

## ROUND 4

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### TOSS-UP

1) EARTH AND SPACE *Multiple Choice* Mammals first evolved during what geologic period?

- W) Permian
- X) Triassic
- Y) Cretaceous [*kri-TAY-shuhs*]
- Z) Paleocene [*pay-lee-uh-SEEN*]

ANSWER: X) TRIASSIC

### BONUS

1) EARTH AND SPACE *Short Answer* What is the series used in igneous [*IG-nee-uhs*] petrology that explains why certain types of minerals tend to be found together while others are almost never associated with one another?

ANSWER: BOWEN'S REACTION SERIES

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### TOSS-UP

2) BIOLOGY *Multiple Choice* In DNA replication, which of the following molecules is synthesized in the same direction that the replication fork is moving?

- W) Leading strand
- X) Okazaki fragment
- Y) Primer
- Z) Lagging strand

ANSWER: W) LEADING STRAND

### BONUS

2) BIOLOGY *Multiple Choice* Which of the following best describes the type of RNA that codes for a complete gene on the sense strand of a DNA molecule?

- W) Ribosomal RNA [*ry-BUH-soh-muhl*]
- X) Mitochondrial RNA [*my-tuh-KON-dree-uhl*]
- Y) Pre-messenger RNA
- Z) Transfer RNA

ANSWER: Y) PRE-MESSENGER RNA

**TOSS-UP**

3) MATH *Short Answer* The average of  $a$  and  $b$  is  $x$ . The average of  $b$  and  $x$  equals the average of  $a$  and  $(b + 1)$ . Find  $a - b$ .

ANSWER: -2

**BONUS**

3) MATH *Short Answer* What is the reciprocal of the complex number  $2 + i$ ?

ANSWER:  $(2/5) - (1/5)i$  (ACCEPT:  $0.4 - 0.2i$ )

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**TOSS-UP**

4) ENERGY *Multiple Choice* The majority of moth species forage for food energy during what stage of their life cycle?

- W) Egg
- X) Larva
- Y) Pupa
- Z) Adult

ANSWER: X) LARVA

**BONUS**

4) ENERGY *Short Answer* The electrical resistance of a semiconducting wire is least likely to be reduced by a decrease in which two of the following four wire characteristics?

(1) melting point, (2) radius, (3) length, (4) temperature

ANSWER: 1 and 2 (ACCEPT: MELTING POINT AND RADIUS)

### TOSS-UP

5) CHEMISTRY *Multiple Choice* With regard to the Rosenmund reduction, which of the following functional group pairs corresponds to the reactant and product, respectively?

- W) Ester and alcohol
- X) Acyl **[AS-il]** chloride and aldehyde **[AL-duh-hyd]**
- Y) Amide and amine **[uh-MEEN]**
- Z) Ketone and alkane **[AL-kayn]**

ANSWER: X) ACYL CHLORIDE AND ALDEHYDE

### BONUS

5) CHEMISTRY *Short Answer* In the industrially important water-gas shift reaction, carbon monoxide and water vapor react to form carbon dioxide gas and hydrogen gas as products. If the system is closed and the reaction has reached equilibrium **[ee-kwuh-LIB-ree-uhm]**, how would the equilibrium shift if the volume is decreased?

ANSWER: UNCHANGED (ACCEPT: THERE IS NO SHIFT)

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### TOSS-UP

6) PHYSICS *Multiple Choice* A human eye has three layers with refractive indices  $n_1$ ,  $n_2$ , and  $n_3$ , where  $n_1 < n_2$  and  $n_1 = n_3$ . Which of the following properties of a light ray is the same in all layers?

- W) Frequency only
- X) Speed only
- Y) Wavelength only
- Z) Frequency and speed

ANSWER: W) FREQUENCY ONLY

### BONUS

6) PHYSICS *Short Answer* A door of area 3 square meters and thickness 4 centimeters is composed of a material whose thermal conductivity is 0.10 watts per meter Kelvin. What is the heat flow, in watts, through the door when the temperature difference is 10 Kelvin?

ANSWER: 75

### TOSS-UP

7) EARTH AND SPACE *Multiple Choice* Which of the following volcanoes form in ocean-continent and ocean-ocean convergent plate boundaries?

- W) Shield
- X) Stratovolcanoes
- Y) Hot spot volcanoes
- Z) Basaltic volcanoes

ANSWER: X) STRATOVOLCANOES

### BONUS

7) EARTH AND SPACE *Multiple Choice* Which of the following is an example of a negative feedback cycle?

- W) The polar climate warms, permafrost melts, microbes digest vegetation and release methane, the methane further warms polar climate
- X) The polar climate warms, sea ice melts, albedo lowers, and polar climate further warms
- Y) Global warming causes more water to evaporate from the surface, which condenses into clouds that then reflect more sunlight back to space, which cools the Earth
- Z) Global warming causes the southwestern U.S. to become even drier, reduced evaporation leads to fewer clouds so the Earth's albedo remains low, thus warming the climate

ANSWER: Y) GLOBAL WARMING CAUSES MORE WATER TO EVAPORATE FROM THE SURFACE, WHICH CONDENSES INTO CLOUDS THAT THEN REFLECT MORE SUNLIGHT BACK TO SPACE, WHICH COOLS THE EARTH

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### TOSS-UP

8) BIOLOGY *Short Answer* What is the term for the type of plant that is adapted to living in a saline environment?

ANSWER: HALOPHYTE

### BONUS

8) BIOLOGY *Multiple Choice* Carbohydrates are best defined as which of the following?

- W) Inorganic compounds containing carbon, hydrogen, and oxygen in a ratio of 1:2:1
- X) Organic compounds containing carbon, hydrogen, and oxygen in a ratio of 1:2:1
- Y) Organic compounds containing carbon, hydrogen, and oxygen in a ratio of 2:1:2
- Z) Inorganic compounds containing carbon, hydrogen, and oxygen in a ratio of 2:1:2

ANSWER: X) ORGANIC COMPOUNDS CONTAINING CARBON, HYDROGEN, AND OXYGEN IN A RATIO OF 1:2:1

### TOSS-UP

9) MATH *Short Answer* Four consecutive odd integers are added. If the smallest integer is  $2m - 1$ , then what is their sum in terms of  $m$ ?

ANSWER:  $8m + 8$

### BONUS

9) MATH *Short Answer* Given  $(2^x)(3^y)(5^z) = 2700$  [**2 to the power of x times 3 to the power of y times 5 to the power of z equals 2700**], find the product  $xyz$ .

ANSWER: 12

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### TOSS-UP

10) ENERGY *Multiple Choice* In which of the following types of electrical equipment is high resistance most undesirable?

- W) Superconducting magnet
- X) Heater
- Y) Stove
- Z) Incandescent light bulb

ANSWER: W) SUPERCONDUCTING MAGNET

### BONUS

10) ENERGY *Multiple Choice* Why are natural gas-fired plants typically used for peaking production?

- W) They are built to have high efficiency
- X) Fuel costs are very stable over time
- Y) Natural gas is more abundant than coal
- Z) They have relatively fast response times

ANSWER: Z) THEY HAVE RELATIVELY FAST RESPONSE TIMES

### TOSS-UP

11) CHEMISTRY *Multiple Choice* Which of the following pairs of compounds, when placed in water, would be expected to yield a precipitate?

- W) Ammonium chloride and sodium nitrate
- X) Sodium acetate and lithium hydroxide
- Y) Potassium sulfide and copper (II) sulfate
- Z) Nitric acid and ammonia

ANSWER: Y) POTASSIUM SULFIDE AND COPPER (II) SULFATE

### BONUS

11) CHEMISTRY *Short Answer* There are two elements whose ground state electron configurations contain exactly two half-filled subshells. What are these two elements?

ANSWER: CHROMIUM AND MOLYBDENUM

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### TOSS-UP

12) PHYSICS *Short Answer* A cheetah has an ability to accelerate from 0 to 30 meters per second in three seconds. Assuming constant acceleration, what distance in meters can the cheetah cover in this time interval?

ANSWER: 45

### BONUS

12) PHYSICS *Short Answer* A pilot in training is placed into a human centrifuge where she will experience 5 g of force pulling her inward, the acceleration at which most people will begin to lose consciousness. Given g as 10 meters per second squared, if the centrifuge has a mechanical arm that holds her at a radius of 8 meters, how fast will the pilot be traveling in meters per second?

ANSWER: 20

### TOSS-UP

13) EARTH AND SPACE *Multiple Choice* Tsunamis are most likely to be generated in which of the following oceans?

- W) Arctic
- X) Atlantic
- Y) Pacific
- Z) Southern

ANSWER: Y) PACIFIC

### BONUS

13) EARTH AND SPACE *Multiple Choice* What is the term for a crescent-shaped sand dune with horns pointed downwind?

- W) Barchan [**bahr-KAHN**]
- X) Traverse
- Y) Parabolic
- Z) Longitudinal

ANSWER: W) BARCHAN

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### TOSS-UP

14) BIOLOGY *Multiple Choice* Which of the following is an example of a negative chemotactic response in bacteria?

- W) Marine bacteria that use carbon dioxide as a nutrient are able to sense the concentration and move toward more highly-concentrated areas
- X) Bacteria being viewed under a microscope move away from the light
- Y) In a petri dish, *E. coli* will move away from concentrated areas of acetate
- Z) Photosynthetic bacteria will move towards the light in a gradient

ANSWER: Y) IN A PETRI DISH, *E. COLI* WILL MOVE AWAY FROM CONCENTRATED AREAS OF ACETATE

### BONUS

14) BIOLOGY *Short Answer* What are the five major steps in Holozoic nutrition?

ANSWER: INGESTION, DIGESTION, ABSORPTION, ASSIMILATION, EGESTION

### TOSS-UP

15) PHYSICS *Multiple Choice* A chunk of gold with a density of 19,300 kilograms per cubic meter and volume of 0.3 cubic meters is completely submerged in water. Assuming  $g = 10$  meters per second squared and the density of water is 1000 kilograms per cubic meter, what is the apparent weight of the gold in newtons?

- W) 54,900
- X) 64,900
- Y) 183,000
- Z) 193,000

ANSWER: W) 54,900

### BONUS

15) PHYSICS *Short Answer* At the bottom of a loop-the-loop on a roller coaster, Mike's apparent weight is three times his weight. Assuming  $g = 10$  meters per second squared and the diameter of the loop-the-loop is 20 meters, what is Mike's speed as a whole number in meters per second?

ANSWER: 14

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### TOSS-UP

16) MATH *Multiple Choice* If an arc of  $60^\circ$  on circle 1 has the same length as an arc of  $45^\circ$  on circle 2, what is the ratio of the area of circle 1 to the area of circle 2?

- W) 16:9
- X) 9:16
- Y) 4:3
- Z) 3:4

ANSWER: X) 9:16

### BONUS

16) MATH *Multiple Choice* A tourist begins a city stroll at an intersection. He walks north one block and then flips a coin. If the coin shows heads, he turns right; if it is tails, he turns left. In all, he walks a total of four blocks, flipping the coin at each corner to decide which way to turn. What is the probability that he ends at the starting point?

- W)  $\frac{1}{8}$
- X)  $\frac{1}{4}$
- Y)  $\frac{1}{3}$
- Z)  $\frac{1}{2}$

ANSWER: X)  $\frac{1}{4}$



### TOSS-UP

17) CHEMISTRY *Multiple Choice* Which of the following best describes the difference between gas diffusion and gas effusion?

- W) Diffusion occurs at constant temperature while effusion occurs at variable temperatures
- X) Diffusion can occur with any gas while effusion occurs only with certain gases
- Y) Diffusion involves gas molecules at the same total pressure while effusion involves gases moving from high pressure to low pressure
- Z) Diffusion is mass dependent while effusion is mass independent

ANSWER: Y) DIFFUSION INVOLVES GAS MOLECULES AT THE SAME TOTAL PRESSURE WHILE EFFUSION INVOLVES GASES MOVING FROM HIGH PRESSURE TO LOW PRESSURE

### BONUS

17) CHEMISTRY *Short Answer* According to kinetic-molecular theory, what is the mathematical relationship between molar mass and average gas phase speed?

ANSWER: INVERSE SQUARE

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### TOSS-UP

18) PHYSICS *Short Answer* By number, rank from greatest to least the moments of inertia for a golf club rotated about the following axes: 1) through the center of mass and parallel to the long axis of the club; 2) through the end of the handle and perpendicular to the long axis of the club; 3) through the center of mass and perpendicular to the long axis of the club.

ANSWER: 2, 3, 1

### BONUS

18) PHYSICS *Short Answer* Properly match the type of energy transfer with the following four situations described: A) mechanical work; B) matter transfer; C) electromagnetic radiation; D) mechanical waves; with 1) pushing a box across the floor; 2) listening to music; 3) seeing a bright light bulb; 4) filling a gas tank with fuel.

ANSWER: A = 1 (ACCEPT: MECHANICAL WORK = PUSHING A BOX ACROSS THE FLOOR);  
B = 4 (ACCEPT: MATTER TRANSFER = FILLING A GAS TANK WITH FUEL);  
C = 3 (ACCEPT: ELECTROMAGNETIC RADIATION = SEEING A BRIGHT LIGHT BULB);  
D = 2 (ACCEPT: MECHANICAL WAVES = LISTENING TO MUSIC)

### TOSS-UP

19) BIOLOGY *Multiple Choice* The drug colchicine [**KOL-chuh-seen**] inhibits polymerization [**puh-lim-er-uh-ZAY-shuhn**] of tubulin in microtubule assembly. Which of the following cell processes would be most severely impacted by colchicine activity?

- W) DNA replication
- X) Mitosis [**my-TOH-sis**]
- Y) Translation
- Z) Cellular respiration

ANSWER: X) MITOSIS

### BONUS

19) BIOLOGY *Short Answer* Name the two types of cell junctions that connect the cytoplasm [**SY-tuh-plaz-uhm**] of adjacent cells

ANSWER: PLASMODESMATA (ACCEPT: PLASMODESMA) AND GAP JUNCTION (ACCEPT: COMMUNICATING JUNCTION)

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### TOSS-UP

20) EARTH AND SPACE *Multiple Choice* Alfred Wegener believed that which of the following caused the continents to move?

- W) Strong earthquakes
- X) Strong winds
- Y) The spinning of the Earth
- Z) The rotation of the Earth's magnetic field

ANSWER: Y) THE SPINNING OF THE EARTH

### BONUS

20) EARTH AND SPACE *Multiple Choice* The dissolving ability of water is related to which of the following?

- W) The attraction between the water molecule's positive and negative charges and charges on other atoms
- X) Its ability to form hydrogen bonds with other molecules
- Y) Its ability to transmit energy from water molecule to water molecule
- Z) Its low viscosity

ANSWER: W) THE ATTRACTION BETWEEN THE WATER MOLECULE'S POSITIVE AND NEGATIVE CHARGES AND CHARGES ON OTHER ATOMS

### TOSS-UP

21) MATH *Multiple Choice* A student must enroll in 5 classes. She must take English, either Sociology or Economics, and either Chemistry, Biology, or Geology. For the other two courses, six offerings are available. How many different schedule selections are possible?

- W) 36
- X) 90
- Y) 180
- Z) 360

ANSWER: X) 90

### BONUS

21) MATH *Short Answer* The sides of a right triangle have lengths  $m$ ,  $m + n$ , and  $m + 2n$ . If  $n$  is positive, what is the ratio of  $m$  to  $n$ ?

ANSWER: 3:1 (ACCEPT: 3)

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### TOSS-UP

22) ENERGY *Short Answer* Some prokaryotes [*proh-KAR-ee-ohts*] derive energy from inorganic compounds such as sulfides, hydrogen, or ammonia. What is this type of metabolism called?

ANSWER: CHEMOLITHOTROPHY

### BONUS

22) ENERGY *Short Answer* Oxides of which two elements comprise most acid rain resulting from power generation?

ANSWER: NITROGEN AND SULFUR

### TOSS-UP

23) BIOLOGY *Short Answer* What human aneuploid **[an-yoo-PLOID]** syndrome is characterized by an XXY chromosome composition and sexual immaturity?

ANSWER: KLINEFELTER

### BONUS

23) BIOLOGY *Multiple Choice* Which of the following is a carnivorous **[kahr-NIV-or-uhs]** plant?

- W) Mushroom
- X) Nightshade
- Y) Nepenthes **[ni-PEN-theez]**
- Z) Datura **[duh-TOOR-uh]**

ANSWER: Y) NEPENTHES

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### TOSS-UP

24) CHEMISTRY *Multiple Choice* With regard to a graph illustrating the distribution of molecular speeds for a gas at different temperatures, which of the following occurs as temperature decreases?

- W) The curve flattens
- X) The average speed increases
- Y) The percentage of gas at higher speeds decreases
- Z) The mean free path decreases

ANSWER: Y) THE PERCENTAGE OF GAS AT HIGHER SPEEDS DECREASES

### BONUS

24) CHEMISTRY *Short Answer* Rank the following four gases in order of increasing effusion rates: 1) Argon, 2) Helium, 3) Oxygen, 4) Chlorine.

ANSWER: 4, 1, 3, 2 (ACCEPT: CHLORINE, ARGON, OXYGEN, HELIUM)

### TOSS-UP

25) PHYSICS *Short Answer* A metal rod with coefficient of linear expansion  $1.7 \times 10^{-5}$  per degree Celsius and length 10.0 meters is at  $20^\circ$  Celsius. What is the increase in length in millimeters when it is heated to  $30^\circ$  Celsius?

ANSWER: 1.7

### BONUS

25) PHYSICS *Multiple Choice* Two pipes of diameters  $d_1$  and  $d_2$  are connected. What is the ratio of kinetic energy per unit volume ( $k_1/k_2$ ) of water flowing through these pipes?

W)  $\left(\frac{d_2}{d_1}\right)^4$  [*open parenthesis d2 over d1 close parenthesis to the power of 4*]

X)  $\left(\frac{d_2}{d_1}\right)^2$  [*open parenthesis d2 over d1 close parenthesis to the power of 2*]

Y)  $\left(\frac{d_1}{d_2}\right)^4$  [*open parenthesis d1 over d2 close parenthesis to the power of 4*]

Z)  $\left(\frac{d_1}{d_2}\right)^2$  [*open parenthesis d1 over d2 close parenthesis to the power of 2*]

ANSWER: W)  $\left(\frac{d_2}{d_1}\right)^4$