BSB ROUND 7

TOSS-UP

1) Chemistry – *Short Answer* How many pi bonds are found in one molecule of acetylene?

ANSWER: TWO

BONUS

1) Chemistry – *Multiple Choice* What is the first step in the dehydration of cyclohexanol in sulfuric acid?

W) Elimination of water
X) Formation of a carbocation
Y) Formation of a sulfite ester
Z) Protonation of the alcohol

ANSWER: Z) PROTONATION OF THE ALCOHOL

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TOSS-UP

2) Math – *Short Answer* A set of scores follow a Gaussian distribution. If the value 50 has a Z-score of 3.25 and the standard deviation is 12, what is the mean of the scores?

ANSWER: 11

BONUS

2) Math – *Short Answer* Player A has a 3/5 chance to win any given tennis game, and a 2/5 chance to lose. Winning the game will increase the player's position one place in an infinite ladder, while losing will cause them to decrease by one place. What is the probability that player A ends up exactly 3 places higher after 5 games?

ANSWER: 162/625
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TOSS-UP

3) Biology – *Multiple Choice* Which of the following phylum-description combinations is NOT true?

W) Calcarea ***[cal-KAIR-ee-uh]*** lack true tissues and have choanocytes ***[CHOH-no-sites]***
X) Echinodermata ***[eh-KEEN-oh-derm-ah-tah]*** are pseudocoelomates ***[pseudo-SEAL-oh-mates]*** and have heads with ciliated crowns
Y) Mollusca are coelomates with three main body parts and have reduced coeloms
Z) Nematoda are cylindrical pseudocoelomates with tapered ends and have no circulatory system

ANSWER: X) ECHINODERMATA ARE PSEUDOCOELOMATES AND HAVE HEADS WITH CILIATED CROWNS

BONUS

3) Biology – *Short Answer* Identify all of the following three statements that are true regarding biomes: 1) Taiga biomes are characterized by great diversity of flora and fauna and high levels of precipitation; 2) Deciduous forest biomes are characterized by long, cold winters and short, wet summers; 3) Desert biomes are characterized by low and unpredictable precipitation.

ANSWER: 3 ONLY

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TOSS-UP

4) Energy – *Short Answer* Scientists in the Tilley Group study the reactive properties and unusual electronic and coordination environments of transition metal centers to shed light on new reaction processes. What theory approximates ligands as point charges to determine the orbital splitting of d-block transition metals?

ANSWER: CRYSTAL-FIELD THEORY (ACCEPT: CFT)

BONUS

4) Energy – *Short Answer* Scientists in the Keasling Lab at UC Berkeley are trying to find nontraditional host cells to use for creating polymers. One key technique used is gel electrophoresis. If a DNA sample is loaded with a chemical that can possibly make cuts at any of three different spots, what number of bands would be observed?

ANSWER: TEN
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TOSS-UP

5) Physics – *Short Answer* What is the magnitude of the average force in newtons required to change the speed of a 1,500-kilogram car by 10 meters per second in a time of 5 seconds?

ANSWER: 3,000

BONUS

5) Physics – *Short Answer* Light consisting of 6.4 electron volt photons is incident on a piece of sodium, which has a work function of 2.7 electron volts. In electron volts, what is the maximum kinetic energy of the ejected electrons?

ANSWER: 3.7

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TOSS-UP

6) Earth and Space – *Short Answer* A primary result of the rotation of Earth on its axis is the apparent deflection of currents. What is the name of this phenomenon which strongly impacts global weather patterns?

ANSWER: CORIOLIS EFFECT

BONUS

6) Earth and Space – *Multiple Choice* Which of the following terms is applied to organisms living on or in the ocean bottom?

W) Plankton
X) Nekton
Y) Benthos
Z) Pelagios

ANSWER: Y) BENTHOS
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TOSS-UP

7) Math – *Multiple Choice* When in standard position, which of the following angles, in radians, has its terminal side in the second quadrant?

W) $16\pi/5$
X) $23\pi/5$
Y) $30\pi/5$
Z) $37\pi/5$

ANSWER: X) $23\pi/5$

BONUS

7) Math – *Multiple Choice* If a non-degenerate triangle's longest side is 6 times as long as its second side, and the third side has a length of 280, which of the following values could be the length of the second side?

W) 40
X) 50
Y) 60
Z) 70

ANSWER: X) 50

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TOSS-UP

8) Physics – *Multiple Choice* Light incident on two slits is used to project an interference pattern onto a screen. The distance between the bright maximums observed on the screen can be increased by what?

W) Making the slit openings wider
X) Moving the slits farther apart
Y) Moving the slits closer together
Z) Increasing the intensity of the light source

ANSWER: Y) MOVING THE SLITS CLOSER TOGETHER

BONUS

8) Physics – *Short Answer* Identify all of the following three subatomic particles that have a spin of zero: 1) Neutron; 2) Photon; 3) Higgs boson.

ANSWER: 3 ONLY
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TOSS-UP

9) Chemistry – *Short Answer* The bond length of an ionic bond can be calculated by determining where the derivative of the bond energy with respect to interionic distance is equal to what value?

ANSWER: ZERO

BONUS

9) Chemistry – *Short Answer* Rank the following three unit cell geometries from highest to lowest atomic packing factor: 1) Simple cubic; 2) Face-centered cubic; 3) Body-centered cubic.

ANSWER: 2, 3, 1

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TOSS-UP

10) Biology – *Multiple Choice* Which of the following hormones does NOT have a direct effect on the kidneys?

W) Antidiuretic hormone
X) Luteinizing hormone
Y) Cortisol
Z) Aldosterone

ANSWER: X) LUTEINIZING HORMONE

BONUS

10) Biology – *Short Answer* In what section of the egg is yolk often concentrated around during embryogenesis in sea urchins and other animals?

ANSWER: VEGETAL POLE
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TOSS-UP

11) Energy – *Multiple Choice* Researchers in the Dames Lab at UC Berkeley have created a thermal regulator for batteries which can be used to maintain constant battery capacity and performance at extreme temperatures. Which of the following describes the reason that low temperatures lead to a decrease in battery capacity?

W) Decrease in rate of ion transfer through electrolyte
X) Decrease in available intercalation sites in anode
Y) Increase in electrolyte entropy
Z) Increase in enthalpy of battery reaction

ANSWER: W) DECREASE IN RATE OF ION TRANSFER THROUGH ELECTROLYTE

BONUS

11) Energy – *Short Answer* Scientists in the Utzat ***[OOT-zat]*** Group at UC Berkeley are studying quantum dots for their biomedical applications. These nanoparticles exhibit discrete energy levels due to what phenomenon?

ANSWER: QUANTUM CONFINEMENT

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TOSS-UP

12) Earth and Space – *Multiple Choice* Which of the following statements accurately describes the significance of the Chandrashekhar ***[shahn-dra-SAY-car]*** limit in astrophysics?

W) It marks the dividing line between white dwarf and red giant stars
X) It determines the minimum mass required for a star to undergo a type 1A supernova
Y) It sets the maximum temperature that can be reached in the core of a star
Z) It represents a fundamental limit on the mass of a stable neutron star

ANSWER: X) IT DETERMINES THE MINIMUM MASS REQUIRED FOR A STAR TO UNDERGO A TYPE 1A SUPERNOVA

BONUS

12) Earth and Space – *Short Answer* If the length of a day were to increase by 4 hours, by what percentage would you expect the Coriolis force on an object moving at 20 meters per second at the equator to change by?

ANSWER: 0%
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TOSS-UP

13) Chemistry – *Multiple Choice* Which of the following compounds is most likely to act as a Lewis base?

W) Methyl chloride
X) Boron trihydride
Y) Ammonia
Z) Aluminum hydride

ANSWER: Y) AMMONIA

BONUS

13) Chemistry – *Multiple Choice* One mole of an ideal gas is compressed reversibly and isothermally at a temperature of 27 degrees Celsius from a volume of 2.7 liters to 1 liter. Which of the following is closest to the work done on the gas in joules?

W) 220
X) 380
Y) 2500
Z) 4200

ANSWER: Y) 2500

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TOSS-UP

14) Earth and Space – *Short Answer* What are the two main factors that determine the the climate of a region?

ANSWER: TEMPERATURE AND PRECIPITATION

BONUS

14) Earth and Space – *Multiple Choice* Which of the following letters in the Koppen classification does NOT correspond to a climate that can be found in Australia?

W) A
X) B
Y) C
Z) D

ANSWER: Z) D
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TOSS-UP

15) Biology – *Short Answer* Species show differences in size, color, ornamentation and behavior. What is the term for these marked distinctions between sexes in secondary sexual characteristics?

ANSWER: SEXUAL DIMORPHISM

BONUS

15) Biology – *Short Answer* Identify all of the following three statements that are true regarding Phyla: 1) Planarians belong to phylum porifera; 2) The phylum Arthropoda includes insects and crustaceans; 3) The phylum Annelida includes sea urchins

ANSWER: 2 ONLY

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TOSS-UP

16) Physics – *Multiple Choice* In a photoelectric experiment, the intensity of incident light is steadily increased while keeping the frequency constant. Which of the following statements is correct?

W) After sufficient exposure to light, current will always be observed
X) Increasing the intensity of light increases the frequency of generated alternating current
Y) Increasing the intensity of light increases the induced current
Z) Increasing the intensity of the light increases the energy of the emitted electrons

ANSWER: Y) INCREASING THE FREQUENCY OF LIGHT INCREASES THE INDUCED CURRENT

BONUS

16) Physics – *Short Answer* A closed container with 0.5 moles of helium gas at initial volume V is adiabatically and reversibly expanded to one thirty-second of its initial pressure. What is the final volume of the gas in terms of V?

ANSWER: $8V$
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TOSS-UP

17) Energy – *Multiple Choice* Scientists at the Mathies group at UC Berkeley use Raman Spectroscopy to study the dynamics of chemical reactions. Which of the following represents a vibration in carbon dioxide that is Raman active but not IR active?

W) Stretching of a single carbon-oxygen bond
X) Scissoring of the carbon dioxide
Y) Symmetric stretch of both carbon-oxygen bonds
Z) Rotation along the linear axis

ANSWER: Y) SYMMETRIC STRETCH OF BOTH CARBON-OXYGEN BONDS

BONUS

17) Energy – *Short Answer* Scientists at the Sarpong lab at UC Berkeley have endeavored to synthesize natural products from common compounds. One such molecule is carvone which has one stereocenter. A certain sample has a 5:3 ratio of the R enantiomer to the S enantiomer. When the sample is illuminated by plane-polarized light, what is the ratio of its optical rotation compared to a pure sample of R enantiomer?

ANSWER: 1 TO 4 (ACCEPT: 25%)

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TOSS-UP

18) Math – *Short Answer* What is the product of the zeros of the polynomial $x^2 + 2x - 15$?

ANSWER: –15

BONUS

18) Math – *Short Answer* In a tournament there's round-robin play of 20 teams, the top 16 go to a quintuple-elimination bracket, with teams eliminated after 5 losses. What is the least number of games that could occur during the tournament?

ANSWER: 265
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TOSS-UP

19) Biology – *Short Answer* Sickle cell disease is characterized by a single point mutation where glutamate is replaced by what amino acid?

ANSWER: VALINE (ACCEPT: VAL)

BONUS

19) Biology – *Multiple Choice* In E. coli, which of the following processes produces the most NADH molecules per glucose molecule?

W) Aerobic respiration
X) Anaerobic respiration using nitrate as the final electron acceptor
Y) Anaerobic respiration using fumarate as the final electron acceptor
Z) Fermentation

ANSWER: W) AEROBIC RESPIRATION

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TOSS-UP

20) Earth and Space – *Multiple Choice* What type of galaxies are the most common in the universe?

W) Spiral
X) Elliptical
Y) Globular
Z) Irregular

ANSWER: X) ELLIPTICAL

BONUS

20) Earth and Space – *Short Answer* Most white dwarfs have densities so high that electrons are displaced inward from their regular orbits. What is the material of this state commonly called?

ANSWER: DEGENERATE MATTER
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TOSS-UP

21) Chemistry – *Multiple Choice* Which of the following molecules is NOT aromatic?

W) Benzene
X) Pyridine
Y) Cyclohexene
Z) Styrene

ANSWER: Y) CYCLOHEXENE

BONUS

21) Chemistry – *Multiple Choice* Which of the following elements has the highest diffusion coefficient into ferromagnetic alpha iron?

W) Helium
X) Carbon
Y) Iron
Z) Copper

ANSWER: W) HELIUM

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TOSS-UP

22) Math – *Short Answer* What is the limit as x approaches 1 for the expression with numerator cube root of $x - 1$ and denominator $x - 1$ to the power of –1?

ANSWER: 0

BONUS

22) Math – *Short Answer* What are the coordinates of the vertex for the graph of the function $f(x) = -3x^2 - 6x - 15$?

ANSWER: (–1, –12) (ACCEPT: $x = -1$ AND $y = -12$)
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TOSS-UP

23) Physics – *Short Answer* A closed hemisphere enclosing no net charge is placed in an electric field. The electric flux through the top, curved surface is 10 newton meters squared per coulomb. In newton meters squared per coulomb, what is the magnitude of the flux through the bottom, circular base of the hemisphere?

ANSWER: 10

BONUS

23) Physics – *Short Answer* A circuit consisting of a fully charged 2 farad capacitor, 2 henry inductor, and a 112 ohm resistor in series is closed. What is the resonant angular frequency of the circuit in radians per second?

ANSWER: 1/2 (ACCEPT: 0.5)