

## ROUND 9

### TOSS-UP

1) PHYSICS *Multiple Choice* Needles  $N_1$ ,  $N_2$ , and  $N_3$  are made of a ferromagnetic, a paramagnetic, and a diamagnetic substance, respectively. When brought close to them, a magnet will do which of the following?

- W) Attract  $N_1$ ,  $N_2$ , and  $N_3$  weakly
- X) Attract  $N_1$  strongly,  $N_2$  weakly, and repel  $N_3$  weakly
- Y) Attract  $N_1$  and  $N_2$  strongly, but repel  $N_3$
- Z) Attract  $N_1$  strongly, but repel  $N_2$  and  $N_3$  weakly

ANSWER: X) ATTRACT  $N_1$  STRONGLY,  $N_2$  WEAKLY, AND REPEL  $N_3$  WEAKLY

### BONUS

1) PHYSICS *Short Answer* Providing your answer as a decimal to the nearest hundredth, what is the potential energy in joules when a spring with a spring constant of 32 newtons per meter is stretched by 10 centimeters?

ANSWER: 0.16

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### TOSS-UP

2) EARTH AND SPACE *Multiple Choice* From 1980 to 2009, 48 weather-related disasters have caused at least 1 billion dollars in economic losses each. Of these 48 instances, the greatest losses have been attributed to which of the following weather disasters?

- W) Hurricanes
- X) Fires
- Y) Floods
- Z) Drought

ANSWER: Z) DROUGHT

### BONUS

2) EARTH AND SPACE *Short Answer* By name or number, identify in which of the following five locations halite and gypsum deposits are most likely to form: 1) submarine canyons, 2) the deep seafloor, 3) deep-sea fans, 4) freshwater lakes, 5) marine environments with restricted circulation.

ANSWER: MARINE ENVIRONMENTS WITH RESTRICTED CIRCULATION (ACCEPT: 5)

### TOSS-UP

3) PHYSICS *Multiple Choice* Two parallel conducting plates, separated by a distance  $d$ , are connected to a battery. Which of the following is correct if the plate separation is doubled while the battery remains connected?

- W) The electric charge on the plates is doubled
- X) The potential difference between the plates is doubled
- Y) The potential difference between the plates is halved
- Z) The electric charge on the plates is halved

ANSWER: Z) THE ELECTRIC CHARGE ON THE PLATES IS HALVED

### BONUS

3) PHYSICS *Short Answer* Rose, whose mass is 45 kilograms, is ice skating with a constant speed of 7 meters per second when she hits a rough patch of ice with a coefficient of friction of 0.08. Providing your answer to the nearest integer, how long will it take in seconds before Rose coasts to a stop?

ANSWER: 9

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### TOSS-UP

4) ENERGY *Multiple Choice* Which of the following uses would NOT be appropriate for class A biosolids?

- W) Compost in a garden
- X) Alternative daily cover at a landfill
- Y) Enrichment for barren soil
- Z) Fertilizer at an organic farm

ANSWER: Z) FERTILIZER AT AN ORGANIC FARM

### BONUS

4) ENERGY *Short Answer* A 75-kilogram pole vaulter tries to vault over a height of 5 meters. Given that  $g$  is 10 meters per second squared, assuming no frictional loss and that all vaulting energy is kinetic, calculate the minimum vertical speed in meters per second that a vaulter needs in order to clear this height.

ANSWER: 10

### TOSS-UP

5) MATH *Short Answer* How many real solutions does the equation  $x^5 + x + 1 = 0$  (read as: x to the fifth plus x plus 1 equals 0) have?

ANSWER: 1

### BONUS

5) MATH *Multiple Choice* Cucumbers grown on a certain farm have normally distributed weights with a standard deviation of 2 ounces. Which of the following is the mean weight if 85% of the cucumbers weigh less than 16 ounces?

- W) 13.92
- X) 14.30
- Y) 14.88
- Z) 15.70

ANSWER: W) 13.92

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### TOSS-UP

6) EARTH AND SPACE *Multiple Choice* Which of the following is NOT an alternative to compression in mountain formation?

- W) Uplift
- X) Folding of rocks during thrust faulting
- Y) Rifting
- Z) Mantle upwelling

ANSWER: X) FOLDING OF ROCKS DURING THRUST FAULTING

### BONUS

6) EARTH AND SPACE *Short Answer* Match the terms amber, petrified, and mold, respectively, with the numbers of the following descriptions: 1) a shell is buried in sediment and then dissolved, leaving the sediment to take the shape of the organism; 2) a life form's pore spaces and cavities are filled with precipitated minerals; and 3) organisms are trapped in hardened resin or tree sap, sealing them from the atmosphere.

ANSWER: AMBER, 3; PETRIFIED, 2; AND MOLD, 1

### TOSS-UP

7) PHYSICS *Multiple Choice* The electron in the ground state of hydrogen is bound by 13.6 electron-volts. How many electron-volts bind the electron in a singly charged helium ion?

- W) 54.4
- X) 27.2
- Y) 13.6
- Z) 6.8

ANSWER: W) 54.4

### BONUS

7) PHYSICS *Short Answer* Erin and her friends go fishing in her 1.20 cubic meter rowboat, which has a mass of 100 kilograms. How many 60.0 kilogram people can get into the boat before the boat sinks?

ANSWER: 18

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### TOSS-UP

8) EARTH AND SPACE *Short Answer* Which planet in our Solar System has the longest sidereal day?

ANSWER: VENUS

### BONUS

8) EARTH AND SPACE *Short Answer* What is another term for a sand sea or dune sea, an area of more than 125 square kilometers covered with moving sand and little or no vegetation?

ANSWER: ERG (DO NOT ACCEPT: DUNE FIELD)

### TOSS-UP

9) ENERGY *Multiple Choice* Which of the following common household items is an example of a technology with high power demand but low contribution to average household energy consumption?

- W) Standard light bulb
- X) Compact fluorescent light bulb
- Y) Microwave
- Z) Personal computer

ANSWER: Y) MICROWAVE

### BONUS

9) ENERGY *Multiple Choice* With a constant braking force, the stopping distance of a car is proportional to which of the following?

- W) The velocity
- X) The square of the velocity
- Y) The product of the velocity and the mass
- Z) The product of the square of the mass and the square of the velocity

ANSWER: X) THE SQUARE OF THE VELOCITY

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### TOSS-UP

10) BIOLOGY *Multiple Choice* Which of the following is NOT true about purple-striped jellies?

- W) Humans exposed to their nematocysts typically have a fatal reaction
- X) Young cancer crabs are often found clinging to the jelly
- Y) They move short distances by pulsing
- Z) They sometimes eat fish eggs

ANSWER: W) HUMANS EXPOSED TO THEIR NEMATOCYSTS TYPICALLY HAVE A FATAL REACTION

### BONUS

10) BIOLOGY *Short Answer* What substance, wrapped around the axons of neurons, helps increase the speed that impulses propagate along the neuron?

ANSWER: MYELIN (ACCEPT: MYELIN SHEATH)

### TOSS-UP

11) MATH *Multiple Choice* Which of the following statements is TRUE about confidence intervals for a sample mean?

- W) A 99% confidence interval is wider than a 95% confidence interval
- X) The 99% confidence interval is not symmetric
- Y) The 95% confidence interval can be interpreted as a 95% chance that the true mean is in the interval
- Z) The 95% confidence interval is symmetric around the true population mean

ANSWER: W) A 99% CONFIDENCE INTERVAL IS WIDER THAN A 95% CONFIDENCE INTERVAL

### BONUS

11) MATH *Short Answer* What is the area of a triangle with side lengths of 10, 12, and 18, rounded to the nearest whole number?

ANSWER: 57

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### TOSS-UP

12) BIOLOGY *Multiple Choice* Which of the following is NOT a characteristic of northern elephant seals?

- W) They are the largest phocids (read as: FOH-sids) in the Northern Hemisphere
- X) They do not eat on land
- Y) They dive to depths of 1,000 to 2,500 feet underwater
- Z) Males live longer than females

ANSWER: Z) MALES LIVE LONGER THAN FEMALES

### BONUS

12) BIOLOGY *Multiple Choice* Insects that eat solid food would likely have a gut with all of these properties, EXCEPT:

- W) Strong musculature
- X) Grinding capabilities
- Y) Sections which narrow to provide filtration
- Z) Protection from abrasion

ANSWER: Y) SECTIONS WHICH NARROW TO PROVIDE FILTRATION

### TOSS-UP

13) ENERGY *Multiple Choice* Which of the following statements is NOT true about liquefied natural gas, or LNG?

- W) LNG is produced by cooling natural gas to  $-260^{\circ}$  Fahrenheit
- X) LNG is odorless
- Y) LNG is corrosive
- Z) If spilled at sea, LNG would evaporate quickly

ANSWER: Y) LNG IS CORROSIVE

### BONUS

13) ENERGY *Short Answer* A 2-kilogram mass is held against a spring compressed by 3 meters and with a spring constant of 500 newtons per meter. What is the maximum kinetic energy in joules the mass can achieve?

ANSWER: 2250

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### TOSS-UP

14) PHYSICS *Multiple Choice* A pendulum with a length of 2.0 meters is released when it makes an angle of 25 degrees from the vertical. Given 9.8 meters per second squared as  $g$ , what is its velocity in meters per second at the bottom of its swing?

- W) 0.9
- X) 1.3
- Y) 1.6
- Z) 1.9

ANSWER: Z) 1.9

### BONUS

14) PHYSICS *Short Answer* A bullet is fired horizontally from a rifle on a table 1.25 meters high. Given  $g$  as 10 meters per second squared and providing your answer as a decimal to the nearest tenth, how long would it take, in seconds, for the bullet to hit the ground?

ANSWER: 0.5

### TOSS-UP

15) BIOLOGY *Short Answer* What is the scientific name for the bacterium that causes whooping cough in humans?

ANSWER: *BORDETELLA PERTUSSIS*

### BONUS

15) BIOLOGY *Multiple Choice* To diagnose whooping cough, which of the following culture media is the medium of choice for bacterial incubation?

W) Super optimal broth

X) Regan-Lowe agar

Y) Xylose lysine deoxycholate agar (read as: ZY-lōes LY-seen dee-ohk-see-KŌE-layt)

Z) Lowenstein-Jensen

ANSWER: X) REGAN-LOWE AGAR

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### TOSS-UP

16) MATH *Short Answer* What is the name of the planar curve with polar equation  $r = \theta$  (read as:  $r$  equals theta)?

ANSWER: SPIRAL (ACCEPT: ARCHIMEDEAN SPIRAL)

### BONUS

16) MATH *Short Answer* Compute the summation from  $n = 1$  to  $n = 180$  of the cosine of  $n$  degrees.

ANSWER: -1



### TOSS-UP

17) CHEMISTRY *Multiple Choice* Which of the following types of mixtures displays the Tyndall effect and also separates when filtered?

- W) Solution
- X) Colloid
- Y) Suspension
- Z) Emulsion

ANSWER: Y) SUSPENSION

### BONUS

17) CHEMISTRY *Short Answer* Using proper chemical nomenclature and indicating the charge and physical state of each substance, what is the balanced net ionic equation for the reaction of aqueous calcium chloride with aqueous silver nitrate?

ANSWER:  $\text{Cl}_{(\text{aq})} + \text{Ag}^{+}_{(\text{aq})} \rightarrow \text{AgCl}_{(\text{s})}$

[NOTE: AQ = AQUEOUS; S = SOLID]

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### TOSS-UP

18) EARTH AND SPACE *Multiple Choice* As Greenland's ice sheet continues to melt, which of the following features could be exposed in coming years?

- W) Arêtes (read as: ah-RATES) and cirques
- X) Moraines and drumlins
- Y) Glacial striations
- Z) Glacial flour and roche moutonnée (read as: ROHWSH MOO-toh-nay)

ANSWER: X) MORAINES AND DRUMLINS

### BONUS

18) EARTH AND SPACE *Short Answer* Residing approximately 2,600 light years away from Earth in a turbulent, star-forming region of the constellation Monoceros, what is the name of the pillar of gas and dust about 7 light years long with a reddish veil produced by glowing hydrogen gas?

ANSWER: CONE NEBULA (ACCEPT: JESUS CHRIST NEBULA)

### TOSS-UP

19) CHEMISTRY *Multiple Choice* Which of the following statements is TRUE about boiling points?

- W) The presence of a non-volatile solute decreases the boiling point of a liquid
- X) A liquid in a vacuum has a higher boiling point than at atmospheric pressure
- Y) A boiling point can be reduced below the triple point
- Z) The boiling point cannot be increased above the critical point

ANSWER: Z) THE BOILING POINT CANNOT BE INCREASED ABOVE THE CRITICAL POINT

### BONUS

19) CHEMISTRY *Short Answer* By name or number, identify all of the following five compounds that are ionic: 1) potassium bromide, 2) sodium sulfate, 3) carbon dioxide, 4) methane, 5) ammonium chloride.

ANSWER: POTASSIUM BROMIDE, SODIUM SULFATE, AND AMMONIUM CHLORIDE  
(ACCEPT: 1, 2, AND 5)

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### TOSS-UP

20) BIOLOGY *Short Answer* In 2008, what new species of large brown seaweed with characteristic V-shaped blades was discovered near the shore of the Aleutian Islands?

ANSWER: GOLDEN V KELP (ACCEPT: *AUREOPHYCUS ALEUTICUS*)  
(DO NOT ACCEPT: KELP, GOLDEN KELP, V KELP)

### BONUS

20) BIOLOGY *Short Answer* What is the term for a fluid-filled cavity formed within the mesoderm in triploblastic animals?

ANSWER: PSEUDOCOELOM

### TOSS-UP

21) CHEMISTRY *Short Answer* By name or number, identify all of the following three species that are predicted by the molecular orbital model to be stable and diatomic: 1)  $\text{He}_2^{2+}$  (read as: He 2 [pause] 2 plus), 2)  $\text{He}_2^{1+}$  (read as: He 2 [pause] 1 plus), 3)  $\text{He}_2$ .

ANSWER:  $\text{He}_2^{2+}$  AND  $\text{He}_2^{1+}$  (ACCEPT: 1 AND 2)

### BONUS

21) CHEMISTRY *Short Answer* By name or number, identify all of the following four sets of atoms and ions that are isoelectronic with each other: set 1)  $\text{S}^{2-}$ ,  $\text{Se}^{2-}$ , Ar; set 2) Cl, Cl, Ar; set 3)  $\text{Ca}^{2+}$ , Cl,  $\text{S}^{2-}$ ,  $\text{K}^{+}$ ; set 4) H,  $\text{Li}^{+}$ , He.

ANSWER:  $\text{Ca}^{2+}$ , Cl,  $\text{S}^{2-}$ ,  $\text{K}^{+}$  AND H,  $\text{Li}^{+}$ , He (ACCEPT: SETS 3 AND 4)

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### TOSS-UP

22) MATH *Short Answer* The parametric equations  $x = 4\cos(t)$  and  $y = 2\sin(t)$  represent what type of conic section?

ANSWER: ELLIPSE

### BONUS

22) MATH *Short Answer* Simplify  $8^{\log_{\text{base } 2 \text{ of } (4)}} - 4^{\log_{\text{base } 2 \text{ of } (8)}}$  (read as: 8 to the power of log base 2 of 4 minus 4 to the power of log base 2 of 8).

ANSWER: 0

### TOSS-UP

23) PHYSICS *Short Answer* What is the term for a vector representing a sine wave that has a magnitude equal to the amplitude of the wave and rotates around an origin?

ANSWER: PHASOR

### BONUS

23) PHYSICS *Short Answer* In a hydraulic machine, a small piston is pushed down a distance of 10 centimeters, causing the large piston on the other end to rise 1 centimeter. Assuming the pistons are in equilibrium, if the small piston is pushed down with a force of 200 newtons, how much force is the large piston exerting in newtons?

ANSWER: 2000

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### TOSS-UP

24) BIOLOGY *Short Answer* Bedbugs belong to which order?

ANSWER: HEMIPTERA

### BONUS

24) BIOLOGY *Multiple Choice* Which of the following is a defining characteristic of the order Hemiptera?

- W) Leathery wings
- X) Wings that are held "roof-like" over the body when the insect is at rest
- Y) Chewing mouthparts that arise from the posterior of the head
- Z) Sucking mouthparts that arise from the anterior of the head

ANSWER: Z) SUCKING MOUTHPARTS THAT ARISE FROM THE ANTERIOR OF THE HEAD

### TOSS-UP

25) CHEMISTRY *Multiple Choice* Effective nuclear charge is BEST described by which of the following?

- W) It is the charge on the nucleus experienced by an electron when accounting for the shielding effect of other electrons
- X) It is the amount of energy required to remove an electron from the valence shell when the atom is in a gaseous state
- Y) It is the energy released when a proton is added to the nucleus
- Z) It is the number of electrons that penetrate the nucleus

ANSWER: W) IT IS THE CHARGE ON THE NUCLEUS EXPERIENCED BY AN ELECTRON WHEN ACCOUNTING FOR THE SHIELDING EFFECT OF OTHER ELECTRONS

### BONUS

25) CHEMISTRY *Short Answer* A soft drink is bottled so that at 25° Celsius, it contains carbon dioxide gas at a pressure of 5 atmospheres over the liquid. Assuming that the partial pressure of carbon dioxide in the atmosphere is  $4 \times 10^{-4}$  atmospheres and that the Henry's law constant for carbon dioxide in aqueous solution is 0.2 moles per liter atmosphere at 25° Celsius, calculate the equilibrium concentrations in moles per liter of carbon dioxide before and after the bottle is opened, respectively.

ANSWER: UNOPENED: 1, OPENED:  $8 \times 10^{-5}$