

### **TOSS-UP**

1) Physics – *Short Answer* What phenomenon results in sound waves bending away from the hot ground on a warm day?

ANSWER: REFRACTION

### **BONUS**

1) Physics – *Short Answer* A container full of water to the brim weighs 25 pounds. If an 8-pound block of balsa wood is added to the container, and the water that spills out is removed, what will the final weight of the container-water-wood system be?

ANSWER: 25

### TOSS-UP

2) Biology – *Multiple Choice* Which of the following is most likely to be true of a sessile animal?

- W) It moves very rapidly
- X) It reproduces asexually
- Y) It is a filter feeder
- Z) It is highly cephalized

ANSWER: Y) IT IS A FILTER FEEDER

### BONUS

2) Biology – *Short Answer* Newborn salmon learn the chemical composition of the water in which they hatch so they can return to the same stream when it is time for them to spawn. This is an example of what type of learning?

ANSWER: IMPRINTING

### TOSS-UP

3) Chemistry – *Short Answer* The kinetic energies of particles in a gas tend to exhibit what distribution?

ANSWER: MAXWELL-BOLTZMANN (ACCEPT: BOLTZMANN)

### BONUS

3) Chemistry – *Short Answer* Identify all of the following three substances that are more acidic than distilled water: 1) Lemon juice; 2) Milk; 3) Ammonia.

ANSWER: 1, 2

### TOSS-UP

4) Earth and Space – *Multiple Choice* A rock formation is subjected to compressional forces at depths where ductile deformation occurs. Which of the following features will likely form?

W) Normal fault

X) Thrust fault

Y) Folds

Z) Thinning

ANSWER: Y) FOLDS

### BONUS

4) Earth and Space – *Short Answer* Place the following three organic materials in order of increasing metamorphic grade: 1) Peat; 2) Bituminous coal; 3) Lignite.

ANSWER: 1, 3, 2

### TOSS-UP

5) Energy – *Short Answer* Scientists at Brookhaven National Lab are making DNA origami. What two purines are found in DNA origami?

ANSWER: GUANINE AND ADENINE (ACCEPT: A AND G)

### BONUS

5) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab are studying protoplanets. Identify all of the following three solar system bodies that are thought to be protoplanets that never became planets: 1) Ceres; 2) Deimos; 3) Ganymede.

ANSWER: 1

### **TOSS-UP**

6) Math – *Short Answer* What is the remainder when 9876 is divided by 9?

ANSWER: 3

### **BONUS**

6) Math – *Short Answer* How many different ways are there to choose a set of 6 students from a class of 10?

ANSWER: 210

### TOSS-UP

7) Physics – *Multiple Choice* An ant is walking on the ground following a curving path. The magnitude of its velocity remains constant. John is tracking its speed in the  $x$  direction, while Poorvi is tracking its speed in the  $y$  direction. Which of the following functions of John and Poorvi's measurements will remain constant?

- W) The sum
- X) The sum of the squares
- Y) The difference of the squares
- Z) The absolute value of the sum

ANSWER: X) THE SUM OF THE SQUARES

### BONUS

7) Physics – *Multiple Choice* Consider a plot showing the temperature of water on the  $x$ -axis and its density on the  $y$ -axis. At what temperature, in degrees Celsius, does the diagram have a local maximum?

- W) 0
- X) 4
- Y) 32
- Z) 100

ANSWER: X) 4

### TOSS-UP

8) Biology – *Multiple Choice* Integral membrane proteins are firmly associated with the cell membrane lipid bilayer and are only removable by agents that interfere with what type of interactions?

W) Hydrophobic

X) Hydrophilic

Y) Covalent

Z) Ionic

ANSWER: W) HYDROPHOBIC

### BONUS

8) Biology – *Short Answer* What is the term for the microscopic blood vessels across which gas and nutrient exchange occurs?

ANSWER: CAPILLARIES



### TOSS-UP

9) Chemistry – *Short Answer* Benzene's stability can be ascribed to delocalized electrons in what type of molecular orbital?

ANSWER: PI

### BONUS

9) Chemistry – *Short Answer* What is the term for a molecule that can act as both a Bronsted-Lowry acid and base?

ANSWER: AMPHIPROTIC (ACCEPT: AMPHOTERIC)

## TOSS-UP

10) Earth and Space – *Short Answer* The intertropical convergence zone, or ITCZ, is found in the area where what set of prevailing winds converge?

ANSWER: TRADE WINDS (ACCEPT: TROPICAL EASTERLIES)

## BONUS

10) Earth and Space – *Multiple Choice* Radon, an element that causes lung cancer, may seep into homes and buildings and concentrate in re-circulated air. Which of the following best describes the source of most radon?

W) Chrysotile asbestos used for insulation releases radon when disturbed

X) Sulfuric acid in groundwater reacts with home building materials to produce radon

Y) Garden pesticides release radon when reacting with home building materials

Z) Uranium in surrounding rocks produces radon through radioactive decay

ANSWER: Z) URANIUM IN SURROUNDING ROCKS  
PRODUCES RADON THROUGH RADIOACTIVE DECAY

## TOSS-UP

11) Energy – *Short Answer* Scientists supported by the Department of Energy are studying mycorrhizae. These structures are an example of what type of symbiosis in which both organisms benefit?

ANSWER: MUTUALISM

## BONUS

11) Energy – *Multiple Choice* Scientists at Brookhaven National Laboratory are studying spintronic devices. Which of the following is a difference between electronics, which relies on electric charge, and spintronics, which relies on the quantum-mechanical spin of electrons?

- W) Spintronics can only be used in quantum computers
- X) Electronics produces less heat than spintronics
- Y) Electrons do not need to move for spintronics
- Z) Spintronic devices must be superconducting

ANSWER: Y) ELECTRONS DO NOT NEED TO MOVE FOR SPINTRONICS

### **TOSS-UP**

12) Math – *Short Answer* What is 7 to the negative one power plus 7 to the negative two power?

ANSWER: 8/49

### **BONUS**

12) Math – *Short Answer* When applying the Euclidean algorithm to find the greatest common divisor of 238 and 349, what is the remainder after the third step?

ANSWER: 15

### TOSS-UP

13) Physics – *Short Answer* What derived SI unit is used to measure force?

ANSWER: NEWTON (ACCEPT: KILOGRAM-METERS PER SECOND SQUARED)

### BONUS

13) Physics – *Short Answer* If sound A is 1000 times as intense as sound B, then, in decibels, how much louder is sound A than sound B?

ANSWER: 30

### TOSS-UP

14) Biology – *Short Answer* What organelle reads mRNA transcripts to produce proteins?

ANSWER: RIBOSOME

### BONUS

14) Biology – *Multiple Choice* What is the term for the site on an enzyme that a substrate binds to?

W) Allosteric site

X) Inhibitory site

Y) Activated complex

Z) Active site

ANSWER: Z) ACTIVE SITE

### **TOSS-UP**

15) Chemistry – *Short Answer* What is the SI unit for amount of substance?

ANSWER: MOLE

### **BONUS**

15) Chemistry – *Short Answer* Rank the following three elements in order of increasing atomic radius: 1) Magnesium; 2) Silicon; 3) Chlorine.

ANSWER: 3, 2, 1

### TOSS-UP

16) Earth and Space – *Multiple Choice* Why are tropical regions of Earth warmer than polar regions?

W) The atmosphere's circulation transports heat from polar regions to tropical regions

X) The ocean's circulation transports heat from polar regions to tropical regions

Y) Earth's spherical shape means that tropical regions are closer to the Sun than polar regions

Z) Earth's spherical shape means that tropical regions receive more direct solar radiation than polar regions

ANSWER: Z) EARTH'S SPHERICAL SHAPE MEANS THAT TROPICAL REGIONS RECEIVE MORE DIRECT SOLAR RADIATION THAN POLAR REGIONS

### BONUS

16) Earth and Space – *Multiple Choice* Which of the following statements regarding ocean acidification is TRUE?

W) The primary cause of falling seawater pH is acid precipitation

X) The average pH of the global surface ocean is expected to fall below 6 by the year 2050

Y) The average pH of the global surface ocean is currently less than 7

Z) Ocean acidification is harmful to calcifying marine organisms

ANSWER: Z) OCEAN ACIDIFICATION IS HARMFUL TO CALCIFYING MARINE ORGANISMS



### TOSS-UP

17) Energy – *Short Answer* Scientists at Brookhaven National Laboratory have built an electron cooling system, which lowers the temperature in their ion beams by injecting cool electrons to mix with the warm ions. What is the name of the law that implies that heat can only flow spontaneously from a hotter body to a colder body?

ANSWER: SECOND LAW OF THERMODYNAMICS (ACCEPT: NEWTON'S LAW OF COOLING)

### BONUS

17) Energy – *Short Answer* Scientists at Pacific Northwest National Lab are utilizing nanoparticles with a magnetite core that could be used to extract valuable elements from wastewater. Given that the iron in magnetite has an average oxidation state of +2 and 2/3, what is the empirical formula of magnetite?

ANSWER:  $\text{Fe}_3\text{O}_4$

### TOSS-UP

18) Math – *Short Answer* A 10-by-20 rectangular wall is tiled with 200 unit square tiles. If the topmost row and the leftmost column are removed, how many of the original tiles remain?

ANSWER: 171

### BONUS

18) Math – *Short Answer* Find the degree measure of the larger of two supplementary angles if one is 8 degrees less than 3 times the other.

ANSWER: 133