSS-UP

21) Math – *Short Answer* At what point do the two lines $y = 5x - 13$ and $y = -3x + 7$ intersect each other?

ANSWER: (5/2, –1/2)

BONUS

21) Math – *Short Answer* A man's watch reads 5:16 PM before boarding a 1 hour and 49 minute flight going westward across two time zones. His layover is 32 minutes after which he then boards a 4-hour and 23-minute flight going east across 4 time zones. If his watch syncs to local time, what is the time on the man's watch when he lands?

ANSWER: 2:00 AM

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TOSS-UP

22) Earth and Space – *Multiple Choice* The surface of a "desert pavement" is composed primarily of which of the following?

W) Clay
X) Sand
Y) Pebbles
Z) Salt

ANSWER: Y) PEBBLES

BONUS

22) Earth and Space – *Short Answer* Over the course of geologic history, durations of time have existed in which there was a high production of biomatter. Name the period in the Mesozoic Era during which most extensive coal deposits were created.

ANSWER: CARBONIFEROUS (ACCEPT: MISSISSIPPIAN OR PENNSYLVANIAN)
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TOSS-UP

23) Physics – *Short Answer* What is the term for the effect resulting when the natural and driving angular frequencies an RLC series circuit match?

ANSWER: RESONANCE

BONUS

23) Physics – *Short Answer* A puck's position is described by the parametric equations $x(t) = -2t^2 + t + 5$ and $y(t) = t^2 + 7$. What is the magnitude of the puck's acceleration?

ANSWER: 2 TIMES THE SQUARE ROOT OF 5