

## ROUND 16A

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### TOSS-UP

1) BIOLOGY *Multiple Choice* Which of the following glial cell types makes up the blood-brain barrier?

- W) Astrocytes
- X) Oligodendrocytes [***OL-i-goh-DEN-ruh-syts***]
- Y) Radial glia
- Z) Schwann cells

ANSWER: W) ASTROCYTES

### BONUS

1) BIOLOGY *Short Answer* Dopamine, norepinephrine [***nohr-ep-uh-NEF-rin***], and epinephrine [***e-puh-NE-frin***] are all derivatives of what amino acid?

ANSWER: TYROSINE

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### TOSS-UP

2) CHEMISTRY *Short Answer* Identify all of the following three instruments or techniques that could be used to determine the concentration of an unknown solution of acetic acid: 1) titration, 2) potentiostat, 3) ion-exchange column.

ANSWER: 1 AND 2 (ACCEPT: TITRATION AND POTENTIOSTAT)

### BONUS

2) CHEMISTRY *Multiple Choice* For a second-order kinetic process where 1 molecule of A irreversibly becomes 1 molecule of B, which of the following plots would generate a line?

- W) Plotting the concentration of A versus time
- X) Plotting one over the concentration of A versus time
- Y) Plotting the log of the concentration of A versus time
- Z) Plotting the exponential of the concentration of A versus time

ANSWER: X) PLOTTING ONE OVER THE CONCENTRATION OF A VERSUS TIME

### TOSS-UP

3) MATH *Short Answer* What is the limit as  $x$  approaches 3 of  $\frac{(x^2-9)}{(x^4-81)}$  [*open parenthesis x squared minus nine close parenthesis divided by open parenthesis x to the fourth minus eighty-one close parenthesis*]?

W) 1

X)  $\frac{1}{9}$

Y)  $\frac{1}{18}$

Z)  $\frac{1}{27}$

ANSWER: Y)  $\frac{1}{18}$

### BONUS

3) MATH *Short Answer* Indicate all of the following three possible values for  $c$  so that the equation  $2x^2 - 3x + c = 0$  [*two x squared minus three x plus c equals zero*] has roots that are irrational: -1, -2, -3.

ANSWER: -1 AND -3

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### TOSS-UP

4) PHYSICS *Short Answer* A single semiconductor crystal that has been selectively doped with small amounts of phosphorous on one end, and aluminum on the other end, creates what type of connection?

ANSWER: P-N JUNCTION

### BONUS

4) PHYSICS *Short Answer* Consider a linear temperature scale, J, on which the boiling point of water is 65 degrees J and the freezing point is negative 15 degrees J. To what temperature in degrees Fahrenheit does a temperature of negative 55 degrees J correspond?

ANSWER: -58

### TOSS-UP

5) EARTH AND SPACE *Multiple Choice* Much of Tibet lies in altitudes above 17,000 feet. At such altitudes, which of the following best approximates the percentage of the atmosphere below the Tibetans?

- W) 10%
- X) 50%
- Y) 90%
- Z) 99%

ANSWER: X) 50%

### BONUS

5) EARTH AND SPACE *Multiple Choice* Some individual minerals in metamorphic rocks are bounded by their crystal faces. What adjective identifies this type of rock?

- W) Xenoblastic [**ZEN-uh-BLAYS-tik**]
- X) Idioblastic [**ID-ee-uh-BLAS-tik**]
- Y) Crystalloblastic
- Z) Porphyroblastic [**POR-fi-roh-BLAS-tik**]

ANSWER: X) IDIOBLASTIC

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### TOSS-UP

6) CHEMISTRY *Multiple Choice* Which of the following describes the conditions of a process that would be impossible without an energy input?

- W)  $\Delta G < 0$ ;  $\Delta H < 0$ ;  $\Delta S > 0$
- X)  $\Delta G > 0$ ;  $\Delta H > 0$ ;  $\Delta S > 0$
- Y)  $\Delta G < 0$ ;  $\Delta H < 0$ ;  $\Delta S < 0$
- Z)  $\Delta G > 0$ ;  $\Delta H > 0$ ;  $\Delta S < 0$

ANSWER: Z)  $\Delta G > 0$ ;  $\Delta H > 0$ ;  $\Delta S < 0$

### BONUS

6) CHEMISTRY *Multiple Choice* Which of the following statements is TRUE regarding calorimetry and heating curves?

- W) Bomb calorimeters directly measure the change in enthalpy of a reaction
- X) A heating curve plots pressure versus temperature and is divided into three regions
- Y) Regions depicting a phase change are flat on a heating curve
- Z) The steeper the slope of a heating curve, the higher the heat capacity of that phase

ANSWER: Y) REGIONS DEPICTING A PHASE CHANGE ARE FLAT ON A HEATING CURVE

### TOSS-UP

7) BIOLOGY *Multiple Choice* Which of the following vitamins is NOT fat soluble?

- W) Tocopherol [*toh-KOF-uh-rol*]
- X) Phylloquinone [*fil-oh-KWIN-ohn*]
- Y) Biotin
- Z) Calciferol [*kal-SIF-uh-rol*]

ANSWER: Y) BIOTIN

### BONUS

7) BIOLOGY *Multiple Choice* Ribulose-1,5-bisphosphate carboxylase [*kahr-BOK-suh-layz*]/oxygenase [*OK-si-juh-nays*], also known as RuBisCO, is an enzyme present in photosynthetic plants and is thought to be the most abundant protein on earth. Which of the following is NOT a reason that plants produce such large quantities of RuBisCO?

- W) RuBisCO is a slow-acting enzyme
- X) RuBisCO lacks specificity for carbon
- Y) RuBisCO is inhibited by carbon dioxide
- Z) Plants build large aggregate complexes of RuBisCO

ANSWER: Y) RuBisCO IS INHIBITED BY CARBON DIOXIDE

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### TOSS-UP

8) ENERGY *Multiple Choice* Graphite is a fantastic electrical conductor. What is its crystal structure?

- W) Tetragonal
- X) Planar
- Y) Octahedral
- Z) Buckeyballs

ANSWER: X) PLANAR

### BONUS

8) ENERGY *Short Answer*: What principle of spectroscopy states that electronic transitions generally happen faster than the vibrational timescale and, by extension, that electronic transitions will only occur if the vibrational wave functions of the two states overlap significantly?

ANSWER: FRANCK-CONDON PRINCIPLE

### TOSS-UP

9) EARTH AND SPACE *Multiple Choice* Evidence of which of the following was gathered from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) and indicates possible low grade subsurface metamorphism on Mars?

- W) Highly folded strata
- X) Hornfels and greenstone
- Y) Magnesium-rich carbonates
- Z) Alteration clays

ANSWER: Z) ALTERATION CLAYS

### BONUS

9) EARTH AND SPACE *Multiple Choice* In the early stages of formation, river valleys exhibit which of the following characteristics?

- W) V- shaped cross sections
- X) Water tables
- Y) Moraines
- Z) U-shaped cross sections

ANSWER: W) V- SHAPED CROSS SECTIONS

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### TOSS-UP

10) MATH *Short Answer* What is the lateral surface area of a right circular cone with radius 5 and height 12?

ANSWER:  $65\pi$

### BONUS

10) MATH *Short Answer* In a 30-60-90 right triangle, the 60 degree angle is bisected. What is the ratio of the segments into which the bisector divides the opposite leg?

ANSWER: ONE HALF (ACCEPT: 2)

### TOSS-UP

11) BIOLOGY *Short Answer* Name the growth response to generalized mechanical disturbances in plants.

ANSWER: THIGMOMORPHOGENESIS (ACCEPT: THIGMOTROPISM)

### BONUS

11) BIOLOGY *Short Answer* In plants, what class of ground tissue is responsible for most of the plants' photosynthesis?

ANSWER: PARENCHYMA

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### TOSS-UP

12) CHEMISTRY *Multiple Choice* Which of the following molecules has T-shaped molecular geometry?

W)  $\text{BF}_3$

X)  $\text{NF}_3$

Y)  $\text{ClF}_3$  [**C-L-F three**]

Z)  $\text{SO}_3$

ANSWER: Y)  $\text{ClF}_3$

### BONUS

12) CHEMISTRY *Short Answer* An adsorption isotherm apparatus consists of a dosing chamber with a volume of 30 milliliters as well as a sample chamber. The two airtight chambers are initially separated by a valve and at a pressure of 0 torr. Helium gas is let into the dosing chamber until the pressure reaches 600 torr. The valve is then opened, and the helium expands into the sample chamber. Once the pressure has equilibrated between both chambers, it is measured to be 400 torr. In milliliters to two significant figures, determine the volume of the sample chamber.

ANSWER: 15

### TOSS-UP

13) PHYSICS *Short Answer* What phenomenon, often observed when nuclear waste is stored in water, occurs when charged particles travel through a medium faster than the speed of light in that medium?

ANSWER: CHERENKOV RADIATION (ACCEPT: VAVILOV-CHERENKOV RADIATION, CHERENKOV LIGHT)

### BONUS

13) PHYSICS *Short Answer* A rocket is at rest in deep space. It suddenly experiences a linear acceleration of 50 meters per second squared for 5 seconds, coasts for 3.0 seconds, and then decelerates at 2.0 meters per second squared until coming to a halt. How far, in meters and to two significant figures, does the rocket travel during the deceleration phase of its journey?

ANSWER: 16,000 METERS

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### TOSS-UP

14) EARTH AND SPACE *Multiple Choice* Which of the following lavas does not have a modern analog?

- W) Komatiite [*kuh-MA-ti-yt*]
- X) Natrocarbonotite
- Y) Phonolite
- Z) Boninite

ANSWER: W) KOMATIITE

### BONUS

14) EARTH AND SPACE *Short Answer* What is the hottest class of brown dwarfs?

ANSWER: L (ACCEPT: L DWARF, M, M DWARF)

### TOSS-UP

15) BIOLOGY *Multiple Choice* Which of the following amniotic egg structures does NOT match its function?

- W) Amnion, protects developing embryo in fluid filled sac
- X) Yolk sac, stockpiles nutrients
- Y) Chorion [**KOHR-ee-on**], facilitates gas exchange
- Z) Allantois, connects yolk to embryo

ANSWER: Z) ALLANTOIS, CONNECTS YOLK TO EMBRYO

### BONUS

15) BIOLOGY *Multiple Choice* Which of the following does albumin [**al-BYOO-muhn**] help to regulate?

- W) Osmotic pressure
- X) Electron transport
- Y) DNA repair
- Z) Heme maturation [**HEEM**]

ANSWER: W) OSMOTIC PRESSURE

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### TOSS-UP

16) MATH *Short Answer* There are 50 people in a room: 28 are male and 32 are in college. Twelve are males in college. How many women who are not in college are in the room?

ANSWER: 2

### BONUS

16) MATH *Short Answer* Set A consists only of positive integers less than or equal to 100, where no two elements of the set sum to 149. What is the maximum possible number of elements in set A?

ANSWER: 74



### TOSS-UP

17) ENERGY *Multiple Choice* Which of the following is NOT a role that large-scale batteries could play in a power generation portfolio based on renewable energy sources?

- W) Frequency modulation
- X) Peak shaving
- Y) Load leveling
- Z) Voltage modulation

ANSWER: W) FREQUENCY MODULATION

### BONUS

17) ENERGY *Short Answer* What term describes quantities that are independent of a system's path, such as enthalpy and entropy?

ANSWER: STATE FUNCTIONS (ACCEPT: FUNCTIONS OF STATE, STATE VARIABLES)

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### TOSS-UP

18) CHEMISTRY *Multiple Choice* Drift and diffusion both describe the movement of particles. Which of the following is an example of drift?

- W) Random thermal motion of holes
- X) Atoms moving from areas of high concentration to areas of low concentration
- Y) Electrons moving to the anode
- Z) Dopants moving into a semiconductor

ANSWER: Y) ELECTRONS MOVING TO THE ANODE

### BONUS

18) CHEMISTRY *Multiple Choice* Which of the following best explains why titanium dichloride is a solid at room temperature, but titanium tetrachloride is a liquid?

- W) The Ti-Cl bond in titanium tetrachloride has more covalent character
- X) The Ti-Cl bond in titanium tetrachloride has more ionic character
- Y) Titanium dichloride forms a molecular solid, whereas titanium tetrachloride does not
- Z) The presence of more gaseous chlorine lowers the melting point of titanium tetrachloride

ANSWER: W) THE Ti-Cl BOND IN TITANIUM TETRACHLORIDE HAS MORE COVALENT CHARACTER

### TOSS-UP

19) BIOLOGY *Short Answer* What group of orange unsaturated hydrocarbons is primarily synthesized by plants for use as photosynthetic pigments and also contains a biologically inactive form of vitamin A?

ANSWER: CAROTENES

### BONUS

19) BIOLOGY *Multiple Choice* Which of the following is true regarding plant ground tissue?

W) Parenchyma [*puh-RENG-kuh-muh*] is mostly responsible for structural support

X) Collenchyma [*kuh-LENG-kuh-muh*] consists of dead cells with thick cell walls

Y) Sclerenchyma [*skli-RENG-kuh-muh*] is the most lignified type of ground tissue

Z) Sclerenchyma cells can adapt to stress conditions at maturity

ANSWER: Y) SCLERENCHYMA IS THE MOST LIGNIFIED TYPE OF GROUND TISSUE

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### TOSS-UP

20) PHYSICS *Short Answer* Identify all of the following three elements that could be used as dopants in germanium to make an *n*-type semiconductor: 1) phosphorous; 2) boron; 3) antimony.

ANSWER: 1 AND 3 (ACCEPT: PHOSPHOROUS AND ANTIMONY)

### BONUS

20) PHYSICS *Short Answer* You throw a tennis ball directly downwards from the top of a building at 6 meters per second. At the same moment, your friend throws a ball directly downwards from the top of another building at 16 meters per second. Assuming the balls hit the ground with the same velocity and that  $g = 10$  meters per second squared, what is the difference in heights of the two buildings, in meters?

ANSWER: 11

### TOSS-UP

21) ENERGY *Multiple Choice* Which of the following compounds acts as a catalyst in the production of biodiesel from oils?

- W) Vegetable oil
- X) Lye
- Y) Methanol
- Z) Copper

ANSWER: X) LYE

### BONUS

21) ENERGY *Short Answer* What quantum mechanical approximation states that nuclei move much more slowly than electrons, and thus can be neglected in the molecular Hamiltonian?

ANSWER: BORN-OPPENHEIMER APPROXIMATION

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### TOSS-UP

22) MATH *Short Answer* Consider a genetics experiment in which you do a dihybrid cross for two genes that you believe will segregate independently. What simple statistical test would be most useful, and least complicated, for determining whether or not there is a significant difference between the observed distribution of genes and the calculated distribution of genes?

ANSWER: CHI SQUARE TEST (ACCEPT: PEARSON'S CHI SQUARE TEST)

### BONUS

22) MATH *Short Answer* The first term in a sequence is 2014, and each successive term is the sum of the cubes of the digits of the term immediately preceding it. What is the 100<sup>th</sup> term?

ANSWER: 370

### TOSS-UP

23) CHEMISTRY *Multiple Choice* Identify which one of the following statements about Boltzmann distribution of energy is false.

- W) Degenerate states have the same energy and will be equally populated
- X) An exponential increase in population with increasing temperature is predicted
- Y) More states are significantly populated if energy level spacings are near  $kT$
- Z) At  $T = 0$ , only the lowest energy state is occupied

ANSWER: X) AN EXPONENTIAL INCREASE IN POPULATION WITH INCREASING TEMPERATURE IS PREDICTED

### BONUS

23) CHEMISTRY *Short Answer* Two moles of calcium nitrate are dissolved in 1 kilogram of water. Approximating the boiling-point-elevation constant of water as  $0.5\text{ }^{\circ}\text{Celsius per molal}$ , and reporting your answer to the nearest degree Celsius, what is the boiling point at standard pressure for this solution?

ANSWER:  $103^{\circ}\text{C}$