

### TOSS-UP

1) Biology — *Multiple Choice* What part of the mammalian female reproductive tract is responsible for making gametes *[GAM-eets]*?

- W) Ovary
- X) Oviduct
- Y) Uterine horn
- Z) Uterine body

ANSWER: W) OVARY

### BONUS

1) Biology — *Short Answer* What enzyme is responsible for transcribing DNA to RNA in bacteria?

ANSWER: RNA POLYMERASE (ACCEPT: RNAP; do not accept: RNA polymerase II)

### TOSS-UP

2) Chemistry — *Multiple Choice* Consider a graph with the mass of a sample on the  $y$ -axis and the sample volume on the  $x$ -axis. Which of the following substances would have the steepest slope on this graph?

- W) Snow
- X) Ice
- Y) Rain
- Z) Steam


ANSWER: Y) RAIN

### BONUS

2) Chemistry — *Multiple Choice* Barium will form an ionic compound in a one-to-one ratio with which of the following elements?

- W) Titanium
- X) Arsenic
- Y) Sulfur
- Z) Iodine

ANSWER: Y) SULFUR



### TOSS-UP

3) Earth and Space — *Multiple Choice* Which of the following stars is located closest to the north celestial pole?

- W) Polaris
- X) Vega [*VAY-ga*]
- Y) Regulus [*REGG-yoo-lus*]
- Z) Rigel [*RYE-jel*]

ANSWER: W) POLARIS

### BONUS

3) Earth and Space — *Multiple Choice* White dwarfs are found in which of the following regions of the H-R diagram?

- W) Top right
- X) Top left
- Y) Bottom right
- Z) Bottom left

ANSWER: Z) BOTTOM LEFT

### TOSS-UP

4) Energy — *Multiple Choice* Scientists at Oak Ridge National Lab are searching for enzymes that can break down lignin. Lignin is found in the highest quantities in what plant tissue?

- W) Wood
- X) Leaf
- Y) Fruit
- Z) Seed

ANSWER: W) WOOD

### BONUS

4) Energy — *Multiple Choice* Scientists at Fermi National Accelerator Lab have measured the magnetic moment of the muon to high precision. Their value exceeded the prediction of theorists by 3.3 standard deviations. Which of the following percentages is closest to the probability of obtaining a value at least this large by chance, assuming that the theoretical value is in fact correct and the measurement error is normally distributed?

- W) 0.05
- X) 0.5
- Y) 2
- Z) 10

ANSWER: W) 0.05

### TOSS-UP

5) Math — *Short Answer* What is the square of the binomial  $x + 12$ ?

ANSWER:  $x^2 + 24x + 144$

### BONUS

5) Math — *Short Answer* Simplify the fraction with numerator 27 minus 45 and denominator 9 minus 12.

ANSWER: 6

## TOSS-UP

6) Physics — *Multiple Choice* Which of the following best describes why objects dropped in a vacuum on Earth will all fall with the same acceleration?

W) The balance of air resistance with gravity imposes a terminal velocity

X) Gravitational force does not depend on mass

Y) Buoyancy balances the force of gravity

Z) Gravitational force is proportional to mass while acceleration is inversely proportional to mass

ANSWER: Z) GRAVITATIONAL FORCE IS PROPORTIONAL TO MASS WHILE ACCELERATION IS INVERSELY PROPORTIONAL TO MASS

## BONUS

6) Physics — *Multiple Choice* Which of the following quantities would have the same units as pressure?

W) Energy times time

X) Force per area

Y) Volume times temperature

Z) Mass per volume

ANSWER: X) FORCE PER AREA

### TOSS-UP

7) Biology — *Short Answer* What is the term for the protective caps at the end of eukaryotic chromosomes that tend to shorten as the cell divides?

ANSWER: TELOMERES

### BONUS

7) Biology — *Multiple Choice* Botanists successfully created viable offspring between two different bamboos that live in the same forest, but noticed that these two species flower during different seasons. Which of the following types of isolation is occurring?

- W) Behavioral
- X) Mechanical
- Y) Geographic
- Z) Temporal

ANSWER: Z) TEMPORAL

### TOSS-UP

8) Chemistry — *Multiple Choice* What type of reaction combines an acid and a base to form a salt and water?

- W) Decomposition
- X) Neutralization
- Y) Single replacement
- Z) Redox

ANSWER: X) NEUTRALIZATION

### BONUS

8) Chemistry — *Short Answer* To the nearest gram, what is the mass of one-half mole of sodium chloride?

ANSWER: 29





## TOSS-UP

9) Earth and Space — *Multiple Choice* What moon is known for its thick nitrogen atmosphere and methane lakes?

W) Ganymede [*GAN-ih-meed*]

X) Titan

Y) Io [*EYE-oh*]

Z) Charon [*KAIR-on*]

ANSWER: X) TITAN

## BONUS

9) Earth and Space — *Short Answer* What greenhouse gas is primarily responsible for the runaway greenhouse effect on Venus?

ANSWER: CARBON DIOXIDE (ACCEPT: CO<sub>2</sub>)

### TOSS-UP

10) Energy — *Short Answer* Scientists at Lawrence Livermore National Lab have validated the possibility that planets composed primarily of hydrogen and helium may experience helium rain. One of the planets in our solar system thought to experience this phenomenon is what gas giant that is home to the great red spot superstorm?

ANSWER: JUPITER

### BONUS

10) Energy — *Short Answer* Pacific Northwest National Lab scientists are utilizing magnetic nanoparticles to extract a metal from brine water. What is this valuable, lightweight metal, known for its use in modern battery technology?

ANSWER: LITHIUM



### TOSS-UP

11) Math — *Short Answer* A 60-foot rope is stretched across 60 feet. How many cuts would be required to cut it into 6-foot sections?

ANSWER: 9

### BONUS

11) Math — *Short Answer* What is the product of the two radical expressions  $13\sqrt{5}$  and  $7\sqrt{5}$ ?

ANSWER: 455

### TOSS-UP

12) Physics — *Multiple Choice* Which of the following is the term for the phenomenon in which light striking a metal ejects electrons from its atoms?

- W) Work function
- X) Semiconductivity
- Y) Photoelectric effect
- Z) Brownian motion

ANSWER: Y) PHOTOELECTRIC EFFECT

### BONUS

12) Physics — *Short Answer* In joules, what is the kinetic energy of a 50-gram object at rest?

ANSWER: 0

### TOSS-UP

13) Biology — *Short Answer* What general process allows a plant to convert solar energy into chemical energy?

ANSWER: PHOTOSYNTHESIS

### BONUS

13) Biology — *Short Answer* Identify all of the following three organelles that are present in both eukaryotes and prokaryotes ***[PRO-care-ee-oats]***: 1) Nuclei; 2) Ribosomes; 3) Mitochondria.

ANSWER: 2

### TOSS-UP

14) Chemistry — *Multiple Choice* Which of the following atoms has the largest atomic radius?

- W) Potassium
- X) Carbon
- Y) Hydrogen
- Z) Fluorine

ANSWER: W) POTASSIUM

### BONUS

14) Chemistry — *Short Answer* Rank the following three elements in order of increasing valence electron counts: 1) Boron; 2) Sulfur; 3) Silicon.

ANSWER: 1, 3, 2

### TOSS-UP

15) Earth and Space — *Multiple Choice* The Geodynamo model is used to explain which of the following aspects of the Earth system?

- W) Tectonic plates
- X) Ocean circulation
- Y) Magnetic field
- Z) Ozone layer

ANSWER: Y) MAGNETIC FIELD

### BONUS

15) Earth and Space — *Multiple Choice* Which of the following best describes how geysers form?

- W) Spontaneous eruption from a pressurized, confined aquifer
- X) Separation of water-rich magma from molten rock as it cools and crystallizes
- Y) Superheating of groundwater by a nearby magma chamber
- Z) Squeezing of groundwater out of fractured rock by tectonic forces

ANSWER: Y) SUPERHEATING OF GROUNDWATER BY A  
NEARBY MAGMA CHAMBER

### TOSS-UP

16) Energy — *Short Answer* Brookhaven National Lab scientists are developing mathematical models of COVID-19 transmission in society. The goal of mass vaccination is to achieve what threshold, at which the immunized population is sufficiently large to shield the susceptible population?

ANSWER: HERD IMMUNITY

### BONUS

16) Energy — *Short Answer* Scientists at SLAC National Accelerator Lab are studying particles with different values of quantum mechanical spin. Identify all of the following three values that are possible values for the spin quantum number of an electron:  
1) Negative one-half; 2) Zero; 3) One-half.

ANSWER: 1, 3



### TOSS-UP

17) Math — *Short Answer* Round 4,269.08 to the nearest hundred.

ANSWER: 4,300

### BONUS

17) Math — *Short Answer* What is the  $y$ -intercept of the line perpendicular to the line with equation  $y = 3x - 4$  and intersecting it at the point  $(2, 2)$ ?

ANSWER:  $2 \frac{2}{3}$  (ACCEPT:  $\frac{8}{3}$ ,  $(0, \frac{8}{3})$ ,  $(0, 2 \frac{2}{3})$ )

### TOSS-UP

18) Physics — *Multiple Choice* Which of the following materials is an electric conductor?

- W) Ceramic
- X) Quartz
- Y) Plastic
- Z) Steel

ANSWER: Z) STEEL

### BONUS

18) Physics — *Short Answer* A car is traveling forwards at 20 meters per second when it begins accelerating forwards at 2.5 meters per second squared. In meters per second, what will its speed be after 15 seconds?

ANSWER: 57.5 (ACCEPT: 57½, 115/2)

Before we leave, let's confirm the team's score. What score does the Official Scorekeeper have? And what is the final score in the Chat Box? Does anyone disagree?

I'd like to remind the Scorekeeper to submit the official scoresheet. Best of luck to the team and thanks for competing in today's event.