

BSB ROUND 1

TOSS-UP

1) Chemistry – *Multiple Choice* Which of the following atoms has the greatest ionization energy?

- W) Fluorine
- X) Neon
- Y) Chlorine
- Z) Argon

ANSWER: X) NEON

BONUS

1) Chemistry – *Multiple Choice* A closed piston with thermally insulating walls contains one mole of an ideal gas. The piston is compressed by an external force. Which of the following quantities is equal to the internal energy change of the system?

- W) Heat released by system
- X) Heat absorbed by system
- Y) Work done by system
- Z) Work done on system

ANSWER: Z) WORK DONE ON SYSTEM

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### TOSS UP

2) Earth and Space – *Short Answer* Through the processes of chemical weathering, the components and internal structures of rocks and minerals are broken down. Iron oxide and what other product are the result of the chemical weathering of pyrite in a moist environment?

ANSWER: SULFURIC ACID (ACCEPT:  $\text{H}_2\text{SO}_4$ )

### BONUS

2) Earth and Space – *Short Answer* What is the series of reactions that formulate the hydrogen fusion reaction in the Sun?

ANSWER: PROTON-PROTON CHAIN (ACCEPT: P-P CHAIN)

### TOSS-UP

3) Math – *Short Answer* In what quadrants does the graph of the equation  $y = -2x^2 - 3$  lie?

ANSWER: THIRD AND FOURTH

### BONUS

3) Math – *Multiple Choice* Each day, Adam eats 40% of the cookies left in a jar. At the start of the 3rd day, there were 27 cookies left in the jar. How many cookies were in the jar initially?

- W) 60
- X) 65
- Y) 75
- Z) 80

ANSWER: Y) 75

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TOSS-UP

4) Biology – *Short Answer* In the mitochondria, what is the name given to the folds found in the inner membrane?

ANSWER: CRISTAE

BONUS

4) Biology – *Multiple Choice* Which of the following organelles is found exclusively in animal cells?

- W) Cytoplasm
- X) Peroxisome
- Y) Nuclear envelope
- Z) Centrosome

ANSWER: Z) CENTROsome

TOSS-UP

5) Physics – *Multiple Choice* Which of the following laws describes the relationship between the electric flux through a surface and the magnitude of net charge it encloses?

- W) Ampere's law
- X) Faraday's law
- Y) Lenz's law
- Z) Gauss's law

ANSWER: Z) GAUSS'S LAW

BONUS

5) Physics – *Multiple Choice* The normal force on a box on an inclined plane is directly proportional to which of the following?

- W) The sine of the incline angle
- X) The cosine of the incline angle
- Y) The tangent of the incline angle
- Z) The secant of the incline angle

ANSWER: X) THE COSINE OF THE INCLINE ANGLE

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### TOSS-UP

6) Energy – *Short Answer* Scientists in the Head-Gordon Lab at UC Berkeley are using computational tools to study the mechanism of action of intrinsically disordered proteins. What simple physics law is used to model molecular bond stretching in molecular dynamics?

ANSWER: HOOKE'S LAW

### BONUS

6) Energy – *Short Answer* Scientists in the Wilson Lab at UC Berkeley are investigating how to engineer genome editing enzymes for cell-targeted delivery. What is the role of the tracrRNA [*TRACER-RNA*] in the CRISPR-Cas9 [*CRISP-er-KAS-nine*] system?

- W) It helps guide the Cas9 protein to the correct location in the genome
- X) It serves as a scaffold for the guide RNA and Cas9 to bind together
- Y) It is involved in the processing of the CRISPR RNA
- Z) It helps recruit other proteins to the CRISPR complex

ANSWER: X) IT SERVES AS A SCAFFOLD FOR THE GUIDE RNA AND CAS9 TO BIND TOGETHER

### TOSS-UP

7) Biology – *Short Answer* What is the name given to the structure formed when homologous chromosomes join together during prophase 1 of meiosis?

ANSWER: TETRAD

### BONUS

7) Biology – *Short Answer* A man who is color blind marries a woman who is not color blind and they have a daughter who is not color blind. If the daughter marries a man with regular vision, what is the probability of their child being a son who is also color blind?

ANSWER: 25% (ACCEPT: 1/4)

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TOSS-UP

8) Physics – *Multiple Choice* Which of the following is NOT a vector quantity?

- W) Velocity
- X) Angular momentum
- Y) Rotational inertia
- Z) Torque

ANSWER: Y) ROTATIONAL INERTIA

BONUS

8) Physics – *Short Answer* A 10-microfarad parallel-plate capacitor is connected to a 12-volt battery in a closed circuit and is fully charged. A dielectric with a constant of 2 is then inserted between the plates of the capacitor. How much charge, in microcoulombs, is stored in the capacitor after the insertion of the dielectric?

ANSWER: 240

TOSS-UP

9) Earth and Space – *Multiple Choice* In which of the following months is North America closest to the sun?

- W) January
- X) March
- Y) June
- Z) September

ANSWER: W) JANUARY

BONUS

9) Earth and Space – *Multiple Choice* Which of the following is NOT an example of a clastic sedimentary rock?

- W) Breccia
- X) Gypsum
- Y) Shale
- Z) Sandstone

ANSWER: X) GYPSUM

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### TOSS-UP

10) Chemistry – *Multiple Choice* Lord Kelvin was able to calculate absolute zero by extrapolating the line of a volume-temperature plot, which is an application of what gas law?

- W) Boyle's law
- X) Charles' law
- Y) Gay-Lussac's law
- Z) Dalton's law

ANSWER: X) CHARLES' LAW

### BONUS

10) Chemistry – *Short Answer* In Rydbergs, what is the magnitude of the energy of the outermost electron in the  $\text{Li}^{2+}$  ion?

ANSWER: 9

### TOSS-UP

11) Math – *Short Answer* What is the greatest common factor of 160 and 288?

ANSWER: 32

### BONUS

11) Math – *Short Answer* A corridor has 4 rooms, labeled from 1 to 4, with each room containing one key, able to unlock one of the four rooms. There can be multiple keys able to unlock a single room or zero keys able to unlock a room, and room 1 is always unlocked. How many ways are there to arrange the keys such that one can never access all the rooms?

ANSWER: 232

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TOSS-UP

12) Energy – *Short Answer* Scientists at the Marletta Lab at UC Berkeley are researching cellulose degradation in order to turn plant biomass into fuel. What term is given to the general type of reaction that degrades cellulose into its monomers?

ANSWER: HYDROLYSIS

BONUS

12) Energy – *Multiple Choice* Scientists in the Doudna Lab at UC Berkeley are using CRISPR-Cas12 [**CRISP-er-KAS-twelve**] to repair point mutations in patients with genetic diseases. For which of the following diseases would this gene therapy be LEAST effective?

- W) Beta thalassemia
- X) Sickle cell disease
- Y) Cystic fibrosis
- Z) Huntington's disease

ANSWER: Z) HUNTINGTON'S DISEASE

TOSS-UP

13) Biology – *Multiple Choice* Trace elements, also known as microminerals, are dietary requirements that are needed in very small amounts for organisms. Which of the following is NOT a trace element for humans?

- W) Molybdenum
- X) Selenium
- Y) Cobalt
- Z) Scandium

ANSWER: Z) SCANDIUM

BONUS

13) Biology – *Short Answer* In conditions that challenge their ability to maintain homeostasis, some organisms have developed adaptations to save energy while avoiding difficult conditions. Hibernation is an example of what physiological state in which activity is low and metabolism decreases?

ANSWER: TORPOR

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### TOSS-UP

14) Physics – *Short Answer* A pendulum oscillates with a period of 3 seconds. If the length of the string were quadrupled, what would be the resulting period in seconds?

ANSWER: 6

### BONUS

14) Physics – *Multiple Choice* A 70-kilogram person rides in an elevator that is accelerating upward at 2 meters per second squared. Assuming  $g$  is 10 meters per second squared, then in newtons, what is the normal force acting on the person?

- W) 560
- X) 700
- Y) 840
- Z) 1,000

ANSWER: Y) 840

### TOSS-UP

15) Math – *Multiple Choice* What is the mean of the following set of 5 numbers: 16, 26, 40, 5, and 13?

- W) 18
- X) 20
- Y) 21
- Z) 23

ANSWER: X) 20

### BONUS

15) Math – *Short Answer* What is the standard form equation of the ellipse that has vertices at the points  $(\pm 8, 0)$  and foci [**FOKE-eye**] at the points  $(\pm 5, 0)$ ?

ANSWER:  $x^2/64 + y^2/39 = 1$

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TOSS-UP

16) Earth and Space – *Short Answer* Under what general rock class would slate be categorized?

ANSWER: METAMORPHIC

BONUS

16) Earth and Space – *Multiple Choice* Lachesis [**LAH-kuh-suhs**], a C-type asteroid, has a mean distance from the Sun of 3.3 AU. Given Jupiter's orbital period is 11.9 years, which of the following is the closest to the ratio of the period of Lachesis to Jupiter?

- W) 1 to 2
- X) 1 to 3
- Y) 1 to 4
- Z) 1 to 8

ANSWER: W) 1 to 2

TOSS-UP

17) Chemistry – *Multiple Choice* What is the angular momentum quantum number of the outermost valence electron of cesium?

- W) 0
- X) 1
- Y) 2
- Z) 3

ANSWER: W) 0

BONUS

17) Chemistry – *Multiple Choice* Most high-temperature superconductors are classified as which of the following materials?

- W) Ceramics
- X) Glasses
- Y) Metals
- Z) Polymers

ANSWER: W) CERAMICS

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### TOSS-UP

18) Math – *Short Answer* What is the period of the following sinusoidal function:  $y = 5 \sin(\frac{18\pi x - 54\pi}{9})$ ?

ANSWER: 1/9

### BONUS

18) Math – *Short Answer* What are all the  $x$ -intercepts of the equation  $x^3 - 5x^2 - 6x + 30$ ?

ANSWER: 5, SQUARE ROOT OF 6, NEGATIVE SQUARE ROOT OF 6

### TOSS-UP

19) Physics – *Multiple Choice* A long, straight wire carries a current  $I$ . At a distance  $r$ , the magnitude of the magnetic field is  $B$ . If both the current in the wire and the distance from the wire are doubled, then what is the new magnitude of the magnetic field?

- W)  $B/4$
- X)  $B/2$
- Y)  $B$
- Z)  $4B$

ANSWER: Y)  $B$

### BONUS

19) Physics – *Short Answer* What is the moment of inertia about the central axis of a solid cylinder with a mass of 5 kilograms and a radius of 2 meters?

ANSWER: 10

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TOSS-UP

20) Earth and Space – *Short Answer* Despite having fossil, geologic, and climatic evidence, Alfred Wegener lacked a mechanism that adequately explained his theory of continental drift. What phenomenon did Harry Hess discover in the 1950's which was crucial to the acceptance of Wegener's theory?

ANSWER: SEA-FLOOR SPREADING

BONUS

20) Earth and Space – *Multiple Choice* Continents have three major features that develop at distinct times during their development. Which of the following are the oldest areas of a growing continent?

- W) Stable platforms
- X) Shields
- Y) Folded mountains
- Z) Mountain cores

ANSWER: X) SHIELDS

TOSS-UP

21) Biology – *Multiple Choice* Which of the following is characteristic of ONLY prokaryotes?

- W) The processed RNA has a poly-A tail
- X) The processed RNA has a 5 prime cap
- Y) The primary transcript is longer than the mRNA
- Z) Transcription of the RNA occurs simultaneously with translation

ANSWER: Z) TRANSCRIPTION OF THE RNA OCCURS SIMULTANEOUSLY WITH TRANSLATION

BONUS

21) Biology – *Multiple Choice* Which of the following is NOT a density-dependent limiting factor in population growth?

- W) Disease
- X) Cooperation
- Y) Competition
- Z) Predation

ANSWER: X) COOPERATION

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### TOSS-UP

22) Energy – *Short Answer* Scientists at the Marqusee [*mar-KEES*] Lab at UC Berkeley are researching the effects of a protein's sequence and environment on the pathway it takes to fold to its native state. What quantity of the protein-environment system needs to be minimized to attain its native state?

ANSWER: FREE ENERGY (ACCEPT: GIBBS FREE ENERGY; HELMHOLTZ FREE ENERGY)

### BONUS

22) Energy – *Short Answer* Scientists in the Polly Arnold Group at UC Berkeley are using f-block elements as catalysts by bonding them to various exotic ligands. They noticed that actinides bond to ligands more readily than lanthanides, which can be best explained by what phenomenon?

ANSWER: LANTHANIDE CONTRACTION

### TOSS-UP

23) Chemistry – *Short Answer* Indicating proper charge, what is the oxidation state of nitrogen in ammonium?

ANSWER:  $-3$  (DO NOT ACCEPT:  $3$ ;  $+3$ )

### BONUS

23) Chemistry – *Multiple Choice* Which of the following gases is most soluble in water?

- W) Argon
- X) Carbon dioxide
- Y) Oxygen
- Z) Nitrogen

ANSWER: X) CARBON DIOXIDE