

BSB ROUND 5

TOSS-UP

1) Biology – *Multiple Choice* Which of the following is NOT part of the endomembrane system?

- W) Endoplasmic reticulum
- X) Golgi apparatus
- Y) Mitochondria
- Z) Lysosome

ANSWER: Y) MITOCHONDRIA

BONUS

1) Biology – *Short Answer* What are the two products of the dehydration reaction between glucose and fructose?

ANSWER: SUCROSE AND WATER

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### TOSS-UP

2) Physics – *Multiple Choice* A 256-gram radioactive sample with a half-life of 3 days is analyzed after 15 days. In grams, what is the amount of remaining radioactive material?

- W) 4
- X) 8
- Y) 16
- Z) 32

ANSWER: X) 8

### BONUS

2) Physics – *Short Answer* A conducting sphere with a total charge of 2 coulombs is initially placed 1 meter away from an infinite neutrally charged conducting plane and then moved to a distance of 0.5 meters away. What is the ratio of the final force to the initial force on the sphere?

ANSWER: 4

### TOSS-UP

3) Chemistry – *Multiple Choice* An unknown solution does not react with copper nitrate, but forms a white precipitate with sodium chloride. Which of the following compounds is most likely to be the unknown solution?

- W) Sodium hydroxide
- X) Silver nitrate
- Y) Potassium chloride
- Z) Sodium carbonate

ANSWER: X) SILVER NITRATE

### BONUS

3) Chemistry – *Multiple Choice* Which of the following 1-molar aqueous solutions will have the lowest pH?

- W) Sodium carbonate
- X) Sodium chloride
- Y) Ammonium chloride
- Z) Potassium bromide

ANSWER: Y) AMMONIUM CHLORIDE

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TOSS-UP

4) Math – *Short Answer* What is e to the power of the quantity 4 times the natural log of 3?

ANSWER: 81

BONUS

4) Math – *Short Answer* What is the dot product of the vectors $11\mathbf{i} + 5\mathbf{j} + 3\mathbf{k}$ and $8\mathbf{i} - 12\mathbf{j} + 17\mathbf{k}$?

ANSWER: 79

TOSS-UP

5) Energy – *Short Answer* Scientists in the Zuerch Lab at UC Berkeley study spin-dynamics in novel quantum materials to answer quantum computing and information storage questions. They must account for the fact that no two electrons may occupy a single quantum state, which is a statement of what principle?

ANSWER: PAULI EXCLUSION PRINCIPLE

BONUS

5) Energy – *Short Answer* Scientists in the Peidong Yang Group at UC Berkeley are investigating new methods of CO₂ reduction in order to convert it into usable fuels such as methanol. How many electrons are transferred to one molecule of CO₂ when it is reduced to methanol?

ANSWER: 6

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### TOSS-UP

6) Earth and Space – *Short Answer* What is the term for the hypothetical point of infinite density and space curvature at the center of a black hole?

ANSWER: SINGULARITY

### BONUS

6) Earth and Space – *Multiple Choice* Which of the following is NOT true regarding Triton?

- W) It follows a retrograde orbit about Neptune
- X) It is a captured object
- Y) It comprises more than 99% of the mass known to orbit Neptune
- Z) It has an elongated elliptical orbit

ANSWER: Z) IT HAS AN ELONGATED ELLIPTICAL ORBIT

### TOSS-UP

7) Chemistry – *Multiple Choice* Which of the following organic compounds contains  $sp^2$ -hybridized carbon atoms?

- W) Ethane
- X) Ethylene
- Y) Acetylene
- Z) Methyl cyanide

ANSWER: X) ETHYLENE

### BONUS

7) Chemistry – *Multiple Choice* Infrared radiation is most closely associated with which of the following?

- W) Molecular rotations
- X) Molecular vibrations
- Y) Electronic transitions
- Z) Optical transitions

ANSWER: X) MOLECULAR VIBRATIONS

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TOSS-UP

8) Math – *Short Answer* Solve the following equation for y when x is 2: $5x + 3$ times the quantity $\underline{y+2} = 2$.

ANSWER: $-24/13$

BONUS

8) Math – *Short Answer* Identify all of the following three functions that are odd about the origin: 1) e to the power $\underline{x^2}$; 2) Sine of the quantity $\underline{x^3}$; 3) Cosine of x .

ANSWER: 2 ONLY

TOSS-UP

9) Physics – *Multiple Choice* Consider two ideal copper wires. If one has twice the length and twice the cross-sectional area of the other, how do the resistances of these two wires compare?

- W) The longer wire has four times the resistance of the shorter wire
- X) The longer wire has twice the resistance of the shorter wire
- Y) Both wires have the same resistance
- Z) The shorter wire has twice the resistance of the longer wire

ANSWER: Y) BOTH WIRES HAVE THE SAME RESISTANCE

BONUS

9) Physics – *Short Answer* An electric dipole with a dipole moment of 10 coulomb meters is aligned with an electric field of 12 newtons per coulomb. How much work, in joules, must be done to rotate the dipole 60 degrees?

ANSWER: 60

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### TOSS-UP

10) Biology – *Short Answer* In a plant population, orange flowers are dominant to white flowers. In a population of 100 flowers, 25% show the recessive phenotype. How many flowers are homozygous dominant?

ANSWER: 25

### BONUS

10) Biology – *Multiple Choice* In gel electrophoresis, what substance is commonly used to stain and visualize DNA?

- W) Coomassie blue
- X) Ethidium bromide
- Y) Ponceau
- Z) Methylene red

ANSWER: X) ETHIDIUM BROMIDE

### TOSS-UP

11) Earth and Space – *Short Answer* What kind of tectonic plate boundary is indicated by Japan's volcanic island arc and trench system?

ANSWER: CONVERGENT

### BONUS

11) Earth and Space – *Short Answer* What astronomical object consists of an active galactic nucleus with a relativistic jet pointed towards the observer, characterized by a high-energy variable spectrum?

ANSWER: BLAZAR

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TOSS-UP

12) Energy – *Multiple Choice* Scientists in the Miller Group at UC Berkeley are studying how the brain transmits information from cell to cell by using neural dyes that can follow the signal transduction pathway through circuits and specific cells. What is the first step of the signal transduction pathway?

- W) Reduction
- X) Reception
- Y) Induction
- Z) Response

ANSWER: X) RECEPTION

BONUS

12) Energy – *Short Answer* Scientists in the Seljak lab study so-called weak lensing, using the distortion in the appearance of galaxies to understand the distribution of dark matter. What theory underpins this analysis?

ANSWER: GENERAL RELATIVITY

TOSS-UP

13) Earth and Space – *Short Answer* In what layer of the Sun do high velocity streams of protons and electrons, collectively known as solar wind, gush out?

ANSWER: CORONA

BONUS

13) Earth and Space – *Multiple Choice* Which of the following scales is incorrectly matched with the weather phenomenon it measures?

- W) Earthquake and Mercalli Scale
- X) Tornado and Saffir-Simpson Scale
- Y) Sunlight intensity and Campbell-Stokes Scale
- Z) Wind speed and Beaufort Scale

ANSWER: X) TORNADO AND SAFFIR-SIMPSON SCALE

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### TOSS-UP

14) Chemistry – *Short Answer* How many radial nodes does a 4d orbital possess?

ANSWER: ONE

### BONUS

14) Chemistry – *Multiple Choice* Which of the following compounds has the highest normal boiling point?

- W) HF
- X) HCl
- Y) HBr
- Z) HI

ANSWER: W) HF

### TOSS-UP

15) Biology – *Short Answer* Sickle-cell disease has multiple symptoms all caused by a single defective gene. This is an example of what phenomenon?

ANSWER: PLEIOTROPY

### BONUS

15) Biology – *Multiple Choice* Which of the following enzymes is incorrectly paired with its location?

- W) Pepsin and stomach
- X) Trypsin and stomach
- Y) Amylase and small intestine
- Z) Lipase and small intestine

ANSWER: X) TRYPSIN AND STOMACH

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TOSS-UP

16) Physics – *Short Answer* What adjective is used to describe light waves that have a constant phase difference over time?

ANSWER: COHERENT

BONUS

16) Physics – *Short Answer* The principle of minimum energy states that, at constant entropy, the internal energy of a closed system will be lowest at equilibrium. What physical law is this principle most directly a result of?

ANSWER: SECOND LAW OF THERMODYNAMICS

TOSS-UP

17) Math – *Short Answer* A line segment has endpoints of $(-2, 7)$ and $(2, -5)$. In slope-intercept form, what is the equation of the line with these two points?

ANSWER: $y = -3x + 1$

BONUS

17) Math – *Short Answer* What is the area of the circle that has the equation $x^2 + y^2 + 4x - 8y = 13$?

ANSWER: 33π

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### TOSS-UP

18) Energy – *Short Answer* Scientists in the Nomura Lab at UC Berkeley have been researching ways to target the “undruggable” proteome using proteolysis-targeting chimeras, or PROTACs. The targets are first tagged for degradation with what regulatory protein?

ANSWER: UBIQUITIN

### BONUS

18) Energy – *Multiple Choice* Scientists in the Nayak Lab at UC Berkeley are investigating how to use genome editing to study archaea that produce and consume the greenhouse gas methane. Which of the following is NOT considered a greenhouse gas?

- W) Ozone
- X) Carbon dioxide
- Y) Water vapor
- Z) Nitrogen

ANSWER: Z) NITROGEN

### TOSS-UP

19) Biology – *Multiple Choice* Which of the following structures in a seed is primarily responsible for providing nutrition to the developing embryo?

- W) Endosperm
- X) Seed coat
- Y) Synergids
- Z) Megasporangium [*mega-spore-ANGY-um*]

ANSWER: W) ENDOSPERM

### BONUS

19) Biology – *Multiple Choice* Which of the following organelles contains an oxygen evolving complex?

- W) Golgi Apparatus
- X) Ribosome
- Y) Chloroplast
- Z) Mitochondrion

ANSWER: Y) CHLOROPLAST

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TOSS-UP

20) Chemistry – *Short Answer* What is the pH of an aqueous solution of 10^{-3} molar NaOH?

ANSWER: 11

BONUS

20) Chemistry – *Multiple Choice* The reaction between a triglyceride and sodium hydroxide is also known as what process?

- W) Condensation
- X) Saponification
- Y) Esterification
- Z) Hydrolysis

ANSWER: X) SAPONIFICATION

TOSS-UP

21) Earth and Space – *Short Answer* The peaks of tall mountains can remain snow-capped in the summer due to the temperature gradient in which layer of the atmosphere?

ANSWER: TROPOSPHERE

BONUS

21) Earth and Space – *Short Answer* What is the name of the largest satellite galaxy of the Milky Way?

ANSWER: LARGE MAGELLANIC CLOUD

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**TOSS-UP**

22) Math – *Short Answer* What is the limit as  $x$  approaches infinity of the fraction with the numerator  $2x^3 - 14x - 17$  and the denominator of  $12x^3 - 22$ ?

ANSWER: 1/6

**BONUS**

22) Math – *Short Answer* If  $f$  of 5 is equal to 7 and  $f$  prime of 5 is equal to 20, estimate the value of  $f$  of 5.4.

ANSWER: 15

### TOSS-UP

23) Physics – *Short Answer* An extrinsic semiconductor is one that has undergone what process?

ANSWER: DOPING

### BONUS

23) Physics – *Multiple Choice* Protons are being accelerated at non relativistic velocities in a particle accelerator. When the speed of the protons is doubled, the de Broglie [*de-BROY*] wavelength will be multiplied by what factor?

W) 2

X) 1

Y) 1/2

Z) 1/4

ANSWER: Y) 1/2