

## **BSB ROUND 3**

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### **TOSS-UP**

1) Biology – *Short Answer* Besides T3 and T4, what other hormone is produced by the thyroid gland?

ANSWER: CALCITONIN

### **BONUS**

1) Biology – *Multiple Choice* Which of the following statements is true regarding carbohydrates?

- W) All carbohydrates in plants consist of alpha-glucose monomers
- X) Glycogen branch points contain alpha 1-2 glycosidic linkages
- Y) Cellulose is a linear carbohydrate
- Z) Chitin *[KITE-in]* is a branched carbohydrate

ANSWER: Y) CELLULOSE IS A LINEAR CARBOHYDRATE

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### **TOSS-UP**

2) Earth and Space – *Multiple Choice* When viewed from Earth, stars often appear to twinkle or flicker. Which of the following phenomena is most responsible for the scintillation effect?

- W) Absorption
- X) Reflection
- Y) Transmission
- Z) Refraction

ANSWER: Z) REFRACTION

### **BONUS**

2) Earth and Space – *Short Answer* Identify all of the following three statements that are true regarding groundwater: 1) Groundwater represents less than 1% of the hydrosphere; 2) Groundwater represents around 40% of all freshwater; 3) Groundwater represents around 96% percent of all liquid fresh water.

ANSWER: 1 AND 3

## **TOSS-UP**

3) Physics – *Multiple Choice* The magnitude of the electric field at a given distance away from a point charge is directly proportional to which of the following?

- W) The square of the distance
- X) The square of the charge
- Y) The inverse square of the distance
- Z) The inverse square of the charge

ANSWER: Y) THE INVERSE SQUARE OF THE DISTANCE

## **BONUS**

3) Physics – *Short Answer* A circuit consisting of a 10-volt battery, 10-ohm resistor, and 10-farad capacitor in series is closed. To the nearest second, how long will it take for the voltage across the capacitor to reach 6.3 volts?

ANSWER: 100

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## **TOSS-UP**

4) Chemistry – *Short Answer* Identify all of the following three hydrogen spectral series which have wavelengths in the visible region of the electromagnetic spectrum: 1) Lyman; 2) Balmer; 3) Paschen.

ANSWER: 2 ONLY

## **BONUS**

4) Chemistry – *Short Answer* To the nearest tenth and in seconds, what is the half-life of a second-order reaction with an initial concentration of 3 molar and a rate constant of 0.2 per molar per second?

ANSWER: 1.7

## **TOSS-UP**

5) Energy – *Multiple Choice* Researchers in the Gao Liu Lab at Lawrence Berkeley National Lab want to replace conventional graphite anodes in lithium ion batteries with silicon anodes, which have a much higher energy density. Pure silicon anodes have diamond-like crystalline structures, which are favored over graphite’s layered structure due to poor pi bonding between silicon anodes. What property of silicon atoms, compared to carbon atoms, is most responsible for this behavior?

- W) Smaller first ionization energy
- X) Smaller electronegativity
- Y) Larger atomic radius
- Z) Smaller electron affinity

ANSWER: Y) LARGER ATOMIC RADIUS

## **BONUS**

5) Energy – *Short Answer* Scientists at UC Berkeley’s Long Group have been looking for methods to capture small gas molecules such as methylamine. To do this, they used what class of high surface area organometallic polymers?

ANSWER: METAL-ORGANIC FRAMEWORKS (ACCEPT: MOFs)

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## **TOSS-UP**

6) Math – *Short Answer* Including one, how many unique factors exist for the number 2022?

ANSWER: 8

## **BONUS**

6) Math – *Short Answer* A triangle with the coordinates (2, 2), (4, 5), and (6, 2) is rotated 90 degrees clockwise about the origin. What are the new coordinates of the triangle?

ANSWER: (2, -2), (5, -4), (2, -6)

## **TOSS-UP**

7) Biology – *Short Answer* An interaction between two organisms in which one organism benefits while the other is neither positively nor negatively affected is an example of what form of symbiosis?

ANSWER: COMMENSALISM

## **BONUS**

7) Biology – *Multiple Choice* Which of the following enzymes is used to make cDNA from eukaryotic mRNA?

- W) RNA polymerase
- X) DNA polymerase
- Y) Taq [*tack*] polymerase
- Z) Reverse transcriptase

ANSWER: Z) REVERSE TRANSCRIPTASE

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## **TOSS-UP**

8) Chemistry – *Multiple Choice* Which of the following elements is a liquid at room temperature?

- W) Sulfur
- X) Selenium
- Y) Chlorine
- Z) Bromine

ANSWER: Z) BROMINE

## **BONUS**

8) Chemistry – *Multiple Choice* Which element has a de Broglie [*de-BROY*] wavelength roughly five times larger than indium?

- W) Fluorine
- X) Iron
- Y) Sodium
- Z) Sulfur

ANSWER: Y) SODIUM

**TOSS-UP**

9) Earth and Space – *Short Answer* What is the term for the stable interiors of the continents in the lithosphere?

ANSWER: CRATONS

**BONUS**

9) Earth and Space – *Short Answer* Hubble's law states that the speed at which a galaxy recedes is directly proportional to what quantity?

ANSWER: DISTANCE FROM OBSERVER (ACCEPT: DISTANCE)

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**TOSS-UP**

10) Math – *Multiple Choice* What is the distance from the origin to the point (4, 8, 8)?

- W) 11
- X) 12
- Y) 13
- Z) 14

ANSWER: X) 12

**BONUS**

10) Math – *Short Answer* A cone has a volume of  $40\pi$  and a height of 7.5. What is the radius of the circular face?

ANSWER: 4

## **TOSS-UP**

11) Physics – *Multiple Choice* The gravitational field within a thin, hollow sphere is proportional to the distance from the center to what power?

- W) -2
- X) -1
- Y) 0
- Z) 1

ANSWER: Y) 0

## **BONUS**

11) Physics – *Short Answer* A rigid container is filled with 1 mole of gas particles, each of radius  $r$ . Identify all of the following three changes to the system that will increase the mean free path: 1) Increasing temperature; 2) Adding more gas; 3) Increasing  $r$  to  $2r$ .

ANSWER: NONE

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## **TOSS-UP**

12) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab are studying liquid-solid phase transitions on the microscopic level to understand better how crystals begin to form. What is the name of the phenomenon that occurs at the point when a liquid starts to form a crystalline solid?

ANSWER: NUCLEATION

## **BONUS**

12) Energy – *Multiple Choice* Scientists in the Connolly Lab at UC Berkeley are using which of the following techniques to track therapeutic stem cells and white blood cells without the use of ionizing radiation?

- W) Flow cytometry
- X) Magnetic particle imaging
- Y) Positron emission tomography
- Z) Computed tomography

ANSWER: X) MAGNETIC PARTICLE IMAGING

## **TOSS-UP**

13) Math – *Short Answer* Expand the following expression: the quantity  $x+y$  cubed.

ANSWER:  $x^3 + 3x^2y + 3xy^2 + y^3$

## **BONUS**

13) Math – *Short Answer* A person wants to fill a 1,546-gallon pool but only has one bucket that can hold 29.5 gallons. What is the minimum number of times the person has to fill the bucket?

ANSWER: 53

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## **TOSS-UP**

14) Biology – *Short Answer* What is the part of the nephron that provides the osmotic gradient for reabsorption?

ANSWER: LOOP OF HENLE

## **BONUS**

14) Biology – *Short Answer* Identify all of the following three statements that are true regarding the three domains of life: 1) Both archaea and bacteria have peptidoglycan in the cell wall; 2) Archaea have only one kind of RNA polymerase while bacteria and eukarya have several kinds of RNA polymerase; 3) The initiator amino acid for protein synthesis is methionine for both archaea and eukarya.

ANSWER: 3 ONLY

## **TOSS-UP**

15) Physics – *Short Answer* What name describes the force exerted on a charged particle moving through uniform electric and magnetic fields?

ANSWER: LORENTZ FORCE

## **BONUS**

15) Physics – *Short Answer* A 5-kilogram mass is moving in uniform circular motion with a radius of 1 meter and a frequency of 3 hertz. In meters per second and to the nearest whole number, what is the tangential velocity of the mass?

ANSWER: 19

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## **TOSS-UP**

16) Earth and Space – *Short Answer* The Hertzsprung-Russell diagram plots the relationship between temperature and what other property of a star?

ANSWER: LUMINOSITY (ACCEPT: ABSOLUTE MAGNITUDE)

## **BONUS**

16) Earth and Space – *Multiple Choice* Which of the following is the main reason that limestone cannot form below 5000 meters in the open ocean?

- W) Lack of limestone-forming organisms in pelagic environments
- X) Consumption of limestone-forming organisms by the deep ocean ecosystem
- Y) The ocean temperature along abyssal plains is too cold for the compaction and cementation of sediments
- Z) The conditions of the overlying water at that depth result in a net dissolution of calcite

ANSWER: Z) THE CONDITIONS OF THE OVERLYING WATER AT THAT DEPTH RESULT IN A NET DISSOLUTION OF CALCITE

## **TOSS-UP**

17) Chemistry – *Multiple Choice* The measured Van't Hoff [**VANT-hoff**] factor of an unknown ionic solid when dissolved in water is 3.4. Which of the following is the most likely identity of the unknown solid?

- W) Sodium chloride
- X) Magnesium chloride
- Y) Iron(III) chloride
- Z) Tin(IV) chloride

ANSWER: Y) IRON(III) CHLORIDE

## **BONUS**

17) Chemistry – *Multiple Choice* The energy of a particle in a 1-dimensional box is proportional to which of the following?

- W) The square of the mass of the particle
- X) The square of the length of the box
- Y) The inverse square of the mass of the particle
- Z) The inverse square of the length of the box

ANSWER: Z) THE INVERSE SQUARE OF THE LENGTH OF THE BOX

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## **TOSS-UP**

18) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab's Laser Accelerator Center have been probing high-temperature seas of electrons traveling at speeds around 0.9c. What state of matter are these electrons in?

ANSWER: PLASMA

## **BONUS**

18) Energy – *Short Answer* Researchers in the Hsu Lab at UC Berkeley have been developing gene editing tools that rely on large CRISPR [**CRISP-er**] proteins to eliminate harmful phenotypic expression. To deliver the CRISPR mRNAs to cells, they emulated certain COVID-19 vaccines by using what class of particles?

ANSWER: LIPID NANOPARTICLES (ACCEPT: LNPs)

## **TOSS-UP**

19) Physics – *Short Answer* Identify all of the following three quantities that affect the frequency of an ideal oscillating spring: 1) Spring constant; 2) Spring stretch; 3) Mass attached to the spring.

ANSWER: 1 AND 3

## **BONUS**

19) Physics – *Multiple Choice* A ray of light, which is traveling in air, is incident on a glass plate at a 30 degree angle with respect to the vertical. The angle of refraction in the glass must be which of the following?

- W) Equal to 30 degrees
- X) More than 30 degrees
- Y) Less than 30 degrees
- Z) Depends on the index of refraction

ANSWER: Y) LESS THAN 30 DEGREES

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## **TOSS-UP**

20) Earth and Space – *Multiple Choice* Which of the following statements about earthquakes is false?

- W) Earthquakes can occur on any type of fault
- X) The intensity of an earthquake is determined by the amount of energy released, as well as the distance from the epicenter and local geology
- Y) Earthquakes only occur near tectonic plate boundaries
- Z) Earthquakes can trigger secondary hazards such as landslides, liquefaction, and tsunamis

ANSWER: Y) EARTHQUAKES ONLY OCCUR NEAR TECTONIC PLATE BOUNDARIES

## **BONUS**

20) Earth and Space – *Short Answer* The equatorial system divides the celestial sphere into coordinates that are similar to latitude and longitude. What term is analogous to latitude in the equatorial system?

ANSWER: DECLINATION

## **TOSS-UP**

21) Biology – *Short Answer* In bacterial DNA replication, what is the protein whose function is to remove RNA nucleotides of primers from the 5 prime end and replace them with DNA nucleotides added to the 3 prime end of the adjacent fragment?

ANSWER: DNA POLYMERASE I (DO NOT ACCEPT: DNA POLYMERASE)

## **BONUS**

21) Biology – *Multiple Choice* Which of the following is NOT a condition for Hardy-Weinberg equilibrium?

- W) Random mating
- X) Natural selection
- Y) No gene flow
- Z) Large population size

ANSWER: X) NATURAL SELECTION

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## **TOSS-UP**

22) Chemistry – *Short Answer* Indicating sign, what is the formal charge on the nitrogen atom in the nitrate ion?

ANSWER: +1

## **BONUS**

22) Chemistry – *Short Answer* Rank the following four forms of sodium chloride in terms of decreasing standard entropy of formation: 1) Liquid; 2) Solid ; 3) Aqueous; 4) Gaseous.

ANSWER: 4, 3, 1, 2

**TOSS-UP**

23) Math – *Short Answer* There are 10 differently-colored coins. If you pull out three individually without replacement, how many different permutations can occur?

ANSWER: 720

**BONUS**

23) Math – *Short Answer* What is the smallest possible perimeter of a triangle with area equal to the square root of 3?

ANSWER: 6