

**ROUND 14A**

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**TOSS-UP**

1) Earth and Space – *Short Answer* What class of barred spiral galaxies has the most tightly wound arms?

ANSWER: SBa (ACCEPT: a)

**BONUS**

1) Earth and Space – *Multiple Choice* Which of the following rock types would be most susceptible to chemical weathering by tropical rainfall?

- W) Granite
- X) Andesite
- Y) Dacite
- Z) Basalt

ANSWER: Z) BASALT

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**TOSS-UP**

2) Energy – *Short Answer* What energy use comprises the greatest percentage of energy used in commercial buildings in the US?

ANSWER: HEATING

**BONUS**

2) Energy – *Short Answer* Uranium-235 and plutonium-239 can be used as fuel in a reactor because they are fissile. Uranium-238, the most abundant form of natural uranium, is NOT fissile, but can be converted to plutonium by absorbing neutrons. What term describes material that can be converted to fuel in this way?

ANSWER: FERTILE

### TOSS-UP

3) Physics – *Short Answer* Identify all of the following four elements that are most commonly used as semiconductor material in integrated circuits: 1) Silicon; 2) Copper; 3) Germanium; 4) Indium.

ANSWER: 1, 3 (ACCEPT: SILICON AND GERMANIUM)

### BONUS

3) Physics – *Multiple Choice* Which of the following particles does NOT correspond to one of the four basic types of radiation?

- W) Electron
- X) Helium nucleus
- Y) Photon
- Z) Lithium nucleus

ANSWER: Z) LITHIUM NUCLEUS

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### TOSS-UP

4) Biology – *Multiple Choice* Which of the following provides the best example of a situation in which genetic drift would play a significant role within a population?

- W) Non-random mating among plants with purple flowers leads to inbreeding and homozygous lethal conditions that prevent seed germination
- X) In a large population of plants with purple flowers, one individual exhibits white flowers caused by a mutation
- Y) In a small population of plants with purple flowers, three white-flowered individuals exist. A deer eats two of the three white flowered plants, thus removing them from the population
- Z) In a small population of plants where some individuals have white and some have purple flowers, bees strongly prefer the purple flowers, thus more seeds are produced from the purple individuals.

ANSWER: Y) IN A SMALL POPULATION OF PLANTS WITH PURPLE FLOWERS, THREE WHITE-FLOWERED INDIVIDUALS EXIST. A DEER EATS TWO OF THE THREE WHITE FLOWERED PLANTS, THUS REMOVING THEM FROM THE POPULATION

### BONUS

4) Biology – *Short Answer* Phosphofructokinase [*faws-fo-frook-tow-KYE-nase*] catalyzes the formation of what molecule from fructose-6-phosphate?

ANSWER: FRUCTOSE-1,6-BISPHOSPHATE

**TOSS-UP**

5) Math – *Multiple Choice* Let  $f(x)$  be a polynomial function with real coefficients and at least one real root. Which of the following must be true?

- W)  $f(x)$  has an even number of non-real complex roots
- X)  $f(x)$  is of odd degree
- Y)  $f(x)$  is an even function
- Z) The graph of  $f(x)$  has a horizontal asymptote

ANSWER: W)  $f(x)$  HAS AN EVEN NUMBER OF NON-REAL COMPLEX ROOTS

**BONUS**

5) Math – *Short Answer* A square has sides of length 10 centimeters. In square centimeters, what is the difference between the areas of its circumscribing circle and its inscribed circle?

ANSWER:  $25\pi$

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**TOSS-UP**

6) Chemistry – *Short Answer* Molten cryolite is used in what industrial process?

ANSWER: HALL-HEROULT PROCESS

**BONUS**

6) Chemistry – *Short Answer* In VSEPR theory, what is the angle, in degrees, between adjacent bonds in an octahedral molecule?

ANSWER: 90

**TOSS-UP**

7) Earth and Space – *Multiple Choice* Which of the following clay minerals forms from the weathering of feldspar and is the main component of most porcelain?

- W) Kaolinite
- X) Chlorite
- Y) Saponite
- Z) Vermiculite

ANSWER: W) KAOLINITE

**BONUS**

7) Earth and Space – *Short Answer* What is the right ascension, to the nearest hour, of the Sun on the summer solstice?

ANSWER: 6



**TOSS-UP**

8) Physics – *Short Answer* What force carrying particle holds quarks together inside of hadrons?

ANSWER: GLUONS

**BONUS**

8) Physics – *Short Answer* You're standing at home plate on a baseball diamond. From 20 meters away, a pitcher throws a 100-gram baseball towards you at negative 40 meters per second. The baseball strikes you in the arm and bounces directly back to the pitcher at +5 meters per second. What impulse, in newton-seconds rounded to the nearest tenth, did your arm deliver to the ball during the collisions?

ANSWER: +4.5 (ACCEPT: 4.5; DO NOT ACCEPT: -4.5)

**TOSS-UP**

9) Biology – *Short Answer* Chlorophyll is a pigment that chelates what metal center?

ANSWER: MAGNESIUM

**BONUS**

9) Biology – *Multiple Choice* Which of the following hormones is most pronouncedly elevated in a woman undergoing menopause?

- W) Follicle-stimulating hormone
- X) Estrogen
- Y) Progesterone
- Z) Testosterone

ANSWER: W) FOLLICLE-STIMULATING HORMONE



**TOSS-UP**

10) Math – *Multiple Choice* Which of the following equations does NOT include the half-line  $y = x$ , where  $x$  and  $y$  are positive, in its solution set?

- W)  $x^y = y^x$
- X) cosine of the product  $xy$  equals sine of the product  $xy$
- Y)  $x$  natural log of  $y = y$  natural log of  $x$
- Z)  $2^x + 3^y = 2^y + 3^x$

ANSWER: X) COSINE OF THE PRODUCT  $xy$  EQUALS SINE OF THE PRODUCT  $xy$

**BONUS**

10) Math – *Short Answer* A national achievement test is administered. The test has a mean score of 100 and a standard deviation of 10. If Ann's Z-score is  $-1.3$ , what is her score on the test?

ANSWER: 87

**TOSS-UP**

11) Chemistry – *Short Answer* Order the following three ions from smallest to largest in terms of ionic radii: 1) Cl minus; 2) Br minus; 3) O two minus.

ANSWER: 3, 1, 2

**BONUS**

11) Chemistry – *Short Answer* What is the general term for the type of catalyst one would use when reacting two immiscible substances or substances in different phases?

ANSWER: PHASE-TRANSFER CATALYST



**TOSS-UP**

12) Energy – *Multiple Choice* Which of the following policies allows users with renewable energy sources to sell excess electricity generated to the utility grid and receive compensation?

- W) Renewable Energy Portfolio Standards
- X) Feed-in Tariff
- Y) Net Metering Agreement
- Z) Carbon Cap and Trade

ANSWER: Y) NET METERING AGREEMENT

**BONUS**

12) Energy – *Multiple Choice* Which of the following countries currently has a full ban on incandescent light bulbs?

- W) United States
- X) Australia
- Y) Argentina
- Z) Italy

ANSWER: Y) ARGENTINA

**TOSS-UP**

13) Math – *Multiple Choice* Given two sets A and B with A union B containing exactly 3 elements, which of the following must be true about sets A and B?

- W) Each set contains at least 2 elements
- X) Each set contains at most 2 elements
- Y) Each set contains at least 3 elements
- Z) Each set contains at most 3 elements

ANSWER: Z) EACH SET CONTAINS AT MOST 3 ELEMENTS

**BONUS**

13) Math – *Short Answer* What is the area between the curves  $y = x + 3$  and  $y = x^3$  between  $x = 0$  and  $x = 1$ ?

ANSWER: 13/4 (ACCEPT: 3.25, 3 1/4)



**TOSS-UP**

14) Biology – *Short Answer* What plant-signaling molecule, similar in structure to aspirin, is thought to be produced around infection sites and carried by the phloem throughout the plant?

ANSWER: METHYLSALICYLIC ACID (ACCEPT: METHYL SALICYLATE, WINTERGREEN OIL)

**BONUS**

14) Biology – *Multiple Choice* The phase of the Plasmodium life cycle in which it lives in the salivary gland of the mosquito is called which of the following?

- W) Sporozoite [*spoor-oh-ZOH-i te*]
- X) Trophozoite [*troh-foh-ZOH-i te*]
- Y) Schizont [*SKIZ-awnt*]
- Z) Gametocyte

ANSWER: W) SPOROZOITE

### TOSS-UP

15) Physics – *Short Answer* What dimensionless quantity is usually defined as the useful output of a heat engine divided by the amount of heat energy input?

ANSWER: EFFICIENCY

### BONUS

15) Physics – *Multiple Choice* By what factor is the intensity of a sound wave multiplied when both angular frequency and displacement amplitude are halved?

- W) 1/16
- X) 1/4
- Y) 4
- Z) 16

ANSWER: W) 1/16

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### TOSS-UP

16) Chemistry – *Short Answer* What is the name for the change in rate of reaction when one of the atoms in the reactants is substituted with one of its isotopes?

ANSWER: KINETIC ISOTOPE EFFECT

### BONUS

16) Chemistry – *Short Answer* Selenous acid is a weak diprotic acid with formula  $\text{H}_2\text{SeO}_3$ . Its first pKa value is 2.5 and its second is 7.3. To one decimal place, what is the pH of a 1 molar solution of sodium hydroselenite [*high-droh-SELL-en-ite*], the amphiprotic [*amfih-PRO-tik*] salt of selenous acid?

ANSWER: 4.9

**TOSS-UP**

17) Earth and Space – *Multiple Choice* Which of the following gases varies the most by volume within the planetary boundary layer?

- W) Ozone
- X) Oxygen
- Y) Water vapor
- Z) Carbon dioxide

ANSWER: Y) WATER VAPOR

**BONUS**

17) Earth and Space – *Short Answer* Given that the global average precipitation is 1000 millimeters per year and the total water vapor in the Earth's atmosphere is estimated to equal a liquid water layer of 25 millimeters, to the nearest whole number of days, what is the average residence time of water vapor in the earth's atmosphere?

ANSWER: 9



**TOSS-UP**

18) Earth and Space – *Multiple Choice* Striations, U-shaped valleys, and fjords are all landscape features formed by what process?

- W) Fluvial erosion
- X) Fluvial deposition
- Y) Glacial erosion
- Z) Glacial deposition

ANSWER: Y) GLACIAL EROSION

**BONUS**

18) Earth and Space – *Short Answer* Given that a day on Jupiter is about ten hours long, rank the following surface locations on the Earth and Jupiter from the one that experiences the smallest Coriolis effect to the one that experiences the greatest Coriolis effect: 1) Jupiter's equator; 2) Jupiter's North pole; 3) Earth's North pole; 4) Earth's tropic of Cancer.

ANSWER: 1, 4, 3 2 (ACCEPT: JUPITER'S EQUATOR; EARTH'S TROPIC OF CANCER; EARTH'S NORTH POLE; JUPITER'S NORTH POLE)

### TOSS-UP

19) Energy – *Multiple Choice* Which of the following is the best estimate of the percent of electricity produced in the United States using petroleum in 2014?

- W) 1
- X) 5
- Y) 10
- Z) 15

ANSWER: W) 1

### BONUS

19) Energy – *Short Answer* Nearly all residential electricity in the United States is supplied at electrical outlets at what voltage, in volts, and frequency in Hertz?

ANSWER: 120, 60

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### TOSS-UP

20) Chemistry – *Short Answer* Identify all of the following three statements that are ALWAYS true regarding an adiabatic process: 1) Change in internal energy equals zero; 2) Heat transfer equals zero; 3) Change in internal energy equals heat transfer.

ANSWER: 2

### BONUS

20) Chemistry – *Short Answer* In organic synthesis, what metal is added to alkyl halides to generate nucleophilic [*NU-klee-oh-FIL-ik*] Grignard [*GRIN-yerd*] reagents that can react with ketones and aldehydes?

ANSWER: MAGNESIUM (ACCEPT: Mg)

**TOSS-UP**

21) Physics – *Short Answer* In the field of electrostatics, integrals of electric field over a closed surface yield electric flux. What is the term for such a closed surface?

ANSWER: GAUSSIAN SURFACE (ACCEPT: GAUSSIAN)

**BONUS**

21) Physics – *Short Answer* What instrument is designed to measure the presence, direction, and strength of an electric current in a conductor, with its earliest versions simply consisting of a compass surrounded by a wire coil?

ANSWER: GALVANOMETER (DO NOT ACCEPT: AMMETER)

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**TOSS-UP**

22) Math – *Short Answer* What is the log base 3 of 729?

ANSWER: 6

**BONUS**

22) Math – *Short Answer* A restaurant's 4 dollar box allows you to pick any 2 of 4 possible entrees (including 2 of the same), one of 2 sides, one of 2 desserts, and one of 3 drinks. How many different orders are possible?

ANSWER: 120

### TOSS-UP

23) Physics – *Multiple Choice* Which of the following quarks does NOT have negative charge?

- W) Charm
- X) Strange
- Y) Down
- Z) Bottom

ANSWER: W) CHARM

### BONUS

23) Physics – *Multiple Choice* Which of the following processes imposes the restriction that the work done on the system is zero, and the change in internal energy is equal to the heat added?

- W) Adiabatic
- X) Constant volume
- Y) Closed cycle
- Z) Free expansion

ANSWER: X) CONSTANT VOLUME