

## ROUND 9A

### TOSS-UP

1) Earth and Space – *Multiple Choice* Which of the following minerals has only one plane of cleavage?

- W) Hornblende
- X) Biotite
- Y) Potassium feldspar
- Z) Augite [*AW-jite*]

ANSWER: X) BIOTITE

### BONUS

1) Earth and Space – *Short Answer* Identify all of the following three statements that are true of the contrails produced by air traffic: 1) They are mostly composed of water ice; 2) They have a high albedo relative to oceans and forests; 3) They form in unstable, convecting layers of the atmosphere.

ANSWER: 1 AND 2

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### TOSS-UP

2) Energy – *Multiple Choice* Which of the following is NOT considered a practical source of biodiesel?

- W) Animal fat
- X) Restaurant oils
- Y) Vegetable oils
- Z) Essential oils

ANSWER: Z) ESSENTIAL OILS

### BONUS

2) Energy – *Multiple Choice* Which of the following countries had the largest wind energy capacity in 2014?

- W) India
- X) United States
- Y) China
- Z) Germany

ANSWER: Y) CHINA

**TOSS-UP**

3) Physics – *Short Answer* A pilot is in a recoverable spin with her engine turned off, and with the plane's nose directed toward the Earth's center. What term describes the limit of her rate of descent?

ANSWER: TERMINAL VELOCITY (ACCEPT: TERMINAL SPEED)

**BONUS**

3) Physics – *Short Answer* An electron in a hydrogen atom is excited from the  $n = 1$  to  $n = 2$  energy level by absorbing a photon. Then, it is excited from the  $n = 2$  to the  $n = 3$  energy level by absorbing a second photon. What is the ratio of the energies of the first photon to the second?

ANSWER: 27:5



**TOSS-UP**

4) Math – *Short Answer* What is the integral from  $-6$  to  $6$  of  $6 dx$ ?

ANSWER: 72

**BONUS**

4) Math – *Short Answer* One endpoint of a diameter of a sphere centered at  $(4, 2, -9)$  is  $(5, -6, 2)$ . What are the coordinates of the other endpoint of that diameter?

ANSWER:  $(3, 10, -20)$

### TOSS-UP

5) Chemistry – *Multiple Choice* An aqueous solution of sodium sulfate is electrolyzed using platinum electrodes. If phenolphthalein [*fee-nawlf-THAY-leen*] indicator is added to the solution, which of the following will be observed?

- W) The solution is colorless everywhere except at the cathode, where it is pink
- X) The solution is colorless everywhere except at the anode, where it is pink
- Y) The solution is pink everywhere except at the cathode, where it is colorless
- Z) The solution is pink everywhere except at the anode, where it is colorless

ANSWER: W) THE SOLUTION IS COLORLESS EVERYWHERE EXCEPT THE CATHODE, WHERE IT IS PINK

### BONUS

5) Chemistry – *Multiple Choice* Hydrogen peroxide is:

- W) Less dense than water and boils at a lower temperature
- X) Less dense than water and boils at a higher temperature
- Y) More dense than water and boils at a lower temperature
- Z) More dense than water and boils at a higher temperature

ANSWER: Z) MORE DENSE THAN WATER AND BOILS AT A HIGHER TEMPERATURE

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### TOSS-UP

6) Biology – *Short Answer* Trans fats are produced from unsaturated fats in what chemical process?

ANSWER: HYDROGENATION (ACCEPT: ISOMERIZATION)

### BONUS

6) Biology – *Short Answer* 5-methylcytosine [*methil-SYE-toh-seen*] is particularly susceptible to mutations because upon deamination [*dee-am-ih-NAY-shun*], it becomes what other nucleobase?

ANSWER: THYMINE

### TOSS-UP

7) Chemistry – *Short Answer* Identify all of the following three compounds that have only London dispersion forces operating between the molecules: 1) Difluoromethane [*dye-floor-oh-MEH-thane*]; 2) Hydrogen chloride; 3) Tetrachloromethane [*tetra-kloor-oh-MEH-thane*].

ANSWER: 3 (ACCEPT: TETRACHLOROMETHANE)

### BONUS

7) Chemistry – *Multiple Choice* A scientist thinks she has found a sample of rock 10 billion years old, a leftover fragment from the formation of an early solar system. Which of the following parent isotope's concentrations would be most useful in confirming this?

- W) Potassium-40
- X) Thorium-238
- Y) Uranium-234
- Z) Carbon-14

ANSWER: W) POTASSIUM-40

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### TOSS-UP

8) Physics – *Multiple Choice* Which of the following is NOT responsible for the failure of a pendulum to reach the height from which it was released as time progresses?

- W) Friction
- X) Gravity
- Y) Air resistance
- Z) Damping

ANSWER: X) GRAVITY

### BONUS

8) Physics – *Short Answer* Undulators are used in light sources to cause emissions of photons from electron bunches. If the spacing between electromagnets is 5 centimeters, and the electron beam has velocity of  $3 \times 10^7$  meters per second, what frequency, to the nearest 100 MHz, of light is emitted?

ANSWER: 300

**TOSS-UP**

9) Earth and Space – *Multiple Choice* Which of the following is a fine-grained, typically buff-colored sediment deposited by wind?

- W) Evaporite
- X) Loess [*LOH-ess*]
- Y) Glaze
- Z) Humus [*HYOO-muss*]

ANSWER: X) LOESS

**BONUS**

9) Earth and Space – *Short Answer* What is the discharge, in meters cubed per second, of a simple river that is 5 meters deep, 10 meters wide, and has a current speed of 5 meters per second?

ANSWER: 250



**TOSS-UP**

10) Math – *Short Answer* How many terms does the binomial expansion of open parenthesis  $x^2 + 3y^3$  close parenthesis to 13<sup>th</sup> power contain?

ANSWER: 14

**BONUS**

10) Math – *Short Answer* A right triangle has hypotenuse of length 46 and one leg of length 44. What is the length of the third side?

ANSWER:  $6\sqrt{5}$

### TOSS-UP

11) Biology – *Short Answer* A scientist has pea plants that are homozygous for purple flowers and plants that are homozygous for white flowers. Given that the purple flower trait is dominant, if the plants are crossed and then the resulting F1 generation is allowed to self-pollinate, what percentage of the resulting F2 plants will have white flowers?

ANSWER: 25

### BONUS

11) Biology – *Multiple Choice* Which of the following molecules is most similar in structure to vitamin A?

- W) Beta carotene
- X) Tocopherol [*toh-KOF-ur-all*]
- Y) Dopamine
- Z) Estradiol [*es-trah-DYE-awl*]

ANSWER: W) BETA CAROTENE

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### TOSS-UP

12) Energy – *Short Answer* Commercial nuclear power reactors in the U.S. include a material that reduces the speed of neutrons to permit fission to occur in the fuel more readily. What is the general term for this material?

ANSWER: MODERATOR

### BONUS

12) Energy – *Short Answer* Energy can be stored in batteries by converting electrical energy into chemical energy. In what device is electrical energy stored as separations of large amounts of static charge?

ANSWER: SUPERCAPACITOR (ACCEPT: CAPACITOR OR ULTRACAPACITOR)

**TOSS-UP**

13) Chemistry – *Multiple Choice* Which of the following molecules is most polar?

- W) Ethane
- X) Carbon tetrachloride
- Y) Hexane
- Z) Pyridine

ANSWER: Z) PYRIDINE

**BONUS**

13) Chemistry – *Multiple Choice* Which of the following neutral ground state atoms has the lowest ionization energy?

- W) Carbon
- X) Boron
- Y) Nitrogen
- Z) Oxygen

ANSWER: X) BORON

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**TOSS-UP**

14) Physics – *Short Answer* The weber is the SI unit for what quantity?

ANSWER: MAGNETIC FLUX (DO NOT ACCEPT: FLUX)

**BONUS**

14) Physics – *Short Answer* What term describes the balance between gravitational force and the outward gas pressure in a stable star?

ANSWER: HYDROSTATIC EQUILIBRIUM (ACCEPT: GRAVITATIONAL EQUILIBRIUM)

**TOSS-UP**

15) Math – *Short Answer* If the graph of  $y$  equals open parenthesis  $x$  minus two close parenthesis squared minus three is translated 6 units up and 3 units to the right, what are the coordinates of the vertex of the image?

ANSWER: (5, 3)

**BONUS**

15) Math – *Short Answer* A bag contains 18 socks: 4 are red, 6 are white, and 8 are blue. How many socks must you take out to be certain that you will have at least one pair of blue socks?

ANSWER: 12



**TOSS-UP**

16) Biology – *Multiple Choice* The suprachiasmatic nucleus is involved in controlling which of the following?

- W) Circadian rhythms
- X) Body temperature
- Y) Heart rate
- Z) Respiration rate

ANSWER: W) CIRCADIAN RHYTHMS

**BONUS**

16) Biology – *Multiple Choice* Which of the following disorders is due to a dominant trait?

- W) Cystic fibrosis
- X) Hemophilia [***HEE-moh-FEEL-ee-ah***]
- Y) Albinism [***AL-bah-nih-zim***]
- Z) Polydactyly [***polly-DAK-til-ee***]

ANSWER: Z) POLYDACTYLY

**TOSS-UP**

17) Energy – *Multiple Choice* Enhanced oil recovery allows residual oil to be produced. Which of the following substances allows more oil to be produced when it is injected into a well to lower the oil viscosity?

- W) A thinner form of oil
- X) Solvents
- Y) Steam
- Z) Saltwater

ANSWER: Y) STEAM

**BONUS**

17) Energy – *Multiple Choice* Recently, two wind turbines were installed inside the Eiffel Tower. The energy produced will be enough to power which of the following?

- W) The tower's first floor
- X) The entire tower, except for lighting
- Y) The lighting for the entire tower
- Z) The entire tower including the lighting

ANSWER: W) THE TOWER'S FIRST FLOOR



**TOSS-UP**

18) Earth and Space – *Short Answer* What country has emitted the most carbon dioxide to Earth's atmosphere during the past five years?

ANSWER: CHINA

**BONUS**

18) Earth and Space – *Multiple Choice* Which of the following is NOT characteristic of currents found on the western boundary of oceanic gyres, relative to other ocean currents?

- W) Warm
- X) Deep
- Y) Narrow
- Z) Slow-moving

ANSWER: Z) SLOW-MOVING

### TOSS-UP

19) Chemistry – *Multiple Choice* The oxidation of elemental lithium with which of the following is a redox reaction that is MOST favorable?

- W) Fluorine gas
- X) Hydrogen gas
- Y) Iron (II)
- Z) Copper (I)

ANSWER: W) FLUORINE GAS

### BONUS

19) Chemistry – *Multiple Choice* Which of the following statements is NOT true regarding colligative [*koh-LIG-ah-tiv*] properties?

- W) They do not depend on the identity of the solute
- X) Sodium chloride has a van't Hoff factor less than one
- Y) The osmotic pressure of a solution increases with increasing solute concentration
- Z) The freezing point of a solution decreases with increasing solute concentration

ANSWER: X) SODIUM CHLORIDE HAS A VAN'T HOFF FACTOR LESS THAN ONE

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### TOSS-UP

20) Earth and Space – *Multiple Choice* Which of the following laws expresses the increase in redshift of a galaxy's spectral lines with distance?

- W) Doppler's Law
- X) Cepheid's Law
- Y) Hubble's Law
- Z) Kepler's Law

ANSWER: Y) HUBBLE'S LAW

### BONUS

20) Earth and Space – *Short Answer* Identify all of the following three statements that are true regarding the differences between S waves and P waves: 1) P waves are longitudinal waves, while S waves are transverse waves; 2) P waves tend to have much larger amplitudes than S waves; 3) P waves travel faster than S waves.

ANSWER: 1 AND 3

**TOSS-UP**

21) Math – *Short Answer* What is the slope of the line with equation  $5x + 3y = 8$ ?

ANSWER:  $-5/3$  (ACCEPT:  $-1\ 2/3$ )

**BONUS**

21) Math – *Short Answer* The three sides of a triangle have lengths 4 centimeters, 6 centimeters, and 7 centimeters. What is the cosine of the smallest angle?

ANSWER:  $23/28$



**TOSS-UP**

22) Physics – *Short Answer* A standard spring mass oscillator on a frictionless surface oscillates at amplitude 2 meters. At what displacement from equilibrium does the spring store zero potential energy?

ANSWER: 0

**BONUS**

22) Physics – *Short Answer* Identify all of the following four particles that obey Bose-Einstein statistics: 1) Super-cooled helium atoms; 2) Beta particles; 3) Gamma rays; 4) Neutrons.

ANSWER: 1 AND 3

### TOSS-UP

23) Earth and Space – *Short Answer* What is the term for a Kuiper [*KYE-pur*] belt object that has been scattered into the region of the outer planetary orbits?

Answer: CENTAUR

### BONUS

23) Earth and Space – *Short Answer* Two stars have the same absolute magnitude. One is at a distance of 10 parsecs and the other is at a distance of 100 parsecs. What is the positive difference in their apparent magnitudes?

ANSWER: 5