

BSB ROUND 2

TOSS-UP

1) Biology – *Multiple Choice* Which biogeochemical cycle has the largest atmospheric reservoir?

- W) Water cycle
- X) Carbon cycle
- Y) Nitrogen cycle
- Z) Phosphorus cycle

ANSWER: Y) NITROGEN CYCLE

BONUS

1) Biology – *Short Answer* During depolarization of a neural cell, the inside of the cell becomes positively charged relative to the outside of the cell due to an influx of what ion?

ANSWER: SODIUM (ACCEPT: Na⁺)

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### TOSS-UP

2) Energy – *Multiple Choice* Researchers in the Somorjai Group at Lawrence Berkeley National Lab are using single-atom precious metal catalysts to convert methanol into hydrogen for use as fuel. Which of the following elements are they using?

- W) Lead
- X) Cadmium
- Y) Platinum
- Z) Ytterbium [*uh-TER-bee-um*]

ANSWER: Y) PLATINUM

### BONUS

2) Energy – *Short Answer* Scientists in the Hartwig Group have been working with organometallic compounds and enzymes to increase the yield and selectivity of desired products. What is the name of the class of substances that they use to activate enzymes?

ANSWER: COFACTORS

### TOSS-UP

3) Math – *Short Answer* What is the sum of the largest prime less than 100 and the smallest prime greater than 100?

ANSWER: 198

### BONUS

3) Math – *Short Answer* In what quadrant does the number  $3 - 5i$  lie on the complex plane?

ANSWER: FOURTH

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TOSS-UP

4) Physics – *Multiple Choice* Two identical balls are tossed directly upward, with ball B at double the speed of ball A. Which statement about these balls is correct?

- W) Ball A will go twice as high as ball B
- X) Ball A will go four times as high as ball B
- Y) Ball B will go twice as high as ball A
- Z) Ball B will go four times as high as ball A

ANSWER: Z) BALL B WILL GO FOUR TIMES AS HIGH AS BALL A

BONUS

4) Physics – *Short Answer* A 40-kilogram block is lifted 5 meters in a span of 20 seconds at a constant velocity. In watts and to the nearest integer, what is the average power due to gravity over this time?

ANSWER: -98

TOSS-UP

5) Earth and Space – *Short Answer* Rank the following three minerals in terms of increasing abundance in the Earth's crust. 1) Quartz; 2) Mica; 3) Feldspar.

ANSWER: 2, 1, 3

BONUS

5) Earth and Space – *Multiple Choice* The resolving power of a telescope most strongly depends on which of the following?

- W) Focal ratio
- X) Diameter of the objective
- Y) Magnification
- Z) Focal length

ANSWER: X) DIAMETER OF THE OBJECTIVE

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### TOSS-UP

6) Chemistry – *Multiple Choice* In order to create the most effective buffer, one should dissolve 1 mole of sodium acetate in water and add which of the following?

- W) 1 mole of calcium acetate
- X) 1 mole of sodium hydroxide
- Y) 0.5 moles of hydrochloric acid
- Z) 0.5 moles of acetic acid

ANSWER: Y) 0.5 MOLES OF HYDROCHLORIC ACID

### BONUS

6) Chemistry – *Multiple Choice* Which of the following elements is NOT normally found in soda-lime glass?

- W) Calcium
- X) Boron
- Y) Sodium
- Z) Silicon

ANSWER: X) BORON

### TOSS-UP

7) Physics – *Short Answer* Identify all of the following three statements that are true regarding mirrors: 1) A concave mirror always produces an image that is inverted, real, and larger; 2) A convex mirror always produces an image that is upright, virtual, and smaller; 3) The focal length is negative for concave mirrors.

ANSWER: 2 ONLY

### BONUS

7) Physics – *Short Answer* If unpolarized light of intensity 10 watts per square meter passes through an ideal polarizer, what is the intensity of the emerging light in watts per square meter?

ANSWER: 5

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TOSS-UP

8) Biology – *Short answer* What class of genes is responsible for limb pattern formation along the anterior-posterior axis during embryonic development?

ANSWER: HOX GENES (ACCEPT: HOMEBOX GENES)

BONUS

8) Biology – *Multiple Choice* Which of the following types of cells is NOT classified as an innate immunity defense?

- W) Neutrophils
- X) Natural killer cells
- Y) Eosinophils [*ee-uh-SIN-uh-files*]
- Z) Plasma cells

ANSWER: Z) PLASMA CELLS

TOSS-UP

9) Earth and Space – *Short Answer* What term is used by geologists to describe rock weathering in which shells or plates are broken away from a rock, leaving it rounded in appearance?

ANSWER: EXFOLIATION

BONUS

9) Earth and Space – *Multiple Choice* Which of the following statements led to the conclusion that the outer core is liquid?

- W) P waves can pass through it
- X) S waves can pass through it
- Y) P waves cannot pass through it
- Z) S waves cannot pass through it

ANSWER: Z) S WAVES CANNOT PASS THROUGH IT

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### TOSS-UP

10) Chemistry – *Short Answer* What law states that the absolute entropy of a perfect crystal at 0 kelvins is zero?

ANSWER: THIRD LAW OF THERMODYNAMICS

### BONUS

10) Chemistry – *Multiple Choice* Which of the following best describes the numerical value of the equilibrium constant of a reaction if equilibrium is reached when most of the reactants remain unreacted?

- W) Much greater than 1
- X) Slightly greater than 1
- Y) Slightly less than 1
- Z) Slightly greater than 0

ANSWER: Z) SLIGHTLY GREATER THAN 0

### TOSS-UP

11) Math – *Short Answer* What is 83 times 17?

ANSWER: 1,411

### BONUS

11) Math – *Short Answer* When rolling 3 dice, what are the two most likely sums of the resulting numbers from each roll?

ANSWER: 10 AND 11

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TOSS-UP

12) Energy – *Short Answer* Scientists at the Lawrence Berkeley National Laboratory are expanding on the 2022 breakthrough in fusion energy, where scientists generated the first net positive energy output. One of the most common fusion reactions is between deuterium and tritium to form helium-4 and what other particle?

ANSWER: NEUTRON

BONUS

12) Energy – *Multiple Choice* Scientists in the Merchant Lab at UC Berkeley are investigating the metabolism and homeostasis of essential trace metal elements such as copper, zinc, and iron in green algae. Which of the following statements correctly describes the role of the enzyme rubisco in the Calvin cycle of photosynthesis?

W) Converting light energy into chemical energy by splitting water molecules and releasing oxygen

X) Fixing carbon dioxide into a three-carbon compound, which is then used to synthesize glucose and other organic molecules

Y) Transferring electrons from NADPH to carbon dioxide, reducing it to glucose

Z) Producing ATP from the energy released by the oxidation of glucose

ANSWER: X) FIXING CARBON DIOXIDE INTO A THREE-CARBON COMPOUND, WHICH IS THEN USED TO SYNTHESIZE GLUCOSE AND OTHER ORGANIC MOLECULES

TOSS-UP

13) Math – *Short Answer* What is log base 4 of 256?

ANSWER: 4

BONUS

13) Math – *Multiple Choice* Which of the following describes the behavior of the graph of the function $f(x) = x^4 - 5x^3$ at $x = 3$?

- W) Concave up and increasing
- X) Concave up and decreasing
- Y) Concave down and increasing
- Z) Concave down and decreasing

ANSWER: X) CONCAVE UP AND DECREASING

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**TOSS-UP**

14) Biology – *Multiple Choice* Which of the following is a measure of the amount of organic matter produced by plants through photosynthesis?

- W) Gross primary production
- X) Gross secondary production
- Y) Net primary production
- Z) Net ecosystem production

ANSWER: W) GROSS PRIMARY PRODUCTION

**BONUS**

14) Biology – *Multiple Choice* Which of the following electrolytes is primarily involved in maintaining proper fluid and electrolyte balance, nerve transmission, and muscle contraction?

- W) Potassium
- X) Chlorine
- Y) Magnesium
- Z) Iodine

ANSWER: W) POTASSIUM

### TOSS-UP

15) Earth and Space – *Short Answer* As they recede, glaciers leave behind a variety of deposits. Which glacial feature is believed to have formed in the bed of a subglacial stream?

ANSWER: ESKER

### BONUS

15) Earth and Space – *Multiple Choice* The first flowering plants appeared in which of the following geologic periods?

- W) Cretaceous
- X) Ordovician [*ore-doh-VISH-uhn*]
- Y) Carboniferous
- Z) Tertiary

ANSWER: W) CRETACEOUS

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TOSS-UP

16) Physics – *Multiple Choice* Monochromatic light shines on metal in a photoelectric effect experiment, causing the emission of electrons. If the intensity of the light is increased, which of the following quantities will also increase?

- W) Stopping potential
- X) Work function
- Y) Cutoff frequency
- Z) Photoelectric current

ANSWER: Z) PHOTOELECTRIC CURRENT

BONUS

16) Physics – *Short Answer* Two balls collide inelastically on a frictionless surface and stick together. One ball has a mass of 2 kilograms and is traveling at 6 meters per second, while the other has a mass of 4 kilograms and was at rest before the collision. In meters per second, what is the speed of the balls after the collision?

ANSWER: 2

TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following is closest to the bond angle in degrees found in ammonia?

- W) 90
- X) 107
- Y) 110
- Z) 120

ANSWER: X) 107

BONUS

17) Chemistry – *Short Answer* Rank the following three compounds in terms of increasing ionic character: 1) Potassium iodide; 2) Calcium oxide; 3) Carbon monoxide.

ANSWER: 3, 1, 2

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### TOSS-UP

18) Earth and Space – *Multiple Choice* Which of the following astronomers proposed the idea of retrograde motion, the apparent westward drift of planets in the night sky?

- W) Nicolaus Copernicus
- X) Johannes Kepler
- Y) Tycho Brahe [*TYE-ko-BRA-hey*]
- Z) Galileo Galilei

ANSWER: Y) TYCHO BRAHE

### BONUS

18) Earth and Space – *Multiple Choice* Which of the following modern day regions was NOT part of Gondwanaland [*gone-DWON-uh-land*]?

- W) Europe
- X) Antarctica
- Y) Africa
- Z) India

ANSWER: W) EUROPE

### TOSS-UP

19) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab are looking into ways of increasing the energy density of lithium-ion batteries with conventional graphite anodes. What term describes the process by which lithium ions insert themselves into the layered structure of graphite anodes?

ANSWER: INTERCALATION

### BONUS

19) Energy – *Multiple Choice* Scientists in the Balsara group at UC Berkeley studying lithium-ion battery electrolytes make use of NMR experiments to observe the chemical environment of many different elements that make up battery electrolytes. However, many elements are difficult to analyze due to the low abundance of their NMR-active nuclei. Which of the following nuclei would be the most difficult to observe based on this fact?

W) Hydrogen-1

X) Lithium-7

Y) Carbon-13

Z) Fluorine-19

ANSWER: Y) CARBON-13

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TOSS-UP

20) Physics – *Short Answer* A Carnot engine running at 75% efficiency has a cold reservoir at 200 kelvins. What is the temperature of its hot reservoir in kelvins?

ANSWER: 800

BONUS

20) Physics – *Short Answer* What nuclide is formed in the alpha decay of radium-226?

ANSWER: RADON-222

TOSS-UP

21) Math – *Short Answer* What is the slope of the line that passes through the two points $(-4, -4)$ and $(8, 4)$?

ANSWER: $2/3$

BONUS

21) Math – *Short Answer* Solve the following system of 3 equations for x , y , and z : $-2x + y + 3z = 7$;
 $6x - y + 8z = -30$; and $-4x - y - 5z = 13$.

ANSWER: $x = -3$; $y = 4$; $z = -1$

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### TOSSUP

22) Chemistry – *Multiple Choice* Which of the following elements is found in all amino acids?

- W) Silicon
- X) Nitrogen
- Y) Phosphorus
- Z) Fluorine

ANSWER: X) NITROGEN

### BONUS

22) Chemistry – *Multiple Choice* Which of the following statements accurately describes the thermodynamics of the polymerization of ethylene?

- W)  $\Delta H$  greater than zero,  $\Delta S$  greater than zero
- X)  $\Delta H$  greater than zero,  $\Delta S$  less than zero
- Y)  $\Delta H$  less than zero,  $\Delta S$  greater than zero
- Z)  $\Delta H$  less than zero,  $\Delta S$  less than zero

ANSWER: Z)  $\Delta H$  LESS THAN ZERO,  $\Delta S$  LESS THAN ZERO

### TOSS-UP

23) Biology – *Multiple Choice* What is white matter in the brain mainly composed of?

- W) Myelinated nerve fibers
- X) Glial cells
- Y) Neuronal cell bodies
- Z) Cerebrospinal fluid

ANSWER: W) MYELINATED NERVE FIBERS

### BONUS

23) Biology – *Multiple Choice* Which of the following is NOT a stop codon?

- W) UGA
- X) UAC
- Y) UAA
- Z) UAG

ANSWER: X) UAC