

## ROUND 11

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### TOSS-UP

1) BIOLOGY *Multiple Choice* Different cell junctions are used to connect neighboring cells as needed for their functions. Which of the following options describes a situation that is utilizing desmosomes [**DEZ-muh-sohms**]?

- W) In developing embryos, ions can travel through a pore connecting the two membranes of adjacent cells to permit rapid cell communication
- X) Muscle cells are joined to form a sturdy sheet
- Y) Skin cells are joined to make a barrier impervious to even water
- Z) In a plant cell, small solutes in the cytoplasm will travel from cell to cell

ANSWER: X) MUSCLE CELLS ARE JOINED TO FORM A STURDY SHEET

### BONUS

1) BIOLOGY *Multiple Choice* During DNA replication, which of the following enzymes is mismatched to its function?

- W) DNA helicase: unwinds DNA strands
- X) DNA primase: creates DNA primer to start replication
- Y) DNA polymerase [**POL-uh-muh-rays**]: joins nucleotides [**NOO-kee-uh-tyds**] together
- Z) Single strand binding protein: prevents parental DNA strands from re-annealing

ANSWER: X) DNA PRIMASE: CREATES DNA PRIMER TO START REPLICATION

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### TOSS-UP

2) CHEMISTRY *Multiple Choice* The following gases are all at standard temperature and pressure. Which of the following gases will have the fastest root mean square speed?

- W) Helium
- X) Molecular nitrogen
- Y) Molecular oxygen
- Z) Sulfur dioxide

ANSWER: W) HELIUM

### BONUS

2) CHEMISTRY *Short Answer* If the  $pK_a$  of a weak acid is 4.74, what is the  $pK_b$  of its conjugate base?

ANSWER: 9.26

### TOSS-UP

3) MATH *Short Answer* Find the sum of the infinite geometric series with first three terms  $1/4$ ,  $1/16$ , and  $1/64$ .

ANSWER:  $1/3$

### BONUS

3) MATH *Multiple Choice* The series with  $n^{\text{th}}$  term  $(-1)^n/n$  [**negative 1 to the  $n$ th power, divided by  $n$** ] is which of the following?

- W) Divergent and unbounded
- X) Divergent and bounded from above only
- Y) Divergent and bounded
- Z) Convergent and bounded

ANSWER: Z) CONVERGENT AND BOUNDED

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### TOSS-UP

4) ENERGY *Multiple Choice* Volatile fossil fuels tend to have low carbon to hydrogen ratios. Which of the following fossil fuels is the most volatile?

- W) Coal
- X) Ethane
- Y) Methane
- Z) Petroleum

ANSWER: Y) METHANE

### BONUS

4) ENERGY *Short Answer* Rank the following four fuels in terms of carbon dioxide intensity, from least to greatest: 1) coal, 2) natural gas, 3) ethanol, 4) biomass.

ANSWER: 4, 3, 2, 1 (ACCEPT: BIOMASS, ETHANOL, NATURAL GAS, COAL)

### TOSS-UP

5) EARTH AND SPACE *Multiple Choice* Which of the following statements is NOT true about the Gulf of Maine?

- W) It is highly fertile
- X) A gyre [**JYUHR**] circulates nutrients and pollution through the Gulf
- Y) It is among the deepest gulfs in the world
- Z) It is sub-arctic, but has a wide range in water temperature

ANSWER: Y) IT IS AMONG THE DEEPEST GULFS IN THE WORLD

### BONUS

5) EARTH AND SPACE *Multiple Choice* Which of the following natural phenomena are associated with a patterned seasonal occurrence that ranges from May 15 to November 30?

- W) East Pacific Ocean hurricane season
- X) Continental U.S. tornado season
- Y) North Indian Ocean typhoon season
- Z) American Southwest monsoon season

ANSWER: W) EAST PACIFIC OCEAN HURRICANE SEASON

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### TOSS-UP

6) CHEMISTRY *Multiple Choice* Which of the following is NOT a step in balancing a redox reaction in an acidic solution?

- W) Write the unbalanced net ionic equation
- X) Determine which atoms are oxidized and which atoms are reduced
- Y) Balance each half-reaction for O by adding hydroxide (OH<sup>-</sup>) to the side with less oxygen
- Z) Balance each half-reaction for H by adding H<sup>+</sup> to the side with less H

ANSWER: Y) BALANCE EACH HALF-REACTION FOR O BY ADDING HYDROXIDE (OH<sup>-</sup>) TO THE SIDE WITH LESS OXYGEN

### BONUS

6) CHEMISTRY *Short Answer* When a certain powder is mixed into a solution of silver nitrate, a white precipitate forms. When the powder is added to a solution of sodium hydroxide, bubbles form, which produce a noxious odor. These bubbles, when bubbled into a solution of nickel (II) hydroxide, produce a drastic color change from green to dark blue. What is the identity of this powder?

ANSWER: AMMONIUM CHLORIDE (ACCEPT: FLUORIDE, BROMIDE, OR IODIDE IN PLACE OF CHLORIDE)

### TOSS-UP

7) BIOLOGY *Multiple Choice* Which of the following is NOT an example of substrate-level phosphorylation [**FOS-for-uh-lay-shuhn**] in cellular respiration?

W) ATP synthase phosphorylates [**FOS-for-uh-layts**] ADP during chemiosmosis [**ke-mee-uh-SMOH-sis**]

X) GDP is phosphorylated [**fos-fer-uh-LAY-ted**] as succinyl [**SUHK-suh-nil**] and CoA is converted to succinate [**SUHK-suh-nayt**]

Y) Phosphofructokinase phosphorylates ADP

Z) Pyruvate [**py-ROO-vayt**] kinase phosphorylates ADP

ANSWER: W) ATP SYNTHASE PHOSPHORYLATES ADP DURING CHEMIOSMOSIS

### BONUS

7) BIOLOGY *Short Answer* Beta-lactams, the class of antibiotics to which penicillin belongs, interfere with bacterial synthesis of what cellular structure in bacteria?

ANSWER: CELL WALL

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### TOSS-UP

8) PHYSICS *Multiple Choice* Two cars of unequal mass crash and stick together in a head on collision. Which of the following statements is true?

W) The car with the larger mass experiences the larger magnitude impulse

X) The car with the smaller mass experiences the larger magnitude impulse

Y) Both cars experience the same magnitude impulse in the same direction

Z) Both cars experience the same magnitude impulse in opposite directions

ANSWER: Z) BOTH CARS EXPERIENCE THE SAME MAGNITUDE IMPULSE IN OPPOSITE DIRECTIONS

### BONUS

8) PHYSICS *Multiple Choice* Two balls are thrown perfectly horizontally off a cliff on Mars, where the acceleration due to gravity is 3.7 meters per second squared. If ball 1 lands 30 meters further than ball 2, which of the following statements is correct about their initial velocities?

W) The velocity of ball 1 is 30 meters per second greater than the velocity of ball 2

X) The velocity of ball 2 is 30 meters per second greater than the velocity of ball 1

Y) The velocity of ball 1 is 30 times larger than the velocity of ball 2

Z) The exact relationship cannot be determined without knowing the height of the cliff

ANSWER: Z) THE EXACT RELATIONSHIP CANNOT BE DETERMINED WITHOUT KNOWING THE HEIGHT OF THE CLIFF

**TOSS-UP**

9) MATH *Short Answer* What is the area of a rhombus with diagonals of lengths 6 and 8?

ANSWER: 24

**BONUS**

9) MATH *Multiple Choice* A curve is given by the equation:  $x^3 + 3y^2 = 4$ . What is the slope of the tangent line at the point with coordinates (1, 1)?

- W) -2
- X) -1/2
- Y) 1/2
- Z) 2

ANSWER: X) -1/2

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**TOSS-UP**

10) ENERGY *Short Answer* In which direction do protons drag water in a polymer electrolyte membrane fuel cell?

ANSWER: ANODE TO CATHODE (ACCEPT: NEGATIVE ELECTRODE TO POSITIVE ELECTRODE)

**BONUS**

10) ENERGY *Short Answer* The three ways to protect yourself from radiation are time, shielding, and what?

ANSWER: DISTANCE

### TOSS-UP

11) EARTH AND SPACE *Multiple Choice* Which of the following statements is NOT true about upwelling?

- W) It is associated with good fishing
- X) Water that rises to the surface as a result of upwelling is typically colder and richer in nutrients
- Y) It is caused when offshore wind causes surface water to build up along a coastline
- Z) It occurs in the open ocean and along coastlines

ANSWER: Y) IT IS CAUSED WHEN OFFSHORE WIND CAUSES SURFACE WATER TO BUILD UP ALONG A COASTLINE

### BONUS

11) EARTH AND SPACE *Short Answer* What law mathematically expresses the amount of radiation emitted by a blackbody at a given temperature?

ANSWER: STEFAN-BOLTZMANN (ACCEPT: STEFAN'S LAW)

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### TOSS-UP

12) CHEMISTRY *Multiple Choice* Which of the following is NOT a property of all amino acids?

- W) They contain both carboxylic [*kahr-bok-SIL-ik*] acid and amine [*uh-MEEN*] functional groups
- X) They are chiral [*KY-ruh*]
- Y) They are considered organic molecules
- Z) They are generally referred to by their common name

ANSWER: X) THEY ARE CHIRAL

### BONUS

12) CHEMISTRY *Short Answer* What is the pH of a 0.001 molar solution of hydrochloric acid?

ANSWER: 3

### TOSS-UP

13) BIOLOGY *Multiple Choice* If you are doing a western blot, what kind of macromolecule are you trying to detect?

- W) DNA
- X) RNA
- Y) Protein
- Z) Carbohydrate

ANSWER: Y) PROTEIN

### BONUS

13) BIOLOGY *Short Answer* In adult humans, how many bones articulate with the occipital bone?

ANSWER: 6

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### TOSS-UP

14) PHYSICS *Multiple Choice* An Atwood's machine is built with a massless and frictionless pulley with a mass of 1 kilogram on one side and a mass of 4 kilograms on the other side. Assuming that the acceleration due to gravity is 10 meters per second squared, which is the speed of the masses in meters per second three seconds after being released?

- W) 5
- X) 6
- Y) 15
- Z) 18

ANSWER: Z) 18

### BONUS

14) PHYSICS *Multiple Choice* You sit on a pier and look straight down into the pond below. The apparent depth of the pond from the surface of the water is 5.0 meters. Given that the refractive indexes of air and water are 1.0 and 1.3, respectively, what is the real depth of the pond in meters?

- W) 0.3
- X) 3.8
- Y) 5.0
- Z) 6.7

ANSWER: Z) 6.7

### TOSS-UP

15) MATH *Short Answer* A point rotates around a circle at the rate of  $40^\circ$  per second. Convert this to revolutions per minute.

ANSWER:  $\frac{20}{3}$  (ACCEPT: 6 2/3)

### BONUS

15) MATH *Short Answer* Given:  $x^2 + y^2 = 34$  in the first quadrant and  $\frac{dx}{dt} = 5$ , find  $\frac{dy}{dt}$  when  $x = 3$ .

ANSWER: -3

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### TOSS-UP

16) ENERGY *Multiple Choice* Acid rain is unusually acidic precipitation containing elevated levels of hydrogen ions. Which of the following emissions is NOT an emission from a power plant that would contribute to acid rain?

- W) Carbon dioxide
- X) Hydroxide
- Y) Nitrogen oxide
- Z) Sulfur dioxide

ANSWER: X) HYDROXIDE

### BONUS

16) ENERGY *Multiple Choice* Which of the following does NOT increase line losses from so-called "corona" effects?

- W) Voltage
- X) Elevation
- Y) Precipitation
- Z) Latitude

ANSWER: Z) LATITUDE

### TOSS-UP

17) EARTH AND SPACE *Multiple Choice* Pangaea [**pan-JEE-uh**] formed by the end of what geologic period?

- W) Paleocene [**pay-lee-uh-SEEN**]
- X) Paleozoic
- Y) Permian
- Z) Pennsylvanian

ANSWER: Y) PERMIAN

### BONUS

17) EARTH AND SPACE *Short Answer* Which of the terrestrial planets in our solar system has the strongest magnetic field?

ANSWER: EARTH

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### TOSS-UP

18) CHEMISTRY *Multiple Choice* Which of the following best explains the difference between real gases and ideal gases?

- W) At low pressure, intermolecular attractions become significant
- X) At high pressure, intermolecular attractions become significant
- Y) As pressure decreases, the volume of the gas itself also decreases
- Z) As pressure increases, the volume of the gas itself also increases

ANSWER: X) AT HIGH PRESSURE, INTERMOLECULAR ATTRACTIONS BECOME SIGNIFICANT

### BONUS

18) CHEMISTRY *Multiple Choice* For a d orbital, which of the following is NOT an allowed value for the magnetic quantum number  $m_l$ ?

- W) -1
- X) 0
- Y) 2
- Z) 3

ANSWER: Z) 3

### TOSS-UP

19) BIOLOGY *Multiple Choice* Which of the following is an example of catabolism in the cell?

- W) Energy is extracted from the fat in avocado
- X) New DNA is synthesized
- Y) Glutamic acid is made from alpha-ketoglutarate [*kee-toh-GLOO-tay-rayt*] in the citric acid cycle
- Z) Dihydroxyacetone [*dy-hy-drok-see-AS-uh-tohn*] phosphate from glycolysis [*gly-KOL-uh-sis*] is converted to a precursor for lipid synthesis

ANSWER: W) ENERGY IS EXTRACTED FROM THE FAT IN AVOCADO

### BONUS

19) BIOLOGY *Multiple Choice* The helix-turn-helix motif is characteristic of a large group of proteins. Which of the following is a common function of the helix-turn-helix motif?

- W) Insertion into the cell membrane
- X) Lipid hydrolysis [*hy-DROL-uh-sis*]
- Y) DNA binding
- Z) Glycosidic bond formation [*gly-kuh-SY-dik*]

ANSWER: Y) DNA BINDING

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### TOSS-UP

20) PHYSICS *Short Answer* Providing your answer in scientific notation with one significant digit, what is the value of 1 erg in joules?

ANSWER:  $1 \times 10^{-7}$

### BONUS

20) PHYSICS *Multiple Choice* A light wave travels a distance of  $3 \times 10^{-7}$  meters in a medium of refractive index  $n \approx 1.5$ . How much time does this trip take?

- W)  $1.5 \times 10^{-6}$  nanoseconds
- X)  $4.5 \times 10^{-6}$  nanoseconds
- Y)  $1.5 \times 10^{-6}$  seconds
- Z)  $4.5 \times 10^{-6}$  seconds

ANSWER: W)  $1.5 \times 10^{-6}$  NANOSECONDS

### TOSS-UP

21) MATH *Multiple Choice* A hypersphere is described by a set of points such that  $w^2 + x^2 + y^2 + z^2 = 36$ . Which of the following statements is NOT true?

- W) (1, 2, 3, 1) lies inside the hypersphere
- X) (1, 5, 5, 1) lies outside the hypersphere
- Y) (3, 3, 3, 3) lies on the hypersphere
- Z) (1, 2, 5, 1) lies outside the hypersphere

ANSWER: Z) (1, 2, 5, 1) LIES OUTSIDE THE HYPERSPHERE

### BONUS

21) MATH *Short Answer* Evaluate  $\sin 15^\circ$  [*sine of 15 degrees*].

ANSWER:  $\frac{\sqrt{6}}{4} - \frac{\sqrt{2}}{4}$  (ACCEPT:  $\frac{\sqrt{6}-\sqrt{2}}{4}$ )

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### TOSS-UP

22) EARTH AND SPACE *Multiple Choice* Which of the following is the most abundant sediment in the oceans?

- W) Hydrogenous [*hy-DROJ-uh-nuhs*]
- X) Terrigenous
- Y) Biogenous
- Z) Cosmogenous

ANSWER: X) TERRIGENOUS

### BONUS

22) EARTH AND SPACE *Multiple Choice* Which of the following is true about the Antarctic ice sheet?

- W) It covers all land features in Antarctica
- X) It is over 4.2 kilometers thick in some areas
- Y) It is approximately 10 times as large in area as the Greenland ice sheet
- Z) It is nearly as large as the contiguous U.S.

ANSWER: X) IT IS OVER 4.2 KILOMETERS THICK IN SOME AREAS

### TOSS-UP

23) CHEMISTRY *Multiple Choice* What is the hybridization of the central oxygen atom in water?

- W) sp
- X) sp<sup>2</sup>
- Y) sp<sup>3</sup>
- Z) sp<sup>3</sup>d

ANSWER: Y) sp<sup>3</sup>

### BONUS

23) CHEMISTRY *Multiple Choice* A system consists of two gases inside a piston. The two gases react to form a solid product. During the reaction, 150 joules of heat are released and the surroundings do 50 joules of work on the system. What is the change in internal energy in joules of the system?

- W) -200
- X) -100
- Y) +100
- Z) +200

ANSWER: X) -100

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### TOSS-UP

24) BIOLOGY *Short Answer* The extracellular matrix protein, collagen, is composed of intertwined helices. How many protein helices come together to form collagen?

ANSWER: 3

### BONUS

24) BIOLOGY *Short Answer* Hemophilia A and Duchenne [*duh-SHAYN*] muscular dystrophy are examples of inherited genetic disorders that show which specific pattern of inheritance?

ANSWER: X-LINKED RECESSIVE (ACCEPT: SEX-LINKED RECESSIVE; DO NOT ACCEPT ALONE: X-LINKED, RECESSIVE)

### TOSS-UP

25) PHYSICS *Multiple Choice* If a light ray passes from air ( $n = 1.00$ ) to acetone ( $n = 1.36$ ), what is the critical angle?

- W)  $47^\circ$
- X)  $67^\circ$
- Y)  $87^\circ$
- Z) There is no total internal reflection

ANSWER: Z) THERE IS NO TOTAL INTERNAL REFLECTION

### BONUS

25) PHYSICS *Multiple Choice* In a science lab, a sphere rolls on a horizontal flat surface until it eventually comes to rest, but not as a result of a frictional force. Which of the following is the best explanation of why the sphere comes to rest?

- W) The spherical shape and/or flat surface must not be ideal and the sphere will stop where a defect makes that location a minimum potential-energy position
- X) Some other force, like fluid friction, must be acting on the sphere
- Y) Angular momentum between the rolling sphere and the spinning Earth must be conserved
- Z) The force of gravity must not be constant even though the surface is flat

ANSWER: W) THE SPHERICAL SHAPE AND/OR FLAT SURFACE MUST NOT BE IDEAL AND THE SPHERE WILL STOP WHERE A DEFECT MAKES THAT LOCATION A MINIMUM POTENTIAL ENERGY POSITION