

## ROUND 9A

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### TOSS-UP

1) Biology – *Short Answer* What leukocyte [**LOO-koh-site**] can have up to a five-lobed nucleus and plays a role in phagocytosis [**fag-oh-sye-TOW-sis**] of bacteria?

ANSWER: NEUTROPHIL

### BONUS

1) Biology – *Short Answer* What type of immune cells use perforins [**PUR-fur-ins**] to induce cell death in infected body cells?

ANSWER: NK CELLS (ACCEPT: NATURAL KILLER CELLS, CYTOTOXIC T CELLS, CTLs)

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### TOSS-UP

2) Energy – *Short Answer* Biogas is a renewable energy source that is typically produced as landfill gas, caused by the breakdown of biodegradable waste via anaerobic microbes. What two gases are the primary constituents of biogas?

ANSWER: METHANE AND CARBON DIOXIDE

### BONUS

2) Energy – *Short Answer* Based on average operating conditions, rank the following household appliances in order of increasing electricity usage per unit time: 1) LCD TV; 2) Toaster oven; 3) Hair dryer; 4) Curling iron.

ANSWER: 1, 4, 2, 3 (LCD TV, CURLING IRON, TOASTER OVEN, HAIR DRYER)

**TOSS-UP**

3) Math – *Short Answer* If  $f$  is a continuous function such that the definite integral from 3 to 7 of  $f$  of  $x$   $dx$  equals 14, what is the average value of  $f$  on the closed interval from 3 to 7?

ANSWER:  $7/2$  (ACCEPT:  $3\frac{1}{2}$ , 3.5)

**BONUS**

3) Math – *Short Answer* How many sides does a regular polygon have if each interior angle measures 177 degrees?

ANSWER: 120

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**TOSS-UP**

4) Earth and Space – *Short Answer* What term, combining the Greek words for blanket and rock, describes the loose, incoherent material of any origin on the surface of a planet or satellite?

ANSWER: REGOLITH

**BONUS**

4) Earth and Space – *Multiple Choice* A barchan dune develops perpendicular to a moderate-velocity, uniform wind. Which of the following dunes is developed by variable wind direction?

- W) Star
- X) Longitudinal
- Y) Seif
- Z) Dome

ANSWER: W) STAR

### TOSS-UP

5) Physics – *Short Answer* What is the largest resonant wavelength, in meters, for sound waves in a 1-meter tube that is closed on one end?

ANSWER: 4

### BONUS

5) Physics – *Multiple Choice* The global positioning system uses corrections to account for special and general relativistic effects. Which of the following is closest to the daily positional deviation that would result if these corrections were not accounted for?

- W) 1 centimeter
- X) 1 meter
- Y) 100 meters
- Z) 10 kilometers

ANSWER: Z) 10 KILOMETERS

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### TOSS-UP

6) Chemistry – *Multiple Choice* Which of the following is the correct definition of molality?

- W) Kilograms of solute per liter of solvent
- X) Moles of solute per liter of solution
- Y) Moles of solute per liter of solvent
- Z) Moles of solute per kilogram of solvent

ANSWER: Z) MOLES OF SOLUTE PER KILOGRAM OF SOLVENT

### BONUS

6) Chemistry – *Multiple Choice* Plants grown with deuterated [*DOO-tur-ated*] water grow more slowly than those grown with non-deuterated water. This is thought to be an illustration of which of the following effects?

- W) Quantum Hall effect
- X) Magnetic isotope effect
- Y) Steric [*steh-rik*] isotope effect
- Z) Kinetic isotope effect

ANSWER: Z) KINETIC ISOTOPE EFFECT

**TOSS-UP**

7) Energy – *Short Answer* The National Renewable Energy Laboratory has recently demonstrated that wind turbines can now increase the stability of a power system by employing what modulating technology?

ANSWER: ACTIVE POWER CONTROLS

**BONUS**

7) Energy – *Short Answer* A major component of gasification-based syngas is carbon monoxide. What is the other major fuel component?

ANSWER: HYDROGEN



**TOSS-UP**

8) Earth and Space – *Short Answer* After the first 4 billion years of Earth’s history, what relatively short evolutionary event brought forth most major animal phyla, as evidenced in the fossil record?

ANSWER: CAMBRIAN EXPLOSION

**BONUS**

8) Earth and Space – *Short Answer* Land that has been frozen for at least two years, including rock or soil, has what classification?

ANSWER: PERMAFROST

**TOSS-UP**

9) Physics – *Multiple Choice* Which of the following correctly describes a magnifying glass?

- W) Single convex lens
- X) Two convex lenses
- Y) Single concave lens
- Z) Two concave lenses

ANSWER: W) SINGLE CONVEX LENS

**BONUS**

9) Physics – *Multiple Choice* A bicyclist goes over the top of a hill with a radius of 50 meters. Which of the following is closest to the maximum speed, in meters per second, the cyclist can have without leaving the ground at the top of the hill?

- W) 11
- X) 22
- Y) 33
- Z) 44

ANSWER: X) 22

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**TOSS-UP**

10) Math – *Short Answer* A triangle has two sides of lengths 38 and 54. What is the largest possible integer length of the third side?

ANSWER: 91

**BONUS**

10) Math – *Short Answer* When applying the Euclidean algorithm to find the greatest common divisor of 42 and 157, what is the remainder after the third step?

ANSWER: 9

### TOSS-UP

11) Biology – *Multiple Choice* Sutures are an example of what type of joint?

W) Synovial [*sin-OH-vee-ul*]

X) Saddle

Y) Disk

Z) Immovable

ANSWER: Z) IMMOVABLE

### BONUS

11) Biology – *Multiple Choice* Hansen's disease is caused by which of the following genera of bacteria?

W) Streptococcus [*strep-toh-kokkus*]

X) Helicobacter [*HEEL-ik-oh-bak-tur*]

Y) Mycobacterium [*MY-koh-bacterium*]

Z) Vibrio [*VIH-bree-oh*]

ANSWER: Y) MYCOBACTERIUM

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### TOSS-UP

12) Chemistry – *Multiple Choice* A student obtained a low value when he attempted to measure the number of waters of hydration in a sample of calcium sulfate. Which of the following mistakes could lead to the erroneous result?

W) The sample was not heated enough

X) The sample was heated too much

Y) A balance that gave uniformly high readings was used

Z) A balance that gave uniformly low readings was used

ANSWER: W) THE SAMPLE WAS NOT HEATED ENOUGH

### BONUS

12) Chemistry – *Multiple Choice* Which of the following elements possesses the largest first ionization energy?

W) Fluorine [*FLOOR-een*]

X) Neon

Y) Calcium

Z) Argon

ANSWER: X) NEON

### TOSS-UP

13) Physics – *Multiple Choice* Which of the following are proper units for entropy [*EN-troh-pee*]?

- W) Joules [*jools*]
- X) Kelvins per joule
- Y) Joules per kelvin
- Z) Joule-kelvins

ANSWER: Y) JOULES PER KELVIN

### BONUS

13) Physics – *Short Answer* An observer is moving at 50 meters per second towards a stationary source that is emitting a wave with velocity 100 meters per second. What is the ratio of the observed frequency to the transmitted frequency before the observer passes the source?

ANSWER: 3/2 (ACCEPT: 1 ½, 1.5, 3 TO 2)

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### TOSS-UP

14) Chemistry – *Multiple Choice* Which of the following electrons would be most effective at shielding the nuclear charge seen by a 3s electron in an aluminum atom?

- W) 1s
- X) 2s
- Y) 2p
- Z) 3s

ANSWER: W) 1s

### BONUS

14) Chemistry – *Multiple Choice* If an organo-magnesium compound is reacted with formaldehyde [*foor-MAL-dih-hide*], which of the following will be formed?

- W) Ketone [*KEE-tone*]
- X) Imine [*IH-meen*]
- Y) Secondary alcohol
- Z) Primary alcohol

ANSWER: Z) PRIMARY ALCOHOL

### TOSS-UP

15) Biology – *Multiple Choice* Which of the following organelles would likely contain a high concentration of catalase [*CAT-ah-lace*]?

- W) Glyoxysome [*glye-OX-ih-sowm*]
- X) Mitochondrion [*my-tow-KON-dree-on*]
- Y) Peroxisome [*per-OX-ih-zohm*]
- Z) Chloroplast [*KLOR-oh-plast*]

ANSWER: Y) PEROXISOME

### BONUS

15) Biology – *Multiple Choice* Which of the following best describes the relationship between glucose and fructose?

- W) Diastereomers [*dye-ah-STARE-ee-oh-murz*]
- X) Epimers [*eh-pih-mur*]
- Y) Stereoisomers [*stereo-EYE-soh-murz*]
- Z) Structural isomers [*eye-soh-murz*]

ANSWER: Z) STRUCTURAL ISOMERS

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### TOSS-UP

16) Earth and Space – *Short Answer* List the following four minerals in order of increasing metamorphic grade:

1) Staurolite; 2) Muscovite; 3) Garnet; 4) Chlorite.

ANSWER: 4, 2, 3, 1 (ACCEPT: CHLORITE, MUSCOVITE, GARNET, STAUROLITE)

### BONUS

16) Earth and Space – *Short Answer* Radiometric dating of natural materials is mainly limited by what property unique to the radionuclide of interest for the specific time scale?

ANSWER: HALF LIFE (ACCEPT: DECAY RATE)



**TOSS-UP**

17) Math – *Short Answer* What is the  $-4/3$  power of  $-27$ ?

ANSWER:  $1/81$

**BONUS**

17) Math – *Short Answer* What is the limit as  $x$  approaches 0 of the fraction with numerator  $e^x - 1$  and denominator  $x^5$ ?

ANSWER: INFINITY (ACCEPT: POSITIVE INFINITY; DO NOT ACCEPT: DOES NOT EXIST)



**TOSS-UP**

18) Energy – *Short Answer* What treaty, signed by the United States, banned the usage of CFCs?

ANSWER: MONTREAL TREATY (ACCEPT: MONTREAL PROTOCOL)

**BONUS**

18) Energy – *Short Answer* Until the 1900s, what fossil fuel was the number one energy source in the United States?

ANSWER: COAL

### TOSS-UP

19) Biology – *Short Answer* What area of the eye has a high concentration of cones and is so crucial for sharp vision that raptors have two?

ANSWER: FOVEA (ACCEPT: FOVEA CENTRALIS)

### BONUS

19) Biology – *Short Answer* Identify all of the following four options that are examples of determinate growth in plants: 1) Shoots; 2) Roots; 3) Flowers; 4) Leaves.

ANSWER: 3 AND 4 (ACCEPT: FLOWERS AND LEAVES)

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### TOSS-UP

20) Chemistry – *Short Answer* What type of bond, which also exists in the transition states of carbocation rearrangements, allows each boron atom to achieve an octet in the compound diborane?

ANSWER: THREE-CENTER TWO-ELECTRON BOND (ACCEPT: BANANA BOND, THREE-CENTER BOND)

### BONUS

20) Chemistry – *Short Answer* Identify all of the following three analytical techniques that could be used to detect the difference between two diastereomers [*dye-ah-STARE-ee-oh-murz*]: 1) X-ray crystallography [*crystal-AW-graphy*]; 2) NMR spectroscopy [*spek-TRAW-scuH-pee*]; 3) Mass spectrometry [*spek-TRAW-metry*].

ANSWER: 1 AND 2

**TOSS-UP**

21) Physics – *Short Answer* What is the mechanical advantage of a 3.5-foot lever if the fulcrum is located 6 inches from one end?

ANSWER: SIX

**BONUS**

21) Physics – *Short Answer* A piano string is tuned to A440. To two significant figures and in milliseconds, what is the period of vibration of this string?

ANSWER: 2.3



**TOSS-UP**

22) Earth and Space – *Short Answer* What type of supernova can leave behind a black hole?

ANSWER: TYPE II

**BONUS**

22) Earth and Space – *Short Answer* What is the term for the minimum distance from a planet at which a satellite can remain intact, without being torn apart by gravitational forces?

ANSWER: ROCHE LIMIT

### TOSS-UP

23) Math – *Short Answer* A pyramid with 14 edges has how many vertices?

ANSWER: 8

### BONUS

23) Math – *Short Answer* A plane is traveling at 380 miles per hour with respect to the Earth. The Sun's reflection off the plane illuminates a small area on the surface of the Earth. A passenger on the plane observes this illuminated spot move between two houses in 12 seconds. To the nearest tenth of a mile, how far apart are the two houses?

ANSWER: 1.3