

## ROUND 4

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### TOSS-UP

1) PHYSICS *Multiple Choice* Which of the following conditions is necessary and sufficient for an object in equilibrium?

W) It is at rest

X) It is moving with constant velocity

Y) It is either moving with constant velocity or with constant acceleration

Z) It is moving with constant acceleration

ANSWER: X) IT IS MOVING WITH CONSTANT VELOCITY

### BONUS

1) PHYSICS *Short Answer* An object with a mass of 1 gram is whirled in a horizontal circle with a radius of 0.5 meters at a constant speed of 2 meters per second. What is the work done on the object, in joules, during one revolution?

ANSWER: 0

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### TOSS-UP

2) EARTH AND SPACE *Short Answer* What theory states that our solar system formed from the compression of a giant, swirling cloud of gas and dust?

ANSWER: NEBULAR

### BONUS

2) EARTH AND SPACE *Short Answer* By name or number, order the following three events from earliest to latest as two air masses of different densities develop into a mid-latitude cyclone: 1) cyclonic circulation, 2) wave development, 3) front development.

ANSWER: FRONT DEVELOPMENT, WAVE DEVELOPMENT, CYCLONIC CIRCULATION  
(ACCEPT: 3, 2, 1)

**TOSS-UP**

3) PHYSICS *Multiple Choice* Which of the following will INCREASE the current from a solar panel?

- W) Using a lead acid cell in series with the solar cells
- X) Using a wet cell in series with the solar cells
- Y) Connecting the solar cells in series
- Z) Connecting the solar cells in parallel

ANSWER: Z) CONNECTING THE SOLAR CELLS IN PARALLEL

**BONUS**

3) PHYSICS *Short Answer* Given a DC circuit with a voltage source delivering 20 volts and a circuit resistance of 5 kilohms, what is the value of the current in amperes?

ANSWER: 0.004

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**TOSS-UP**

4) ENERGY *Multiple Choice* An RLC circuit must contain all of the following, EXCEPT:

- W) A capacitor
- X) An inductor
- Y) A diode
- Z) A resistor

ANSWER: Y) A DIODE

**BONUS**

4) ENERGY *Short Answer* By name or number, identify all of the following four factors that directly affect the amount of electricity generated from hydroelectric dams: 1) water temperature, 2) flow, 3) head, 4) time of day.

ANSWER: FLOW AND HEAD (ACCEPT: 2 AND 3)

**TOSS-UP**

5) MATH *Multiple Choice* A line with the equation  $y = cx + c$ , where  $c$  is a non-zero real number, must intersect which of the following?

- W) Positive  $x$ -axis
- X) Positive  $y$ -axis
- Y) Negative  $x$ -axis
- Z) Negative  $y$ -axis

ANSWER: Y) NEGATIVE  $x$ -AXIS

**BONUS**

5) MATH *Short Answer* Find the slope of the line tangent to the parametric curve at the given point:  $x = e^t$ , and  $y = \ln t$  (read as:  $y$  equals the natural log of  $t$ ) at  $t = 1$ .

ANSWER:  $1/e$

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**TOSS-UP**

6) EARTH AND SPACE *Short Answer* Name the three layers of the Sun's atmosphere.

ANSWER: PHOTOSPHERE, CHROMOSPHERE, CORONA

**BONUS**

6) EARTH AND SPACE *Short Answer* The region around Sweden has undergone elastic strain due to pressure from ancient ice cover. What will happen to the elevation of this region over the next 10,000 years?

ANSWER: INCREASE

### TOSS-UP

7) PHYSICS *Multiple Choice* Neglecting the effect of air resistance, a stone dropped off of a 197-meter high building lands on the ground at which of the following approximate times in seconds?

- W) 3
- X) 4
- Y) 6
- Z) 18

ANSWER: Y) 6

### BONUS

7) PHYSICS *Short Answer* A capacitor has a very large capacitance of 10 farads and is charged by placing a potential difference of 2 volts between its plates. How much energy in joules is stored in the capacitor?

ANSWER: 20

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### TOSS-UP

8) EARTH AND SPACE *Multiple Choice* Which of the following BEST describes how planets are distinguishable from stars in the night sky?

- W) Planets appear brighter than stars
- X) Planets appear redder than stars
- Y) Planets appear bigger than stars
- Z) Planets have periods of retrograde motion while stars do not

ANSWER: Z) PLANETS HAVE PERIODS OF RETROGRADE MOTION WHILE STARS DO NOT

### BONUS

8) EARTH AND SPACE *Short Answer* What unit equal to 0.01 millimeters thickness at STP is used to measure Earth's atmospheric ozone layer?

ANSWER: DOBSON UNIT

**TOSS-UP**

9) ENERGY *Multiple Choice* Which of the following statements is NOT true about the current electricity system in the United States?

- W) It is 99.7% reliable
- X) It consists of more than 9,000 electric generating units
- Y) It has more than 1,000,000 megawatts of generating capacity
- Z) It is largely decentralized

ANSWER: Z) IT IS LARGELY DECENTRALIZED

**BONUS**

9) ENERGY *Short Answer* Taking the latent heat of fusion to be 80 calories per gram, how much energy, in kilocalories, does it take to bring 10 grams of ice at 0° Celsius to liquid water at 20° Celsius?

ANSWER: 1

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**TOSS-UP**

10) BIOLOGY *Short Answer* Insect symbionts are represented in all EXCEPT which of the following three groups: 1) bacteria, 2) fungi, or 3) animals?

ANSWER: ANIMALS (ACCEPT: 3)

**BONUS**

10) BIOLOGY *Short Answer* By name or number, list all of the following four pollinators that are members of the order Hymenoptera (read as: hy-meh-NOHP-teh-rah): 1) ruby-throated hummingbird, 2) monarch butterfly, 3) green bottle fly, 4) honey bee.

ANSWER: HONEY BEE (ACCEPT: 4)

**TOSS-UP**

11) MATH *Short Answer* What is the numerical value of  $115^2$ ?

ANSWER: 13225

**BONUS**

11) MATH *Short Answer* What is the coefficient corresponding to  $x^3$  in the binomial expansion of  $(x + 2)^5$  (read as: the quantity  $x$  plus 2 to the power of 5)?

ANSWER: 40

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**TOSS-UP**

12) BIOLOGY *Multiple Choice* Which of the following is NOT synthesized by the human liver?

- W) Hemoglobin
- X) Fibrinogen (read as; fy-BRI-noh-jehn)
- Y) Albumin
- Z) Lipoprotein

ANSWER: W) HEMOGLOBIN

**BONUS**

12) BIOLOGY *Short Answer* By name or number, give all of the following five choices that are components of bile in vertebrates: 1) water, 2) cholesterol, 3) lymph, 4) bilirubin, 5) amylase.

ANSWER: WATER, CHOLESTEROL, BILIRUBIN (ACCEPT: 1, 2, AND 4)

**TOSS-UP**

13) ENERGY *Short Answer* As the grade of coal increases, how do the concentrations of carbon and sulfur change, respectively?

ANSWER: CARBON INCREASES AND SULFUR DECREASES

**BONUS**

13) ENERGY *Short Answer* If burned over the course of a minute, providing your answer to the nearest ten, about how many kilowatts of power would a pound of human fat release?

ANSWER: 240 (ACCEPT: 250, 260, 270, 280, 290)

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**TOSS-UP**

14) PHYSICS *Short Answer* What is the phrase that refers to the energy required by an incident photon to cause the photoelectric effect?

ANSWER: WORK FUNCTION

**BONUS**

14) PHYSICS *Short Answer* By name or number, identify all of the following four household items that make use of the Bernoulli principle: 1) refrigerator, 2) can opener, 3) washing machine, 4) vacuum cleaner.

ANSWER: VACUUM CLEANER (ACCEPT: 4)

**TOSS-UP**

15) BIOLOGY *Short Answer* Name the plant tissue beneath the epidermis that makes up the cells that surround a stoma.

ANSWER: PARENCHYMA

**BONUS**

15) BIOLOGY *Multiple Choice* Mineral salts participate in enzymatic activity as which of the following?

- W) Co-factors
- X) Activators
- Y) Stabilizers
- Z) Catalysts

ANSWER: W) CO-FACTORS

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**TOSS-UP**

16) MATH *Multiple Choice* Which of the following statements is NOT true about Taylor series?

- W) Taylor series are defined for infinitely differentiable functions
- X) All Taylor series are power series
- Y) All Taylor series are convergent
- Z) The first  $n$  terms of a Taylor series approximate a function with a polynomial

ANSWER: Y) ALL TAYLOR SERIES ARE CONVERGENT

**BONUS**

16) MATH *Short Answer* Considering the function  $f(x) = 3x^2 - 4x + 1$ , what is the average rate of change from  $x = 2$  to  $x = 5$ ?

ANSWER: 17



### TOSS-UP

17) CHEMISTRY *Multiple Choice* Which of the following statements is TRUE of ceramics?

- W) They are homogeneous
- X) They are heterogeneous (read as: heh-teh-roh-JEE-nee-is)
- Y) They are chelates
- Z) They are a form of glass

ANSWER: X) THEY ARE HETEROGENEOUS

### BONUS

17) CHEMISTRY *Multiple Choice* Which of the following elements has the valence electron configuration of  $3s^23p^3$ ?

- W) Phosphorus
- X) Oxygen
- Y) Bromine
- Z) Nitrogen

ANSWER: W) PHOSPHORUS

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### TOSS-UP

18) EARTH AND SPACE *Short Answer* What term is often used to describe a winter storm that strikes the East Coast of the United States, involving a low pressure system that picks up moisture from the ocean and often dumps snow on land?

ANSWER: NOR'EASTER

### BONUS

18) EARTH AND SPACE *Short Answer* What optical device completely eliminates chromatic aberration in telescopes?

ANSWER: CURVED MIRRORS (ACCEPT: MIRRORS)

### TOSS-UP

19) CHEMISTRY *Multiple Choice* Which of the following represents the electron-pair geometry of the central oxygen atom of ozone?

- W) Linear
- X) Trigonal planar
- Y) Tetrahedral
- Z) Trigonal bipyramidal

ANSWER: X) TRIGONAL PLANAR

### BONUS

19) CHEMISTRY *Short Answer* Within a single atom, what is the maximum number of electrons that can fit in an atomic shell defined by the quantum numbers  $n = 3$  and  $l = 2$  (read as: L equals 2)?

ANSWER: 10

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### TOSS-UP

20) BIOLOGY *Short Answer* One group of carbohydrates is known as polyhydroxylated aldehydes. By what other term is this group described?

ANSWER: ALDOSE

### BONUS

20) BIOLOGY *Short Answer* Bacteria depend on cell membrane lipids to provide structure and stability. What physical environmental factor is most likely to cause these membranes to lose stability?

ANSWER: TEMPERATURE

**TOSS-UP**

21) CHEMISTRY *Short Answer* What is the IUPAC name for  $\text{SnCl}_2 \cdot 6\text{H}_2\text{O}$ ?

ANSWER: TIN (II) CHLORIDE HEXAHYDRATE

**BONUS**

21) CHEMISTRY *Short Answer* By name or number, list all of the following five substances that are NOT Newtonian fluids: 1) gasoline, 2) yogurt, 3) water, 4) blood, 5) ketchup.

ANSWER: YOGURT, BLOOD, AND KETCHUP (ACCEPT: 2, 4, AND 5)

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**TOSS-UP**

22) MATH *Multiple Choice* Which of the following statements is NOT an advantage of a repeated-measures design compared to an independent-measures design to compare two treatment conditions?

- W) It requires fewer subjects
- X) It is better suited to study development that takes place over time
- Y) It reduces problems caused by individual differences
- Z) It reduces the confounding effects of other factors

ANSWER: Z) IT REDUCES THE CONFOUNDING EFFECTS OF OTHER FACTORS

**BONUS**

22) MATH *Short Answer* The linear function  $y = f(x)$  contains the two points (2, 1) and (5, 8). In simplest form, what is  $f(13)$ ?

ANSWER:  $80/3$  (ACCEPT:  $26 \frac{2}{3}$ )

### TOSS-UP

23) MATH *Short Answer* A population has a mean of 73 and a standard deviation of 8. If the distribution is standardized to create a new distribution with a mean of 100 and a standard deviation of 20, what is the new value of a score of 65 from the original distribution?

ANSWER: 80

### BONUS

23) MATH *Short Answer* What are, respectively, the amplitude, period, horizontal shift, and vertical shift of  $y = -5 + 7\cos [\pi/6 (x + \pi/12)]$  (read as: y equals negative 5 plus 7 cosine of open bracket pi over 6 open parenthesis x plus pi over 12 close parenthesis close bracket)?

ANSWER: AMPLITUDE = 7, PERIOD = 12, HORIZONTAL SHIFT =  $-\pi/12$  (ACCEPT:  $\pi/12$  LEFT), VERTICAL SHIFT = -5 (ACCEPT: 5 DOWN)

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### TOSS-UP

24) BIOLOGY *Short Answer* If a person suffers an injury and is no longer able to walk but the heart was not affected, which peripheral nervous system component is most likely to have been damaged?

ANSWER: SOMATIC (ACCEPT: SOMATOMOTOR SYSTEM)

### BONUS

24) BIOLOGY *Short Answer* What is the technical name of the process, usually occurring in the fall, through which deciduous plants systematically shed their leaves? A thin layer of cells may be produced during this process, thus further sealing the site of detachment.

ANSWER: ABSCISSION

### TOSS-UP

25) CHEMISTRY *Multiple Choice* Which of the following can bond to a metal ion?

- W) Ligand
- X) Lewis acid
- Y) Bronsted-Lowry acid
- Z) Enantiomer

ANSWER: W) LIGAND

### BONUS

25) CHEMISTRY *Short Answer* How many milliliters of 0.75 molar HCl are required to completely neutralize 25.0 milliliters of 0.15 molar Ba(OH)<sub>2</sub>?

ANSWER: 10