

## ROUND 10

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### TOSS-UP

1) MATH *Multiple Choice* In the graph of the function  $f(x) = \frac{3}{2} \sin\left(\frac{x}{2}\right)$  [f of x equals three halves the sine of the quantity x over 2], at which of the following x coordinates would  $f(x) = 0$ ?

- W)  $\pi/2$
- X)  $\pi$
- Y)  $2\pi$
- Z)  $3\pi/2$

ANSWER: Y)  $2\pi$

### BONUS

1) MATH *Short Answer* Expressing the answer in simplest form, solve  $\left|2r - \frac{13}{4}\right| < \frac{5}{2}$  [the absolute value of the quantity 2r minus 13 fourths is less than 5 halves].

ANSWER:  $3/8 < r < 2 \frac{7}{4}$  (ACCEPT:  $3/8 < r < \frac{23}{4}$ )

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### TOSS-UP

2) BIOLOGY *Multiple Choice* During the process of protein synthesis, what is the function of the TATA box and on what type of nucleic acid is it found?

- W) Where DNA replication begins, found on the DNA template
- X) Where transcription begins, found on the DNA
- Y) Where translation begins, found on the mRNA
- Z) Where elongation begins, found on the tRNA

ANSWER: W) WHERE DNA REPLICATION BEGINS, FOUND ON THE DNA TEMPLATE

### BONUS

2) BIOLOGY *Short Answer* By number, identify all of the following five choices that are effects of stimulation of the sympathetic divisions of the autonomic nervous systems: 1) constricts eye pupil; 2) relaxes bronchi [**BRONG-kee**]; 3) stimulates saliva secretion; 4) inhibits urination; 5) stimulates norepinephrine [**nohr-ep-uh-NEF-rin**] release.

ANSWER: 2, 4, 5

### TOSS-UP

3) PHYSICS *Short Answer* A 9 volt DC power supply is connected to a 10 henry inductor and a 30 ohm resistor in series. Providing your answer as a decimal to the nearest tenth, after the circuit has been connected for a very long time, how much current in amperes flows through the circuit?

ANSWER: 0.3

### BONUS

3) PHYSICS *Short Answer* A 9 volt battery is composed of six 1.5 volt cells, which are connected in series. Each cell has an internal resistance of 0.2 ohms. Providing your answer to the nearest tenth, what is the maximum current in amperes that can be obtained from such a battery?

ANSWER: 7.5

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### TOSS-UP

4) EARTH AND SPACE *Multiple Choice* Severe weather events are most commonly associated with which of the following types of weather front?

- W) Stationary
- X) Occluded
- Y) Warm
- Z) Cold

ANSWER: Z) COLD

### BONUS

4) EARTH AND SPACE *Short Answer* What is the name for a very coarse-grained intrusive igneous rock, having large crystals that are usually several centimeters in length and forming in the later stages of a magma chamber's crystallization?

ANSWER: PEGMATITE

### TOSS-UP

5) CHEMISTRY *Multiple Choice* How many total atoms are contained within a body-centered orthorhombic [**ohr-thuh-ROM-bik**] unit cell?

- W) 2
- X) 3
- Y) 4
- Z) 6

ANSWER: W) 2

### BONUS

5) CHEMISTRY *Short* In kilojoules per mole to the nearest whole number, what is the total bond energy for ethane, assuming that the carbon-hydrogen bond energy is 413 kilojoules per mole and the carbon-carbon bond energy is 348 kilojoules per mole?

ANSWER: 2826

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### TOSS-UP

6) MATH *Short Answer* Find a value for  $a$  such that the  $\lim_{x \rightarrow \infty} \frac{ax^5 - x^3 + x}{x - x^2 + 2x^5} = 3$  [**limit as  $x$  approaches infinity of the fraction with numerator  $ax$  to the fifth minus  $x$  cubed plus  $x$  and denominator  $x$  minus  $x$  cubed plus  $2x$  to the fifth equals 3**].

ANSWER: 6

### BONUS

6) MATH *Short Answer* Differentiate  $\sin(\cos x)$  [**sine of cosine of  $x$** ].

ANSWER:  $-\cos(\cos x)\sin x$  [ACCEPT:  $\cos(\cos x)(-\sin x)$  or  $-\sin x \cos(\cos(x))$ ]; DO NOT ACCEPT:  $-\cos^2 x \sin x$ ]

### TOSS-UP

7) BIOLOGY *Multiple Choice* Which of the following is the enzyme that maintains chromosomal stability by protecting chromosome ends?

- W) Telomerase [*tuh-LOM-uh-rays*]
- X) Nuclease [*NOO-kee-ays*]
- Y) Terminase
- Z) Polymerase [*POL-uh-muh-rays*]

ANSWER: W) TELOMERASE

### BONUS

7) BIOLOGY *Short Answer* By number, order the following five cell layers in a non-woody eudicot [*yoo-DY-kot*] stem from most lateral to most medial: 1) epidermis [*ep-i-DER-mis*], 2) vascular cambium [*KAM-bee-uhm*], 3) pith, 4) primary phloem [*FLOH-em*], 5) primary xylem [*ZY-luhm*].

ANSWER: 1, 4, 2, 5, 3

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### TOSS-UP

8) ENERGY *Multiple Choice* Powerful X-ray technology developed at DOE national laboratories is revealing new insights into diseases ranging from Alzheimer's to swine flu. This X-ray crystallography [*kris-tl-OG-ruh-fee*] has been used for all EXCEPT which of the following?

- W) Revealing the structures of diseased and disease-causing molecules
- X) Creating three-dimensional maps of mutated enzymes
- Y) Producing scattered, low intensity X-ray beams to surround the surface of the molecules
- Z) Allowing medical researchers to develop drugs to prevent mutated enzymes from triggering cancer cells

ANSWER: Y) PRODUCING SCATTERED, LOW INTENSITY X-RAY BEAMS TO SURROUND THE SURFACE OF THE MOLECULES

### BONUS

8) ENERGY *Multiple Choice* Several types of geologic formations can serve as a storage reservoir [*REZ-er-vwohr*] for carbon. Which of the following formations is an example of this type of storage?

- W) Fresh water reservoir
- X) Deep saline reservoir
- Y) Ocean reservoir
- Z) Granitic plateaus [*pla-TOHZ*]

ANSWER: X) DEEP SALINE RESERVOIR

### TOSS-UP

9) PHYSICS *Short Answer* The sound level of a normal conversation is measured at 65 decibels. If the intensity of the sound waves in the conversation was multiplied by a factor of 100 as people began to yell, what would the new sound level measure in decibels?

ANSWER: 85

### BONUS

9) PHYSICS *Short Answer* Given acceleration due to gravity as 9.8 meters per second squared, how much horizontal force, to the nearest newton, is required to keep a 30 kilogram block moving at constant speed across a horizontal surface, with a frictional coefficient of 0.20 between the floor and the block?

ANSWER: 59

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### TOSS-UP

10) EARTH AND SPACE *Short Answer* What is the common term for ocean currents that form large, rotating loops?

ANSWER: GYRES

### BONUS

10) EARTH AND SPACE *Short Answer* What is the most common type of evaporite?

ANSWER: HALITE (ACCEPT: NaCl)

### TOSS-UP

11) CHEMISTRY *Multiple Choice* Which of the following describes the relationship between cis-3-pentene and trans-3-pentene?

- W) Structural isomers [**EYE-suh-mers**]
- X) Chiral molecules
- Y) Diastereomers [**dy-uh-STER-ee-uh-mers**]
- Z) Enantiomers [**ih-NAN-tee-uh-mers**]

ANSWER: Y) DIASTEREOMERS

### BONUS

11) CHEMISTRY *Short Answer* Osmium is one of the densest elements known at 22.59 grams per milliliter. Providing your answer to three decimal places, what would be the volume in milliliters of a bar of osmium weighing 2.0 grams?

ANSWER: 0.089

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### TOSS-UP

12) BIOLOGY *Short Answer* During cellular respiration, what molecule is produced in the cytoplasm and transported to the mitochondria [**my-tuh-KON-dree-uh**], where it is converted into acetyl [**uh-SET-l**] CoA?

ANSWER: PYRUVATE

### BONUS

12) BIOLOGY *Multiple Choice* Which of the following best describes adaptive immunity?

- W) It includes external barriers such as secretions from mucous membranes
- X) It is found in both vertebrates and invertebrates
- Y) It involves the lymphatic system
- Z) It includes an interaction of pathogens, antibodies, and lymphocytes [**LIM-fuh-syts**]

ANSWER: Z) IT INCLUDES AN INTERACTION OF PATHOGENS, ANTIBODIES, AND LYMPHOCYTES

### TOSS-UP

13) EARTH AND SPACE *Multiple Choice* Which of the following is the average approximate length of time in years between Earth's magnetic pole reversals?

- W) 3
- X) 300
- Y) 3,000
- Z) 300,000

ANSWER: Z) 300,000

### BONUS

13) EARTH AND SPACE *Short Answer* What is the name given to the type of stream that flows only during wet periods?

ANSWER: INTERMITTENT (ACCEPT: EPHEMERAL)

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### TOSS-UP

14) MATH *Multiple Choice* Bacteria in a culture are growing exponentially, such that on day 0, there are 100 bacteria, on day 1, there are 200 bacteria, and on day 2, there are 400 bacteria. Which of the following equations expresses the number of bacteria,  $y$ , present at any time  $t$ ?

- W)  $y = 100 + 2^t$  [***y equals 100 plus 2 to the power of t***]
- X)  $y = 100(2^t)$  [***y equals 100 times the quantity 2 to the power of t***]
- Y)  $y = 2^t$  [***y equals 2 to the power of t***]
- Z)  $y = 200(2^t)$  [***y equals 200 times the quantity 2 to the power of t***]

ANSWER: X)  $y = 100(2^t)$

### BONUS

14) MATH *Short Answer* Find the remainder when  $f(x) = x^6 + 5x^5 - x^3 + x - 6$  is divided by  $(x + 1)$ .

ANSWER: -10

### TOSS-UP

15) BIOLOGY *Multiple Choice* Bacteria use which of the following mechanisms during quorum **[KWOHR-uhm]** sensing?

- W) Hetero-induction
- X) Apoptosis
- Y) Density independent gene regulation
- Z) Autoinducers

ANSWER: Z) AUTOINDUCERS

### BONUS

15) BIOLOGY *Multiple Choice* Which of the following epithelial **[ep-uh-THEE-lee-uhl]** tissues is NOT correctly matched to its location in the human body?

- W) Simple cuboidal epithelium **[KYOO-boid-uhl ep-uh-THEE-lee-uhm]**—Rectal lining
- X) Simple squamous **[SKWAY-muhs]** epithelium—Alveoli lining
- Y) Stratified squamous epithelium—Esophageal **[ih-sof-uh-JEE-uhl]** lining
- Z) Pseudostratified ciliated columnar epithelium—Bronchiole lining

ANSWER: W) SIMPLE CUBOIDAL EPITHELIUM—RECTAL LINING

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### TOSS-UP

16) ENERGY *Multiple Choice* Which of the following geothermal power plant types uses steam directly from the ground to spin a turbine?

- W) Binary cycle
- X) Flash steam
- Y) Dry steam
- Z) Hybrid steam

ANSWER: Y) DRY STEAM

### BONUS

16) ENERGY *Short Answer* If the solar power incident over 1 square meter at 1 au from the Sun is 1000 watts, what level in watts will it achieve at 2 au?

ANSWER: 250



### TOSS-UP

17) PHYSICS *Multiple Choice* Tripling the power output from a speaker emitting a single tone will result in an increase in sound intensity in decibels that is closest to which of the following?

- W) 0.3
- X) 2
- Y) 4
- Z) 5

ANSWER: Z) 5

### BONUS

17) PHYSICS *Short Answer* When subjected to a potential difference of 100 volts, a parallel-plate capacitor builds up a charge on one plate of 0.2 coulombs. Providing your answer to the nearest thousandth, what is this capacitor's capacitance in farads?

ANSWER: 0.002

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### TOSS-UP

18) EARTH AND SPACE *Multiple Choice* Niagara Falls can be classified as which of the following types of waterfall?

- W) Block
- X) Chute **[SHOOT]**
- Y) Tiered
- Z) Cataract

ANSWER: W) BLOCK

### BONUS

18) EARTH AND SPACE *Short Answer* An igneous rock which has crystallized deep below the Earth's surface has the following approximate composition: 70% pyroxene **[py-ROK-seen]**, 15% plagioclase **[play-jee-uh-klays]**, and 15% olivine. What is the name of this igneous rock?

ANSWER: GABBRO

### TOSS-UP

19) CHEMISTRY *Short Answer* How many modes of vibration would a non-linear molecule with 9 atoms exhibit?

ANSWER: 21

### BONUS

19) CHEMISTRY *Short Answer* When an acid is added to any metal carbonate, such as barium carbonate, what gas is always formed?

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

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### TOSS-UP

20) MATH *Short Answer* What is the solution to the following system of three equations: equation one:  $2x - y + 3z = 8$ ; equation two:  $x - 6y - z = 0$ ; and equation three:  $-6x + 3y - 9z = 24$ ?

ANSWER: NO SOLUTION

### BONUS

20) MATH *Short Answer* What is the remainder when  $2x^3 - x^2 + 3x - 4$  is divided by  $x + 3$ ?

ANSWER: -76

### TOSS-UP

21) BIOLOGY *Multiple Choice* Which of the following bases wobbles on a transfer RNA anticodon?

- W) First base
- X) Second base
- Y) Third base
- Z) First base and third base

ANSWER: W) FIRST BASE

### BONUS

21) BIOLOGY *Multiple Choice* The mRNA codon for methionine [*meh-THY-uh-noon*] is 5'-A-U-G-3'. From 5 prime to 3 prime, which of the following would be the anticodon present in the cognate tRNA?

- W) 5'-UAC-3'
- X) 5'-GUA-3'
- Y) 5'-CAU-3'
- Z) 5'-AUG-3'

ANSWER: Y) 5'-CAU-3'

[NOTE: 3' = THREE PRIME and 5' = FIVE PRIME]

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### TOSS-UP

22) ENERGY *Multiple Choice* Which of the following statements is NOT true?

- W) Gas stoves with electronic ignition use much less energy than older models with pilot lights
- X) Using the self-cleaning cycles regularly in your oven increases overall energy savings
- Y) Microwaves and toaster ovens cook meals with less power than most traditional ovens
- Z) Cooktops work more efficiently when they are clean

ANSWER: X) USING THE SELF-CLEANING CYCLES REGULARLY IN YOUR OVEN INCREASES OVERALL ENERGY SAVINGS

### BONUS

22) ENERGY *Short Answer* Many consider the start of the U.S. natural gas industry to have occurred in 1859, when a 69-foot well in Pennsylvania struck natural gas and oil. Who is credited with drilling this well?

ANSWER: EDWIN DRAKE (ACCEPT: DRAKE)

### TOSS-UP

23) PHYSICS *Short Answer* What is the efficiency of an ideal Carnot engine operating between temperature reservoirs of 27° Celsius and 227° Celsius?

ANSWER: 40%

### BONUS

23) PHYSICS *Short Answer* A parachutist lands on the ground at a speed of 6 meters per second. Providing your answer to the nearest tenth and given acceleration due to gravity as 10 meters per second squared, what is the height in meters from which a free-falling object would have to fall to reach the same speed?

ANSWER: 1.8

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### TOSS-UP

24) EARTH AND SPACE *Multiple Choice* Which of the following types of sedimentary rock is never formed through biochemical processes?

- W) Limestone
- X) Coal
- Y) Halite
- Z) Chert

ANSWER: Y) HALITE

### BONUS

24) EARTH AND SPACE *Multiple Choice* Which of the following is true of ocean wave energy?

- W) It is the frictional effect of wind
- X) It is the strength of surface ocean currents
- Y) It transfers energy to the top 200 meters of the ocean
- Z) It occurs in shallow water and migrates outward

ANSWER: W) IT IS THE FRICTIONAL EFFECT OF WIND

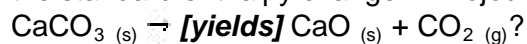
### TOSS-UP

25) CHEMISTRY *Short Answer* By number, name all of the following four nonmetal oxides that have bent molecular geometries: 1) sulfur dioxide, 2) carbon dioxide, 3) nitrogen dioxide, 4) sulfur trioxide.

ANSWER: 1, 3

### BONUS

25) CHEMISTRY *Multiple Choice* Given that the standard enthalpy **[EN-thal-pee]** of formation for solid calcium carbonate is -1200 kilojoules per mole, for solid calcium oxide is -600 kilojoules per mole, and for gaseous carbon dioxide is -400 kilojoules per mole, which of the following is the standard enthalpy change in kilojoules per mole for the reaction:



W) -400

X) -200

Y) 200

Z) 600

ANSWER: Y) 200

**[NOTE: (S) = SOLID; (G) = GASEOUS]**