

### TOSS-UP

1. Chemistry *Short Answer* Name all of the following 3 elements that are found almost exclusively in one oxidation state:

- 1) Iron
- 2) Manganese
- 3) Carbon

ANSWER: NONE [EY]

### BONUS

1. Chemistry *Multiple Choice* The pH of a 0.01 M solution of a strong acid is 2 since all of the acid dissociates. The pH of 0.01 M solution of acid **A** is found to be 1.7. Which of the following could be an explanation for why the pH of acid **A** is lower than that of a strong acid?

- W) **A** is a weak acid
- X) **A** forms hydrogen bonds, lowering acidity
- Y) **A** is diprotic
- Z) The pH meter must have been wrong; these results are impossible

ANSWER: Y) **A** IS DIPROTIC [YL]

### TOSS-UP

2. Math *Short Answer* The Blair Scibowl A team's 5 members are trying to take a photo together. If they are standing in a line, but Yunyi and Dr. Chen cannot be next to each other, how many ways are there to order them?

ANSWER: 72 [CW]

### BONUS

2. Math *Short Answer* Chris is playing a game of life and death against Yunyi. Each player rolls two fair six-sided dice. To win the game, a player must roll a sum of 7 on their turn. The game continues until someone wins, and Chris goes first. What is the probability that Chris wins?

ANSWER: 6/11 [CW]

### TOSS-UP

3. Earth and Space *Short Answer* Because its gravity keeps the rings of Saturn confined to their paths, Mimas is known as what kind of object?

ANSWER: SHEPHERD MOON [SC]

**BONUS**

3. Earth and Space *Short Answer* Identify all of the following 4 quantities that typically increases as a lava becomes more basaltic:

- 1) Gas content
- 2) Viscosity
- 3) Silica content
- 4) Eruption Explosiveness

ANSWER: NONE [YL]

**TOSS-UP**

4. Biology *Short Answer* Respiratory Distress Syndrome is caused by a deficiency in what substance, which is used to reduce surface tension in the lungs?

ANSWER: SURFACTANT [KD]

**BONUS**

4. Biology *Short Answer* Identify all of the following 3 groups of protists that settle as siliceous ooze:

- 1) Forams
- 2) Radiolarians
- 3) Diatoms

ANSWER: 2 AND 3 [KD]

**TOSS-UP**

5. Physics *Multiple Choice* Which of the following accurately describes the distribution of current flow through an idealized, perfectly conducting wire?

- W) Evenly distributed throughout the interior
- X) Unevenly distributed throughout the interior
- Y) Entirely distributed along the surface
- Z) It depends on the shape of the wire

ANSWER: Y) ENTIRELY DISTRIBUTED ALONG THE SURFACE [SC]

### BONUS

5. Physics *Short Answer* Stephen is speeding on a highway. He is driving at a comically high speed of 300 meters per second past a police officer who is initially at rest. The moment Stephen passes by, the police officer immediately accelerates at a constant rate of 10 meters per second squared to catch up to him. If Stephen maintains a constant speed throughout, how long in seconds does it take for the police officer to catch him?

ANSWER: 60 [YL]

### TOSS-UP

6. Chemistry *Short Answer* What is the molecular formula for sodium hypobromite?

ANSWER: NaBrO [EZ]

### BONUS

6. Chemistry *Short Answer* What is the VSEPR [VESP-ER] structure of sulfur tetrafluoride?

ANSWER: SEE-SAW [EZ]

### TOSS-UP

7. Math *Short Answer* How many diagonals does a regular decagon have?

ANSWER: 35 [EZ]

### BONUS

7. Math *Short Answer* Many expected value problems can be simplified significantly using the property that the expected value for the sum of variables, independent or dependent, is equal to the sum of their expected values. What is the name for this property?

ANSWER: LINEARITY OF EXPECTATION [YL]

### TOSS-UP

8. Earth and Space *Multiple Choice* Which of the following moons in the solar system is the most irregular in shape?

W) Phobos

- X) Tritan
- Y) Enceladus
- Z) Ganymede

ANSWER: W) PHOBOS [YL]

### BONUS

8. Earth and Space *Short Answer* What is the most common mineral found in the rings of Saturn?

ANSWER: ICE (ACCEPT: WATER ICE) [SC]

### TOSS-UP

9. Biology *Multiple Choice* Which of the following is not a mechanism of sympatric speciation?

- W) Allopolyploidy
- X) Geographic separation
- Y) Habitat Differentiation
- Z) Sexual selection

ANSWER: X) GEOGRAPHIC SEPARATION [KD]

### BONUS

9. Biology *Multiple Choice* One cell that is observed to have high concentrations of Maturation Promoting Factor is fused with another cell that is observed to be in the process of duplicating its centrosome. Which of the following phases of the cell cycle would the resulting cell most likely be in?

- W) G0
- X) S
- Y) G2
- Z) M

ANSWER: Z) M [KD]

### TOSS-UP

10. Physics *Multiple Choice* Which of the following effects describes the expulsion of magnetic fields from the interior of superconductors, and is responsible for small-scale magnetic levitation displays?

- W) Meissner effect
- X) Josephson effect
- Y) Ferromagnetism
- Z) Faraday's Law

ANSWER: W) MEISSNER EFFECT [RY]

### BONUS

10. Physics *Multiple Choice* A boat with a very dense rock inside floats inside of a sink filled with water. If a person takes the rock out of the boat and throws it into the water, which of the following will occur?

- W) The boat will sink, the water rises
- X) The boat will sink, the water lowers
- Y) The boat will float, the water rises
- Z) The boat will float, the water lowers

ANSWER: Z) The boat will float, the water lowers [RY]

### TOSS-UP

11. Chemistry *Short Answer* Caleb is taking performance-enhancing drugs. If there are initially 160 milligrams of drugs in Caleb's bloodstream with a half-life of 2 hours, how many milligrams of drugs are in his bloodstream after 6 hours?

ANSWER: 20 [AY]

### BONUS

11. Chemistry *Short Answer* Rank the following 3 acid solutions in order of increasing pH in water:

- 1) 1M H<sub>2</sub>SO<sub>4</sub>
- 2) 2M HCl
- 3) 6M H<sub>3</sub>PO<sub>4</sub>

ANSWER: 2, 1, 3 [AY]

### TOSS-UP

12. Math *Multiple Choice* Given that  $\log(2)$  is approximately 0.3,  $\log(3)$  is approximately 0.5, and  $\log(5)$  is approximately 0.7. Which of the following is closest to  $\log(900)$ ?

- W) 2.4

- X) 2.6
- Y) 2.8
- Z) 3.0

ANSWER: Z) 3.0 [EZ]

### BONUS

12. Math *Short Answer* There are 7 boxes numbered 1 through 7 with 6 balls in each box. The box labeled with the number  $x$  contains  $x-1$  green balls and  $7-x$  red balls. A box is chosen at random and a ball is drawn at random from it. If the ball is red, what is the probability it came from box number 1?

ANSWER: 2/7 [EZ]

### TOSS-UP

13. Earth and Space *Short Answer* Identify all of the following 3 moons that are known to exhibit magmatic volcanism?

- 1) Io
- 2) Europa
- 3) Ganymede

ANSWER: 1 ONLY [SC]

### BONUS

13. Earth and Space *Short Answer* Identify all of the following 3 minerals that have zero planes of cleavage:

- 1) Fluorite
- 2) Quartz
- 3) Feldspar

ANSWER: 2 ONLY [YL]

### TOSS-UP

14. Biology *Short Answer* Chymotrypsin (*KY-mo-TRIP-sin*) is an enzyme known for cleaving peptides at the C-terminus of amino acids with aromatic side chains. Identify all of the following 3 amino acids at which a peptide is likely to be cleaved by chymotrypsin:

- 1) Phenylalanine
- 2) Tyrosine
- 3) Tryptophan

ANSWER: ALL [KD]

### BONUS

14. Biology *Multiple Choice* Lucas just had an ischemic (*is-KEE-mic*) stroke due to his bad drinking habits - now, he has fluent aphasia and can't understand anything the people around him are saying. What region of the brain did he most likely damage?

- W) Hypothalamus
- X) Wernicke's Area
- Y) Broca's Area
- Z) Prefrontal Cortex

ANSWER: X) WERNICKE'S AREA [MS]

### TOSS-UP

15. Physics *Short Answer* Galilean transformations in classical physics predict that an object can accelerate to infinite velocity. However, special relativity states that the maximum possible speed is the speed of light. What alternative transformations are instead used that approximate Galilean transformations at non-relativistic speeds but hold for relativistic speeds as well?

ANSWER: LORENTZ TRANSFORMATIONS [YL]

### BONUS

15. Physics *Short Answer* A configuration of point charges is created such that the electric field due to the point charges is proportional to distance to the power of -6. What is the ratio of the electric potential energy of an electron positioned 2 meters away to that of an alpha particle positioned 4 meters away?

ANSWER: -16 (DO NOT ACCEPT: 16) [YL]

### TOSS-UP

16. Chemistry *Multiple Choice* What properly describes the relative inactivity of the outermost s electrons in post-transition metals?

- W) Octet rule
- X) Lanthanide contraction

- Y) Inert pair effect
- Z) Jahn-Teller effect [**YAN-teller**]

ANSWER: Y) INERT PAIR EFFECT [**AY**]

### BONUS

16. Chemistry *Short Answer* How many alpha decays are required during the decay pathway from uranium-238 to lead-206?

ANSWER: 8 [**YL**]

### TOSS-UP

17. Math *Short Answer* How many edges does a pentagonal pyramid have?

ANSWER: 10 [**EZ**]

### BONUS

17. Math *Multiple Choice* What conic section is represented by the locus of points that are equidistant from a point and a line?

- W) Circle
- X) Ellipse
- Y) Parabola
- Z) Hyperbola

ANSWER: Y) PARABOLA [**EZ**]

### TOSS-UP

18. Earth and Space *Short Answer* Identify all of the following 3 rocks that are sedimentary:

- 1) Limestone
- 2) Andesite
- 3) Bituminous coal

ANSWER: 1 AND 3 [**YL**]

### BONUS

18. Earth and Space *Multiple Choice* Which of the following effects is causing small particles to disappear from Saturn's rings?



- W) Poynting-Robertson drag
- X) Magnetostatic force
- Y) Electrostatic force
- Z) Gravitational force

ANSWER: X) MAGNETOSTATIC FORCE [SC]

#### TOSS-UP

19. Biology *Short Answer* Steph is analyzing some onion cells with his new super high focus microscope. Identify all of the following 3 organelles that would likely be present in these cells:

- 1) Mitochondria
- 2) Centrioles
- 3) Lysosomes

ANSWER: 1 ONLY [KD]

#### BONUS

19. Biology *Multiple Choice* A keystone species is removed from an ecosystem. Which of the following outcomes is most likely to occur as a direct result?

- W) A decrease in species diversity
- X) An increase in primary productivity
- Y) Stabilization of the trophic structure
- Z) A decrease in competition among remaining species

ANSWER: W) A DECREASE IN SPECIES DIVERSITY [MS]

#### TOSS-UP

20. Physics *Short Answer* Identify all of the following three quantities that, when doubled, would increase the spacing between bands of a Young's double-slit experiment: 1: Wavelength of the light; 2: Distance between the two slits; 3: Distance from the slits to the screen.

ANSWER: 1 AND 3 [YL]

#### BONUS

20. Physics *Short Answer* A particle with mass 5 kilograms travels along the x-axis with a displacement as a function of time of  $x(t) = 3t^2 - 5t + 12$ . What is the net work done in joules on the particle between  $t = 0$  and  $t = 2$ ?

ANSWER: 60 [YL]