

## ROUND 11

### TOSS-UP

1) CHEMISTRY *Multiple Choice* Which of the following is NOT true:

- W) any foreign substance added to water will cause a freezing point drop
- X) a nonvolatile solute raises the boiling point of a solvent
- Y) methane has a higher boiling point than ethane
- Z) freezing point depression is a colligative property

ANSWER: Y) METHANE HAS A HIGHER BOILING POINT THAN ETHANE

### BONUS

1) CHEMISTRY *Short Answer* According to standard chemical nomenclature, what is the formula for aluminum bicarbonate?

ANSWER:  $\text{Al}(\text{HCO}_3)_3$

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### TOSS-UP

2) BIOLOGY *Multiple Choice* Which of the following types of biological molecules is digested by trypsin:

- W) proteins
- X) nucleic acids
- Y) carbohydrates
- Z) lipids

ANSWER: W) PROTEINS

### BONUS

2) BIOLOGY *Short Answer* Name all of the following 4 choices that are typically considered human autoimmune dysfunctions: Rheumatoid arthritis; Lupus; shingles; Down's syndrome

ANSWER: RHEUMATOID ARTHRITIS; LUPUS

### TOSS-UP

3) PHYSICS *Multiple Choice* Which of the following is closest to the radius of a hydrogen nucleus:

- W) 1 micrometer
- X) 1 angstrom
- Y) 1 picometer
- Z) 1 femtometer

ANSWER: Z) 1 FEMTOMETER

### BONUS

3) PHYSICS *Short Answer* Consider a planet where  $g$  equals 5.0 meters per second squared. Ignoring friction, if an object started from rest, how far would it fall vertically off a cliff in 4.0 seconds, giving your answer in standard SI units?

ANSWER: 40 METERS (must give units)

(Solution:  $d = \frac{1}{2} \times at^2 = \frac{1}{2} \times 5 \times 4^2 = 40$  meters)

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### TOSS-UP

4) MATH *Multiple Choice* The graph of the relation  $y = -\sqrt{(25 - x^2)}$  is a:

- W) circle
- X) semi-circle
- Y) parabola
- Z) straight line

ANSWER: X) SEMI-CIRCLE

### BONUS

4) MATH *Short Answer* If  $y$  varies directly as  $x$  and  $z$ , and  $y = 12$  when  $x = 4$  and  $z = 5$ , find  $y$  when  $x = 10$  and  $z = 20$ :

ANSWER: 120

(Solution:  $y = kxz$ ;  $12 = k(4)(5)$ ;  $k = 3/5$ ;  $y = 3/5(10)(20) = 120$ )

### TOSS-UP

5) EARTH SCIENCE *Short Answer* What is the third most common gas naturally found in the Earth's clean, dry atmosphere?

ANSWER: ARGON

### BONUS

5) EARTH SCIENCE *Multiple Choice* The Earth's greenhouse effect is primarily caused by which of the following:

- W) incoming solar ultraviolet light is absorbed by the ozone layer
- X) outgoing infrared solar radiation is trapped by the lower atmosphere
- Y) incoming infrared solar radiation is trapped by the magnetic field
- Z) outgoing X-rays are absorbed by the troposphere and reflected to the Earth's surface

ANSWER: X) OUTGOING INFRARED SOLAR RADIATION IS TRAPPED BY THE LOWER ATMOSPHERE

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### TOSS-UP

6) GENERAL SCIENCE *Multiple Choice* Ed the entomologist is setting up mosquito traps in a farmer's field in Nebraska. Which of the following would be the BEST mosquito attractant to ensure he traps the greatest number and variety of mosquitoes:

- W) oxygen
- X) nitrogen
- Y) dry ice
- Z) methane

ANSWER: Y) DRY ICE

(Solution: mosquitoes attracted to CO<sub>2</sub>)

### BONUS

6) GENERAL SCIENCE *Short Answer* Rounded to the nearest whole number, convert 3,000 meters per second into kilometers per hour:

ANSWER: 10,800

### TOSS-UP

7) ASTRONOMY *Multiple Choice* Which of the following is LEAST accurate:

- W) most stars visible to the unaided eye are part of the Milky Way galaxy
- X) there are 88 constellations officially recognized by the IAU
- Y) a red supergiant has a hotter surface than our Sun
- Z) the constellation Leo is located within 9° of the ecliptic

ANSWER: Y) A RED SUPERGIANT HAS A HOTTER SURFACE THAN OUR SUN

### BONUS

7) ASTRONOMY *Multiple Choice* Which of the following is NOT true:

- W) the core of a red supergiant is hotter than the core of a main sequence K-type star
- X) helium flash is something that occurs in red giant stars
- Y) the Pleiades is an open star cluster
- Z) there is more lithium than carbon in the universe

ANSWER: Z) THERE IS MORE LITHIUM THAN CARBON IN THE UNIVERSE

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### TOSS-UP

8) CHEMISTRY *Multiple Choice* Carbon monoxide, or CO, will be adsorbed (read as: ADD-sorbed) onto the surface of which of the following metals the MOST strongly:

- W) iron
- X) nickel
- Y) cobalt
- Z) gold

ANSWER: W) IRON

### BONUS

8) CHEMISTRY *Short Answer* Arrange the following 3 choices in order of increasing bond energies: O<sub>2</sub>; N<sub>2</sub>; F<sub>2</sub>

ANSWER: F<sub>2</sub>; O<sub>2</sub>; N<sub>2</sub>



### TOSS-UP

9) BIOLOGY *Multiple Choice* At which of the following pH levels will human pepsin be most active:

- W) 2
- X) 4
- Y) 6
- Z) 8

ANSWER: W) 2

### BONUS

9) BIOLOGY *Short Answer* What is the most plentiful class of immunoglobulins in human plasma?

ANSWER: IgG (ACCEPT: G or IMMUNOGLOBULIN G)

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### TOSS-UP

10) PHYSICS *Short Answer* What constant is given as the amount of electric charge per mole of electrons?

ANSWER: FARADAY CONSTANT (ACCEPT: FARADAY)

### BONUS

10) PHYSICS *Multiple Choice* Which of the following best describes the direction of the force on an electron moving through a magnetic field:

- W) opposite to the direction of the velocity
- X) the same direction as the velocity
- Y) the same direction as the magnetic field
- Z) perpendicular to the magnetic field

ANSWER: Z) PERPENDICULAR TO THE MAGNETIC FIELD

### TOSS-UP

11) MATH *Multiple Choice* Which of the following is a second quadrant angle in standard position:

- W)  $500^\circ$
- X)  $-180^\circ$
- Y)  $-680^\circ$
- Z)  $930^\circ$

ANSWER: W)  $500^\circ$

### BONUS

11) MATH *Short Answer* Giving your answer in simplest radical form, rationalize the denominator of the following expression:  $\frac{-3\sqrt{2}}{(\sqrt{3} - \sqrt{5})}$

ANSWER:  $\frac{3\sqrt{6} + 3\sqrt{10}}{2}$  (ACCEPT:  $\frac{3}{2}(\sqrt{6} + \sqrt{10})$ )

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### TOSS-UP

12) EARTH SCIENCE *Multiple Choice* Which of the following minerals occurs in small amounts in many igneous rocks, is black and shiny, often occurs in small hexagonal blocks, and is soft with good cleavage:

- W) biotite
- X) olivine
- Y) plagioclase
- Z) quartz

ANSWER: W) BIOTITE

### BONUS

12) EARTH SCIENCE *Multiple Choice* Which of the following is NOT true of basalt and gabbro:

- W) they formed from magma at the same temperature
- X) they are derived from basaltic magma
- Y) they formed from magma with the same silica content
- Z) they are both intrusive igneous rocks

ANSWER: Z) THEY ARE BOTH INTRUSIVE IGNEOUS ROCKS

(Solution: basalt = extrusive; gabbro = intrusive)

### TOSS-UP

13) GENERAL SCIENCE *Multiple Choice* A standard rain gauge consists of a metal canister open at the top in which a funnel drains rainwater into a narrow cylinder. Each time they are deployed to the field, a small amount of light oil is added to the cylinder. This is done to:

- W) deter birds from drinking the water
- X) stop the canister from oxidizing
- Y) prevent the growth of blue-green algae
- Z) prevent water evaporation

ANSWER: Z) PREVENT WATER EVAPORATION

### BONUS

13) GENERAL SCIENCE *Multiple Choice* Which of the following is a widely-used analgesic and antipyretic medication which is not considered an NSAID (read as: en-say'd):

- W) acetylcysteine
- X) acetaminophen
- Y) acetylsalicylic acid
- Z) ibuprophen

ANSWER: X) ACETAMINOPHEN

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### TOSS-UP

14) ASTRONOMY *Multiple Choice* Which of the following is LEAST likely to occur for a stargazer observing from mid-northern latitudes during summer months:

- W) the planet Venus passing within a few degrees of the Moon a few hours after sunset
- X) the Moon at perigee
- Y) the planet Saturn passing with 5 degrees of the Moon
- Z) the planet Mercury within 10 degrees of the zenith

ANSWER: Z) THE PLANET MERCURY WITHIN 10 DEGREES OF THE ZENITH

### BONUS

14) ASTRONOMY *Short Answer* Through how many degrees does the Earth rotate in 8 hours?

ANSWER: 120

(Solution:  $15^\circ$  per hour  $= 8 \times 15^\circ = 120^\circ$ )

### TOSS-UP

15) CHEMISTRY *Multiple Choice* The molal (read as: moe-lahl) is a concentration unit that is most appropriately used in experimental designs that determine:

- W) freezing point depression
- X) osmotic pressure
- Y) density
- Z) vapor pressure lowering

ANSWER: W) FREEZING POINT DEPRESSION

### BONUS

15) CHEMISTRY *Short Answer* A 4.0 gram sample of calcium chloride contains  $6.0 \times 10^{22}$  cations. Giving your answer in scientific notation to the nearest whole number, determine the number of anions in 2 grams of  $\text{CaCl}_2$ . Assume the atomic mass of calcium is 40 and chloride is 35.

ANSWER:  $6 \times 10^{22}$

(Solution:  $(2\text{g CaCl}_2)(6.0 \times 10^{22} \text{ Ca}^{2+}/4\text{g CaCl}_2)(2 \text{ Cl}^-/1 \text{ Ca}^{2+}) = 6.0 \times 10^{22} \text{ Cl}^-$ )

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### TOSS-UP

16) BIOLOGY *Multiple Choice* Which of the following is the main target of bacteria by the antibiotic penicillin:

- W) energy production
- X) DNA synthesis
- Y) cell wall synthesis
- Z) translation

ANSWER: Y) CELL WALL SYNTHESIS

### BONUS

16) BIOLOGY *Short Answer* What is the most common term for the form of protection when a non-poisonous frog has the same appearance as a poisonous frog?

ANSWER: BATESIAN MIMICRY (ACCEPT: MIMICRY or WARNING MIMICRY)  
(DO NOT ACCEPT: MULLERIAN MIMICRY)

### TOSS-UP

17) PHYSICS *Multiple Choice* During positron emission, which of the following most likely occurs:

- W) a proton changes to an electron
- X) a proton changes to a neutron
- Y) a neutron changes to an electron
- Z) a neutron changes to a proton

ANSWER: X) A PROTON CHANGES TO A NEUTRON

### BONUS

17) PHYSICS *Short Answer* Name all of the following 4 isotopes that release energy if they undergo fission: helium-4; hydrogen-2; uranium-235; iron-56

ANSWER: URANIUM-235

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### TOSS-UP

18) MATH *Short Answer* Identify the type of conic section represented by the equation,  $x^2 + y^2 + 10y + 16 = 0$ :

ANSWER: CIRCLE

(Solution:  $x^2 + (y + 5)^2 = 9$ )

### BONUS

18) MATH *Short Answer* Find the area, in centimeters squared and in simplest radical form, of a regular or equilateral triangle whose circumscribed circle has a radius of 8 centimeters:

ANSWER:  $48\sqrt{3}$

(Solution: apothem = 4; perimeter =  $(8\sqrt{3})(3)$ ;  $A = \frac{1}{2}(4)(24\sqrt{3}) = 48\sqrt{3} \text{ cm}^2$ )



### TOSS-UP

19) EARTH SCIENCE *Short Answer* What type of fog frequently forms in valleys when the wind is light and the ground cools until the dew point is reached?

ANSWER: RADIATION FOG (ACCEPT: RADIATION or RADIATIONAL)

(Solution: brought about by radiational cooling)

### BONUS

19) EARTH SCIENCE *Short Answer* Giving your answer as morning, afternoon, evening, or night, when does most radiational cooling occur for any location in the U.S.?

ANSWER: NIGHT

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### TOSS-UP

20) GENERAL SCIENCE *Short Answer* What is the sling psychrometer used to measure?

ANSWER: HUMIDITY (ACCEPT: RELATIVE HUMIDITY; AMBIENT HUMIDITY)

### BONUS

20) GENERAL SCIENCE *Multiple Choice* From which of the following is camphor derived:

- W) petroleum distillate
- X) the wood of an evergreen tree of the laurel family
- Y) the bark of a fir tree from the Mediterranean
- Z) the seed pod of the camphor herb

ANSWER: X) THE WOOD OF AN EVERGREEN TREE OF THE LAUREL FAMILY

### TOSS-UP

21) ASTRONOMY *Short Answer* As seen from the Earth, what planet has the smallest maximum eastern elongation?

ANSWER: MERCURY

### BONUS

21) ASTRONOMY *Short Answer* Choosing from noon, sunset, midnight or sunrise, at what time of the day does a new Moon rise for an observer at mid-northern latitudes in September?

ANSWER: SUNRISE

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### TOSS-UP

22) CHEMISTRY *Short Answer* What is the electron capacity in each of the 4 sublevels s, p, d, and f, respectively?

ANSWER: s = 2; p = 6; d = 10; f = 14

### BONUS

22) CHEMISTRY *Short Answer* A sample of oxygen gas is collected over water at 14°C. Knowing that the vapor pressure of water at 14°C is 1.6 kilopascals, and that the pressure of the resultant mixture is 120 kilopascals, find the pressure, to the first decimal place, exerted by the dry oxygen alone:

ANSWER: 118.4

(Solution:  $P_{\text{dry}} = P_{\text{t}} - P_{\text{wv}} = 120 \text{ kPa} - 1.6 \text{ kPa} = 118.4 \text{ kPa}$ )

### TOSS-UP

23) BIOLOGY *Short Answer* What cell in the peripheral blood is the immediate precursor of the macrophage?

ANSWER: MONOCYTE

### BONUS

23) BIOLOGY *Short Answer* Name all of the following 4 cells that are leukocytes: neutrophil; basophil; melanocyte; macrophage

ANSWER: NEUTROPHIL; BASOPHIL

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### TOSS-UP

24) PHYSICS *Short Answer* As opposed to spontaneous emission, what is the type of emission, first theorized by Albert Einstein, where a photon interacts with an atom's electron which, when it returns to a ground state, emits a coherent photon?

ANSWER: STIMULATED EMISSION (ACCEPT: STIMULATED)

### BONUS

24) PHYSICS *Short Answer* Order the following 4 choices from the one with the LOWEST temperature to the one with the HIGHEST temperature: copper freezes; water boils; solar corona; lead melts

ANSWER: WATER BOILS; LEAD MELTS; COPPER FREEZES; SOLAR CORONA

### TOSS-UP

25) MATH *Short Answer* Simplify  $i^{17}$  (read as:  $i$  to the 17<sup>th</sup> power):

ANSWER:  $i$

(Solution:  $i^{17} = i^1 = i$ )

### BONUS

25) MATH *Short Answer* Solve the following equation for  $x$ :  $2^7 \times 2^{(x^2-2)} = 2^{21}$

ANSWER: 4 OR -4 (ACCEPT:  $x = \pm 4$ )

(Solution:  $7 + x^2 - 2 = 21$ ;  $x = 4$  and  $-4$ )