

## ROUND 12

---

### TOSS-UP

1) EARTH AND SPACE *Multiple Choice* In which of the following states are you most likely to find glacially transported sediment from North America's last major glacial maximum?

- W) Virginia
- X) Colorado
- Y) California
- Z) Michigan

ANSWER: Z) MICHIGAN

### BONUS

1) EARTH AND SPACE *Short Answer* A Hertzsprung-Russell diagram plots the relationship between its luminosity and what other characteristic?

ANSWER: SPECTRAL TYPE (ACCEPT: TEMPERATURE, COLOR)

---

### TOSS-UP

2) BIOLOGY *Multiple Choice* Which of the following is the mechanism of action of most insecticides?

- W) Blocking oxygen intake
- X) Disrupting nerve function
- Y) Preventing digestion
- Z) Stopping DNA synthesis

ANSWER: X) DISRUPTING NERVE FUNCTION

### BONUS

2) BIOLOGY *Short Answer* What is the general name for integral membrane proteins that directly couple the energy of ATP hydrolysis to the movement of molecules against their concentration gradient?

ANSWER: PRIMARY ACTIVE TRANSPORTERS (ALSO ACCEPT: DIRECT ACTIVE TRANSPORT; DO NOT ACCEPT: ACTIVE TRANSPORTERS, SECONDARY ACTIVE TRANSPORTERS)

### TOSS-UP

3) CHEMISTRY *Short Answer* What is the name of the property that distinguishes L-alanine [**AL-uh-neen**] from D-alanine?

ANSWER: CHIRALITY (ACCEPT: ENANTIOMER, HANDEDNESS, ROTATION OF POLARIZED LIGHT)

### BONUS

3) CHEMISTRY *Multiple Choice* Which of the following would NOT be a good method to determine the molecular weight of a protein?

- W) Isoelectric focusing
- X) Electrophoresis [**i-lek-troh-fuh-REE-sis**]
- Y) Gel filtration
- Z) Ultracentrifugation

ANSWER: W) ISOELECTRIC FOCUSING

---

### TOSS-UP

4) MATH *Short Answer* What is the sum of the infinite geometric series with a first term of  $1/3$  and a second term of  $1/9$ ?

ANSWER:  $1/2$  (ACCEPT: 0.5)

### BONUS

4) MATH *Short Answer* How many real solutions does the following equation have:  
 $(x^2 + 1)^2 + 2(x^2 + 1) - 3 = 0$  [**x squared plus 1 quantity squared plus 2 times open parenthesis x squared plus 1 close parenthesis minus 3 equals zero**]?

ANSWER: ONE

### TOSS-UP

5) PHYSICS *Multiple Choice* Two identically sized conducting spheres, A, with a charge of  $+3.2 \times 10^{-19}$  coulombs, and B, with a charge of  $-6.4 \times 10^{-19}$  coulombs, are allowed to touch. While they are touching, sphere A does which of the following?

- W) Gains three protons
- X) Loses three protons
- Y) Gains three electrons
- Z) Gains four electrons

ANSWER: Y) GAINS THREE ELECTRONS

### BONUS

5) PHYSICS *Short Answer* A car's starter motor draws a current of 100 amperes at 12.0 volts when starting the engine. The mechanical power required to turn the engine is 960 watts. At what rate, in watts, is energy from the battery converted to heat?

ANSWER: 240

---

### TOSS-UP

6) EARTH AND SPACE *Multiple Choice* Which of the following is a sedimentary rock that forms as a result of precipitation during evaporation of seawater?

- W) Conglomerate
- X) Gypsum
- Y) Basalt
- Z) Shale

ANSWER: X) GYPSUM

### BONUS

6) EARTH AND SPACE *Multiple Choice* The gemstones ruby and sapphire are a part of which of the following mineral groups?

- W) Carbonates
- X) Oxides
- Y) Sulfates
- Z) Silicates

ANSWER: X) OXIDES

**TOSS-UP**

7) BIOLOGY *Short Answer* Name the protein that polymerizes [*puh-LIM-uh-ryz-es*] to form microtubules.

ANSWER: TUBULIN

**BONUS**

7) BIOLOGY *Short Answer* Which amino acid participates in the formation of disulfide bonds?

ANSWER: CYSTEINE

---

**TOSS-UP**

8) ENERGY *Short Answer* Neutrons in fission reactors are categorized based on their origin. What term describes neutrons emitted directly from a fission event, rather than from a subsequent or unrelated decay event?

ANSWER: PROMPT

**BONUS**

8) ENERGY *Short Answer* How much heat energy in BTUs is needed to heat 200 pounds of water from 50 degrees to 130 degrees Fahrenheit?

ANSWER: 16,000

### TOSS-UP

9) CHEMISTRY *Short Answer* The molecule chlorine trifluoride has what molecular geometry?

ANSWER: T-SHAPED

### BONUS

9) CHEMISTRY *Short Answer* Given a box of length  $a$  and a particle of radius  $b$ , molecular weight  $c$ , and velocity  $d$ , what is the average position of the particle in the box with respect to length?

ANSWER:  $a/2$

---

### TOSS-UP

10) MATH *Short Answer* If each side of a rectangle is increased by 10%, by what percentage is its area increased?

ANSWER: 21 (ACCEPT: 21%)

### BONUS

10) MATH *Short Answer* Express  $\frac{(1 - 2i)}{(4 - 5i)}$  [*the quantity 1 plus 2 i divided by the quantity 4 minus 5 i*] in standard  $a + bi$  form.

ANSWER:  $-6/41 + (13/41)i$  [DO NOT ACCEPT:  $(-6 + 13i)/41$ ]

### TOSS-UP

11) PHYSICS *Multiple Choice* When a resistor, inductor, and capacitor are connected in series to an AC generator, the current through the capacitor must be in phase with the voltage across which of the following?

- W) The capacitor
- X) The inductor
- Y) The entire circuit
- Z) The resistor

ANSWER: Z) THE RESISTOR

### BONUS

11) PHYSICS *Multiple Choice* In a series resonant circuit, the circuit impedance at resonance is always which of the following?

- W) Equal to the resistance
- X) Equal to the capacitive reactance
- Y) Equal to the inductive reactance
- Z) Greater than the capacitive reactance

ANSWER: W) EQUAL TO THE RESISTANCE

---

### TOSS-UP

12) EARTH AND SPACE *Multiple Choice* Which of the following processes leads directly to the formation of topsoil and subsoil in the A and B horizons?

- W) Erosion and deposition
- X) Erosion and leaching
- Y) Weathering and leaching
- Z) Weathering and deposition

ANSWER: Y) WEATHERING AND LEACHING

### BONUS

12) EARTH AND SPACE *Short Answer* Taking the value of the Hubble constant to be 75 kilometers per second per megaparsec, if a galaxy is observed with a recessional velocity of 50 kilometers per second, what is its distance, in kiloparsecs, to two significant figures?

ANSWER: 670

### TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following venomous snakes produces mostly neurotoxins?

- W) Black mamba
- X) Eastern diamondback rattlesnake
- Y) Cottonmouth
- Z) Copperhead

ANSWER: W) BLACK MAMBA

### BONUS

13) BIOLOGY *Short Answer* What is the name of the plant hormone, produced in older leaves, root caps, and stems, which promotes bud and seed dormancy?

ANSWER: ABSCISIC ACID (ACCEPT: ABSCISIN II AND DORMIN)

---

### TOSS-UP

14) CHEMISTRY *Multiple Choice* Which of the following molecules can ionize in water?

- W) Ethyl acetate
- X) Diethyl ether
- Y) Acetic acid
- Z) Acetic anhydride

ANSWER: Y) ACETIC ACID

### BONUS

14) CHEMISTRY *Multiple Choice* Which of the following best explains the relative acidity of carboxylic acids?

- W) Resonance-stabilized conjugate base
- X) Long O-H bond length
- Y) Polar covalent O-H bond
- Z)  $sp^2$ -hybridized carbonyl carbon

ANSWER: W) RESONANCE-STABILIZED CONJUGATE BASE

### TOSS-UP

15) PHYSICS *Multiple Choice* The root mean square voltage of a sinusoidal AC coupled circuit is approximately equal to its maximum value multiplied by which of the following?

- W) 0.5
- X) 0.7
- Y) 1.4
- Z) 1.7

ANSWER: X) 0.7

### BONUS

15) PHYSICS *Short Answer* In one cycle, a heat engine exhausts 3000 joules of heat while performing 1500 joules of work. What is its percentage of efficiency to the tenths place?

ANSWER: 33.3%

---

### TOSS-UP

16) MATH *Short Answer* If the graph of  $y = (x - 2)^2 - 3$  [**y equals open parenthesis x minus 2 close parenthesis squared minus three**] is translated 5 units up and 2 units to the right, what is the vertex of the new parabola obtained?

ANSWER: (4, 2)

### BONUS

16) MATH *Short Answer* Solve  $3x - 2ix = 5$  for  $x$  in standard  $a + bi$  form.

ANSWER:  $\frac{15}{13} + \frac{10}{13}i$

**TOSS-UP**

17) CHEMISTRY *Short Answer* What is the term that describes the temperature at which ferromagnetic materials no longer exhibit spontaneous magnetization?

ANSWER: CURIE (ACCEPT: CURIE POINT)

**BONUS**

17) CHEMISTRY *Short Answer* What isotope will be formed when oxygen-19 undergoes beta minus decay?

ANSWER: FLUORINE-19 (ACCEPT: F-19)

---

**TOSS-UP**

18) EARTH AND SPACE *Multiple Choice* Which of the following types of smog in the boundary layer of the atmosphere contains sulfur dioxide?

- W) Oxidizing
- X) Photochemical
- Y) Reducing
- Z) Boundary layer

ANSWER: Y) REDUCING

**BONUS**

18) EARTH AND SPACE *Multiple Choice* Glacial striations indicate which of the following?

- W) The absolute age of a glacial event
- X) The direction of glacial advancement
- Y) The direction of glacial retreat
- Z) The thickness of the glacier

ANSWER: X) THE DIRECTION OF GLACIAL ADVANCEMENT

### TOSS-UP

19) BIOLOGY *Short Answer* What is the common name of a living species in the order Proboscidea [**pro-bos-SID-ee-uh**]?

ANSWER: ELEPHANTS (ACCEPT: AFRICAN ELEPHANT OR ASIAN ELEPHANT)

### BONUS

19) BIOLOGY *Multiple Choice* In which of the following glands do hematopoietic [**hi-mat-oh-poi-EE-tik**] stem cells develop into T cells?

- W) Pineal [**PIN-ee-uh**]
- X) Thymus [**THY-muhs**]
- Y) Pituitary [**pi-TOO-i-ter-ee**]
- Z) Adrenal

ANSWER: X) THYMUS

---

### TOSS-UP

20) ENERGY *Multiple Choice* What does it mean when a wind generator has a cut-in speed of 3 meters per second?

- W) It won't produce any power unless the wind speed is lower than 3 meters per second
- X) It will stop producing power at 3 meters per second to protect itself from breaking
- Y) It will produce the maximum power at 3 meters per second
- Z) It won't produce any power unless the wind speed is higher than 3 meters per second

ANSWER: Z) IT WON'T PRODUCE ANY POWER UNLESS THE WIND SPEED IS HIGHER THAN 3 METERS PER SECOND

### BONUS

20) ENERGY *Short Answer* Nuclides, such as U-235 and Pu-239, are often used as fuel in light water nuclear reactors. These isotopes are considered both fissile and fissionable because they are capable of undergoing fission after capturing what type of neutrons?

ANSWER: THERMAL (ACCEPT: SLOW)

### TOSS-UP

21) CHEMISTRY *Multiple Choice* Which of the following, when added to an aqueous [**ay-KWEE-uhs**] sample containing calcium carbonate, would be most likely to produce bubbles?

- W) Hydrogen chloride
- X) Water
- Y) Ammonia
- Z) Lithium hydroxide

ANSWER: W) HYDROGEN CHLORIDE

### BONUS

21) CHEMISTRY *Multiple Choice* Which of the following sets are all strong electrolytes?

- W) Hydrogen chloride, phosphoric acid, acetic acid
- X) Hydrogen chloride, sodium hydroxide, phosphoric acid, potassium hydroxide
- Y) Hydrogen iodide, hydrogen bromide, lithium hydroxide, nitric acid
- Z) Ammonia, potassium hydroxide, sodium hydroxide, lithium hydroxide

ANSWER: Y) HYDROGEN IODIDE, HYDROGEN BROMIDE, LITHIUM HYDROXIDE, NITRIC ACID

---

### TOSS-UP

22) MATH *Multiple Choice* For  $f(x) = x^2 + 2x + 4$ , which of the following statements is NOT true?

- W)  $f(x)$  has a maximum value
- X) The graph of  $f$  is not a line
- Y) The graph of  $f$  has no  $x$ -intercepts
- Z) The graph of  $f$  has a  $y$ -intercept

ANSWER: W)  $f(x)$  HAS A MAXIMUM VALUE

### BONUS

22) MATH *Short Answer* The volume of an open-ended circular cylinder is  $32\pi$  cubic centimeters, and its base has a radius of 4 meters. What is the surface area of the cylinder, in terms of  $\pi$  and in square meters?

ANSWER:  $16\pi$

### TOSS-UP

23) PHYSICS *Multiple Choice* A wire of radius  $A$  carries a uniform current  $I$ . The total magnetic energy per unit length contained within the wire is which of the following?

- W) Proportional to  $A^2$
- X) Proportional to  $A$
- Y) Independent of  $A$
- Z) Zero

ANSWER: Y) INDEPENDENT OF  $A$

### BONUS

23) PHYSICS *Multiple Choice* The period of a mass bouncing on a spring is measured in the reference frame of an observer as  $T$ . If the system were instead moving past the observer with a velocity of  $0.8c$ , which of the following is closest to the period she would observe?

- W)  $0.44T$
- X)  $0.6T$
- Y)  $1.7T$
- Z)  $1.9T$

ANSWER: Y)  $1.7T$

---

### TOSS-UP

24) EARTH AND SPACE *Multiple Choice* Which of the following is characteristic of a deep residual soil?

- W) Unaltered bedrock
- X) An immature soil
- Y) Soil that has been weathering for a long period of time
- Z) Soil derived from rocks exposed to the hydrosphere and atmosphere

ANSWER: Y) SOIL THAT HAS BEEN WEATHERING FOR A LONG PERIOD OF TIME

### BONUS

24) EARTH AND SPACE *Multiple Choice* The word "solstice" means "sunstop." Which of the following does this reference?

- W) The Sun's daily change in declination stops and reverses direction
- X) The Sun literally stops in our sky for a brief but measurable time
- Y) The Earth reaches the point where the Sun shines directly on the equator, restarting the solar calendar
- Z) The ancient belief that the Earth orbited the Sun

ANSWER: W) THE SUN'S DAILY CHANGE IN DECLINATION STOPS AND REVERSES DIRECTION

**TOSS-UP**

25) BIOLOGY *Multiple Choice* Which of the following is NOT a seedless plant?

- W) St. John's wort
- X) Hornwort
- Y) Whisk fern
- Z) Liverwort

ANSWER: W) ST. JOHN'S WORT

**BONUS**

25) BIOLOGY *Multiple Choice* A *Paramecium* [**par-uh-MEE-see-uhm**] lives in fresh water and has a contractile vacuole [**kuhn-TRAK-tl VAK-yoo-ohl**] that allows it to regularly expel excess water that enters its cell. Which of the following is correct?

- W) The inside of the cell is hypertonic compared to the outside of the cell, so water enters the cell through osmosis
- X) The inside of the cell is hypotonic to the outside of the cell, so water enters the cell through osmosis
- Y) The inside and outside of the cell are isotonic, but water enters the cell as the *Paramecium* swims around
- Z) The cellular processes of the *Paramecium* produce a lot of excess water, so it needs to get rid of the extra water

ANSWER: X) THE INSIDE OF THE CELL IS HYPOTONIC TO THE OUTSIDE OF THE CELL, SO WATER ENTERS THE CELL THROUGH OSMOSIS