

## ROUND 5

### TOSS-UP

17) PHYSICS Multiple Choice If two inductance coils of inductance  $L$  are connected in parallel, but are well separated, the equivalent inductance of the system is which of the following?

W)  $0.5L$

X)  $L$

Y)  $2L$

Z)  $L^2$

ANSWER: W)  $0.5L$

### BONUS

17) PHYSICS Multiple Choice Two balls are dropped one second apart from a tall building. Given  $g$  as 10 meters per second squared and neglecting air resistance, what is the approximate distance in meters between the two balls three seconds after the first ball is dropped?

W) 20

X) 25

Y) 45

Z) Depends on the masses

ANSWER: X) 25

### TOSS-UP

8) EARTH AND SPACE Short Answer Name the three quantities that can completely describe any black hole.

ANSWER: SPIN, MASS, CHARGE (ACCEPT: ANGULAR MOMENTUM OR ANGULAR VELOCITY INSTEAD OF SPIN)

### BONUS

8) EARTH AND SPACE Multiple Choice Which of the following is the dominant cooling mechanism in a core-collapse supernova?

W) X-rays and gamma-rays

X) Synchrotron emission

Y) Neutrinos

Z) Electron evaporation

ANSWER: Y) NEUTRINOS

### TOSS-UP

4) MATH Multiple Choice For all real numbers, the expression [the square root of the quantity  $x$  squared minus  $4x$  plus  $4$ ] equals which of the following?

W)  $x$   $2$

X)  $x$   $2x + 2$

Y)  $|x$   $2|$  [the absolute value of the quantity  $x$  minus  $2$ ]

Z)  $x + 2$

ANSWER: Y)  $|x - 2|$

### BONUS

4) MATH Short Answer What are the coordinates of the vertex of the graph of  $y = 2x^2 + 8x - 3$ ?

ANSWER: (-2, -11)

### TOSS-UP

14) BIOLOGY Multiple Choice Which of the following organelles within the eukaryotic [yoo-KAR-ee-oh-tik] cell functions as the digestive system of the cell, serving both to degrade material taken up from outside the cell and to digest obsolete components of the cell itself?

W) Lysosome

X) Golgi apparatus

Y) Smooth endoplasmic reticulum [EN-duh-plaz-mik ri-TIK-yuh-luhm]

Z) Rough endoplasmic reticulum

ANSWER: W) LYSOSOME

### BONUS

14) BIOLOGY Short Answer By number, order the following five stages of animal development from earliest to latest: 1) gastrulation, 2) organogenesis, 3) fertilization, 4) gametogenesis, 5) cleavage.

ANSWER: 4, 3, 5, 1, 2

### TOSS-UP

9) PHYSICS Short Answer In your interferometry [in-ter-fuh-ROM-i-try] experiment, you measure a minimum intensity of 1 watt per meter squared and a maximum intensity of 19 watts per meter squared. What is the visibility of your fringes?

ANSWER: 0.9

### BONUS

9) PHYSICS Short Answer The sound source of a ship's sonar system operates at a frequency 22 kilohertz. The speed of sound in water is 1482 meters per second. Providing your answer to the nearest hundredth, what is the wavelength of the waves in meters emitted by the source?

ANSWER: 0.07

### TOSS-UP

21) CHEMISTRY Short Answer According to valence bond theory, what is the hybridization of the central atom of methane?

ANSWER: sp<sup>3</sup>

### BONUS

21) CHEMISTRY Short Answer A lab performs atomic spectroscopy, usually using a flame as an excitation source. However, flames only ionize a very small percentage of the atoms, so the lab wants to find a better excitation source. Name a common source that could be used to solve this problem.

ANSWER: PLASMA (ACCEPT: PLASMA EMISSION, INDUCTIVELY COUPLED PLASMA SOURCE, OR ICP)

### TOSS-UP

5) BIOLOGY Short Answer What is the term for the hypothesized process by which eukaryotes [yoo-KAR-ee-ohts] evolved a photosynthetic [foh-tuh-SIN-thuh-tik] organelle?

ANSWER: ENDOSYMBIOSIS

BONUS

5) BIOLOGY Multiple Choice Which of the following is NOT an example of energy coupling?

W) An ion releases energy as it travels through an ion channel down its concentration gradient

X) A kinase hydrolyzes ATP for energy to catalyze a reaction

Y) A transport molecule uses energy from one molecule going down its concentration gradient to power transport of another molecule up its gradient

Z) As protons move down their concentration gradient, ATP synthase gathers energy to catalyze the synthesis of ATP

ANSWER: W) AN ION RELEASES ENERGY AS IT TRAVELS THROUGH AN ION CHANNEL DOWN ITS CONCENTRATION GRADIENT

TOSS-UP

20) MATH Short Answer In terms of a, b, c, and d, what is the slope of the line  $3x + 2by = cd$ ?

ANSWER:  $-\frac{3}{2b}$

BONUS

20) MATH Multiple Choice Which of the following points lies in the solution set for the system of two inequalities:  $2y - x \geq -6$  and  $2y - 3x < -6$ ?

W) (-4, -1)

X) (3, 1)

Y) (0, -3)

Z) (4, 3)

ANSWER: X) (3, 1)

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## TOSS-UP

4) EARTH AND SPACE Short Answer Mechanical weathering is one type of weathering, what is the other?

ANSWER: CHEMICAL (ALSO ACCEPT BIOLOGICAL)

## BONUS

4) EARTH AND SPACE Multiple Choice For the June solstice, which of the following statements is NOT true?

W) The northern hemisphere experiences the day with the longest period of sunlight

X) There are 24 hours of sunlight in the Arctic Circle

Y) Earth is further from the Sun than it is at the winter solstice

Z) The Sun is directly overhead at noon in the Arctic Circle

ANSWER: Z) THE SUN IS DIRECTLY OVERHEAD AT NOON IN THE ARCTIC CIRCLE

## TOSS-UP

6) MATH Short Answer In the three by three matrix,  
[such that row one

contains negative 2, 2, and 0; row two contains 4, 1, and negative 5; row three contains 8,

3, and 7], which is the

[x sub 2, 3] element?

ANSWER:

5

## BONUS

6) MATH Short Answer If the squared length of the diagonal of one face of a cube is 162, what is the surface area in square units of the cube?

ANSWER: 486

## TOSS-UP

2) BIOLOGY Multiple Choice The amino acid sequence of a protein represents the translation

of which of the following?

W) The template DNA strand

X) The nontemplate DNA strand

Y) The tRNA nucleotide sequence [NOO-klee-uh-tyd]

Z) The reverse-complement of the mRNA strand

ANSWER: X) THE NONTEMPLATE DNA STRAND

BONUS

2) BIOLOGY Multiple Choice Which of the following insect orders is characterized by the beak or stylet arising from the posterior part of the head and extending along the insect's sternum?

W) Hymenoptera [hy-muh-NOP-ter-uh]

X) Homoptera [hoh-MOHP-tuh-ruh]

Y) Coleoptera [koh-lee-OP-ter-uh]

Z) Hemiptera [hi-MIP-ter-uh]

ANSWER: X) HOMOPTERA

TOSS-UP

8) EARTH AND SPACE Multiple Choice Which of the following sedimentary rocks is most likely to be changed to slate during regional metamorphism?

W) Shale

X) Conglomerate

Y) Dolostone [DO-luh-stohn]

Z) Breccia [BRECH-ee-uh]

ANSWER: W) SHALE

BONUS

8) EARTH AND SPACE Multiple Choice Which of the following describes a rock that is metamorphic and shows signs of foliation?

W) It has bands of coarse intergrown crystals of various sizes

X) It has particles of 0.01 centimeters to 1.0 centimeters cemented together

Y) It has intergrown crystals less than 0.1 centimeter in size

Z) It has intergrown crystals, mostly 2.0 centimeters in size

ANSWER: W) IT HAS BANDS OF COARSE INTERGROWN CRYSTALS OF VARIOUS SIZES

TOSS-UP

20) EARTH AND SPACE Short Answer The North Star today is Polaris. In the time of the Babylonians, it was Thuban. What is the reason for this change?

ANSWER: PRECESSION OF THE EQUINOXES (ACCEPT: PRECESSION OR AXIAL PRECESSION)

BONUS

20) EARTH AND SPACE Short Answer What kind of telescope mount requires motion along only one axis to track a celestial object?

ANSWER: EQUATORIAL

TOSS-UP

21) CHEMISTRY Short Answer According to valence bond theory, what is the hybridization of the central atom of methane?

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TOSS-UP

17) CHEMISTRY Short Answer What element has the following four characteristics: 1) it occurs naturally only in combination with other elements in minerals; 2) it is used primarily as a hardening agent in alloys; 3) its dust is highly toxic, and 4) it is an alkaline [AL-kuh-lyn] earth metal.

ANSWER: BERYLLIUM

BONUS

17) CHEMISTRY Short Answer Identify all of the following four compounds that are ionic: 1) sodium sulfate, 2) methane, 3) ammonium chloride, 4) beryllium iodide.

ANSWER: 1 AND 3 (ACCEPT: SODIUM SULFATE AND AMMONIUM CHLORIDE)

TOSS-UP

11) MATH Short Answer What is the surface area of a cube with volume 8?

ANSWER: 24

BONUS

11) MATH Short Answer In terms of  $x$  and in standard polynomial form, what is the volume of a right rectangular prism with dimensions  $(x + 4)$ ,  $(x + 1)$ , and  $(x + 6)$ ?

ANSWER:  $x^3 + 11x^2 + 34x + 24$

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ANSWER: EQUATORIAL

## TOSS-UP

14) EARTH AND SPACE Multiple Choice The curve that the position of the Sun at noon traces on the sky over the course of a year most closely resembles which of the following?

W) Line

X) Figure 8

Y) Ellipse

Z) Circle

ANSWER: X) FIGURE 8

## BONUS

14) EARTH AND SPACE Multiple Choice Which of the following should NEVER occur?

W) Mercury at inferior conjunction

X) Venus at opposition

Y) Mars at eastern quadrature

Z) Jupiter at conjunction

ANSWER: X) VENUS AT OPPOSITION

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14) BIOLOGY Multiple Choice Which of the following organelles within the eukaryotic [yoo-KAR-ee-oh-tik] cell functions as the digestive system of the cell, serving both to degrade material taken up from outside the cell and to digest obsolete components of the cell itself?

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## TOSS-UP

5) CHEMISTRY Multiple Choice When assigning electrons to subshells, which of the following subshells will be filled first?

W) 4f

X) 5s

Y) 5d

Z) 6s

ANSWER: X) 5s

BONUS

5) CHEMISTRY Short Answer Which of the gas laws is demonstrated when an aerosol can is thrown into a fire and explodes?

ANSWER: AMONTONâ€™S (ACCEPT: IDEAL GAS LAW OR GAY-LUSSACâ€™S LAW)

TOSS-UP

2) BIOLOGY Multiple Choice Which of the following is NOT an evolutionary adaptation of plants to arid climates?

W) Leaves have a waxy coating

X) Carbon incorporation and the Calvin cycle are separated

Y) Stomata are closed at night

Z) Leaves are absent

ANSWER: Y) STOMATA ARE CLOSED AT NIGHT

BONUS

2) BIOLOGY Multiple Choice Which of the following mammal species is usually considered diurnal [dy-UR-nl]?

W) Eastern fox squirrel

X) Black-footed ferret

Y) Virginia opossum

Z) Raccoon

ANSWER: W) EASTERN FOX SQUIRREL