

## ROUND 17A

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### TOSS-UP

1) Biology – *Multiple Choice* The majority of speciation [*spee-see-AY-shun*] occurs under which of the following circumstances?

- W) When populations undergo sexual selection
- X) When populations become geographically separated
- Y) When populations are R selected
- Z) When populations reach carrying capacity

ANSWER: X) WHEN POPULATIONS BECOME GEOGRAPHICALLY SEPARATED

### BONUS

1) Biology – *Short Answer* A bacterial colony is raised in heavy nitrogen media for several generations, then transferred to a nitrogen-14 medium. Identify all of the following statements that will be true after one generation: 1) Half of the bacteria will have denser DNA than the other half; 2) Half of the bacteria will have no heavy nitrogen in their DNA; 3) Half of the bacteria will have no nitrogen-14 in their DNA.

ANSWER: NONE

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### TOSS-UP

2) Chemistry – *Multiple Choice* Which of the following molecular geometries can exhibit meridional isomerism?

- W) Linear
- X) Square planar
- Y) Tetrahedral
- Z) Octahedral

ANSWER: Z) OCTAHEDRAL

### BONUS

2) Chemistry – *Short Answer* What is the fewest number of carbonyl [*carbon-EEL*] stretching bands that can be seen in the infrared spectrum of a metal atom that is bound to four CO ligands [*LIH-gunz*]?

ANSWER: 1

### TOSS-UP

3) Earth and Space – *Multiple Choice* Comet McNaught visited in 2007 but is now on a path to leave the solar system forever. Which of the following best describes its orbit?

- W) Circular
- X) Elliptical
- Y) Parabolic
- Z) Hyperbolic

ANSWER: Z) HYPERBOLIC

### BONUS

3) Earth and Space – *Short Answer* 21-centimeter radiation is observed throughout much of space because it is generated from the neutral form of what element?

ANSWER: HYDROGEN

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### TOSS-UP

4) Math – *Short Answer* Consider a triangle with two sides with lengths of 4 and 9. How many different integers could be the length of the third side?

ANSWER: 7

### BONUS

4) Math – *Short Answer* What is the limit as  $x$  approaches 0 of the fraction with numerator  $x - 1 + e$  to the power  $3x$  and denominator  $\sin x$ ?

ANSWER: 4

**TOSS-UP**

5) Energy – *Multiple Choice* The energy price spikes in the 1970s and in 2008 suggested which of the following about U.S. energy usage?

- W) Usage rises in response to rising prices
- X) Usage stays the same when prices rise
- Y) Usage drops in response to rising prices
- Z) There was no consistent trend about U.S. energy usage

ANSWER: Y) USAGE DROPS IN RESPONSE TO RISING PRICES

**BONUS**

5) Energy – *Short Answer* What country is the source of the largest percentage of petroleum imported to the US?

ANSWER: CANADA

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**TOSS-UP**

6) Physics – *Short Answer* What is the name of the low-temperature state characterized by zero resistance transport of electron pairs?

ANSWER: SUPERCONDUCTIVITY

**BONUS**

6) Physics – *Short Answer* Most ships are more stable in a capsized rather than upright state. Order the following points from bottom-most to top-most for an upright, metastable ship: 1) Center of gravity; 2) Center of buoyancy; 3) Metacenter.

ANSWER: 2, 1, 3

### TOSS-UP

7) Biology – *Short Answer* Methylation [*meth-il-AY-shun*] of cytosine [*sigh-toh-seen*] was once thought to play an important role in repressing gene regulation. Deamination [*dee-am-ih-NAY-shun*] of 5-methylcytosine [*five methil-SYE-toh-seen*] results in the production of what other nucleobase?

ANSWER: THYMINE

### BONUS

7) Biology – *Short Answer* Identify all of the following three disorders that are usually inherited dominantly:  
1) Huntington's disease; 2) Albinism [*AL-beh-nih-zim*]; 3) Polydactyly [*polly-DAK-til-ee*].

ANSWER: 1 AND 3

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### TOSS-UP

8) Chemistry – *Short Answer* Identify all of the following three fatty acids that are unsaturated: 1)  $C_{13}H_{27}COOH$ ; 2)  $C_{17}H_{35}COOH$ ; 3)  $C_{16}H_{29}COOH$ .

ANSWER: JUST 3

### BONUS

8) Chemistry – *Short Answer* What reaction in organic chemistry forms alkenes via a reaction of a carbonyl [*carbon-EEL*] group with a yellow-colored phosphorous ylide [*ILL-id*]?

ANSWER: WITTIG REACTION

**TOSS-UP**

9) Earth and Space – *Short Answer* Scientists can study solar fusion via observations of certain near-massless particles that travel through the Sun. What are these particles?

ANSWER: NEUTRINOS

**BONUS**

9) Earth and Space – *Multiple Choice* Which of the following is the best approximation of how much time a supergiant star can survive by way of silicon fusion?

- W) 1 day
- X) 1 year
- Y) 1 thousand years
- Y) 1 million years

ANSWER: W) 1 DAY

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**TOSS-UP**

10) Energy – *Short Answer* In a junction transistor used as a switch, which terminal controls the current through the other two terminals?

ANSWER: BASE

**BONUS**

10) Energy – *Multiple Choice* Oil shale is a type of organic-rich sedimentary rock that can be used to produce shale oil, also known as tight oil, which is a substitute for conventional crude oil. Which of the following varieties of oil shale is NOT classified as a marine shale?

- W) Kukersite
- X) Torbanite
- Y) Tasminite
- Z) Marinite

ANSWER: X) TORBANITE

### TOSS-UP

11) Physics – *Short Answer* How much work, in joules [*joules*], is done on a particle of charge 2 coulombs as it accelerates over a distance of 1 meter in an electric field of strength 9 volts per meter?

ANSWER: 18

### BONUS

11) Physics – *Multiple Choice* Which of the following conservation laws is related by Noether's theorem to translational spatial symmetry?

- W) Conservation of mass
- X) Conservation of linear momentum
- Y) Conservation of angular momentum
- Z) Conservation of electric charge

ANSWER: X) CONSERVATION OF LINEAR MOMENTUM

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### TOSS-UP

12) Math – *Short Answer* Evaluate the following expression:  $-i^{33}$ .

ANSWER:  $-i$

### BONUS

12) Math – *Short Answer* A triangular right prism has each edge of length 4. What is its surface area?

ANSWER:  $48 + 8\sqrt{3}$  (ACCEPT:  $8\sqrt{3} + 48$ )

**TOSS-UP**

13) Energy – *Multiple Choice* The further advancement of rechargeable batteries is currently hindered by unavoidable growth of what during battery cell recharge?

- W) Lithium dendrites
- X) Potassium salts
- Y) Nickel deposits
- Z) Lead precipitates

ANSWER: W) LITHIUM DENDRITES

**BONUS**

13) Energy – *Multiple Choice* Lawrence Livermore National Laboratory's National Ignition Facility is using what technology to further nuclear fusion energy research?

- W) Magnetic plasma confinement
- X) Toroidal plasma confinement
- Y) Laser inertial confinement
- Z) Electromagnetic implosion

ANSWER: Y) LASER INERTIAL CONFINEMENT

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**TOSS-UP**

14) Physics – *Short Answer* The precession of Mercury's orbit about the sun presented an anomaly for the scientists that observed it. What theory correctly predicted the magnitude of precession each year?

ANSWER: GENERAL RELATIVITY (ACCEPT: GENERAL THEORY OF RELATIVITY)

**BONUS**

14) Physics – *Short Answer* A charged conducting sphere is connected by a long, thin conducting wire to an uncharged conducting sphere that has half the radius of the first sphere. After some time has passed, what fraction of the original charge remains on the first sphere?

ANSWER: 2/3

**TOSS-UP**

15) Earth and Space – *Short Answer* In 1967, Jocelyn Bell detected a regularly pulsing radio signal, which she called LGM. What type of celestial object produced this signal?

ANSWER: PULSAR (DO NOT ACCEPT: NEUTRON STAR)

**BONUS**

15) Earth and Space – *Short Answer* What carbonate mineral is green in color and contains copper as its main cation?

ANSWER: MALACHITE

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**TOSS-UP**

16) Chemistry – *Short Answer* Identify all of the following four compounds that are polar:

1) XeF<sub>4</sub>; 2) SF<sub>4</sub>; 3) BrF<sub>5</sub>; 4) PF<sub>5</sub>.

ANSWER: 2 AND 3

**BONUS**

16) Chemistry – *Multiple Choice* Which of the following is NOT one of the seven crystal lattice systems?

W) Orthorhombic

X) Monoclinic

Y) Octagonal

Z) Cubic

ANSWER: Y) OCTAGONAL

**TOSS-UP**

17) Biology – *Short Answer* In *E. coli*, a certain gene undergoes a mutation such that the resulting protein is much larger in size and now non-functional. What type of mutation likely occurred?

ANSWER: INSERTION

**BONUS**

17) Biology – *Short Answer* A scientist crosses a pea plant that is true breeding for the dominant traits of round and yellow seeds with a plant that is true breeding for wrinkled, green seeds. What fraction of the offspring will have round, green seeds?

ANSWER: 0



**TOSS-UP**

18) Math – *Short Answer* A set of test scores is normally distributed with mean 72 and standard deviation 6. What score corresponds to a Z-score of  $-1.5$ ?

ANSWER: 63

**BONUS**

18) Math – *Short Answer* A 5-digit palindrome has 3 different digits and is divisible by 18. What is its largest possible value?

ANSWER: 89,298

### TOSS-UP

19) Earth and Space – *Short Answer* Unlike reflectors, refracting telescopes may require an additional lens to correct for what optical disturbance?

ANSWER: CHROMATIC ABERRATION

### BONUS

19) Earth and Space – *Short Answer* The addition of what metal to the Earth's oceans has been proposed as a potential way to decrease atmospheric carbon dioxide through the stimulation of photosynthetic bacteria?

ANSWER: IRON

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### TOSS-UP

20) Chemistry – *Short Answer* Within a valence bond interpretation, what is the hybridization of the carbon atoms' valence electrons in the ethylene molecule?

ANSWER: SP2

### BONUS

20) Chemistry – *Multiple Choice* Which of the following elements has an electron configuration that follows the simple order of orbital filling?

W) Technetium [*tek-NEE-shee-um*]

X) Ruthenium [*roo-THEE-nee-um*]

Y) Rhodium

Z) Palladium [*pah-LAID-ee-um*]

ANSWER: W) TECHNETIUM

**TOSS-UP**

21) Physics – *Short Answer* What quark was most recently discovered?

ANSWER: TOP QUARK

**BONUS**

21) Physics – *Short Answer* If an electron is moving in the positive- $x$  direction with increasing speed, identify all of the following three scenarios that could be responsible for the driving force: 1) A magnetic field pointing in the negative- $x$  direction; 2) An electric field pointing in the negative- $x$  direction; 3) A magnetic field pointing in the negative- $z$  direction.

ANSWER: 2

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**TOSS-UP**

22) Math – *Short Answer* What base-10 numeral does the following Roman numeral represent: CMXLVI?

ANSWER: 946

**BONUS**

22) Math – *Short Answer* What is the following cross product of vectors:  $5\mathbf{i} - 3\mathbf{j} + \mathbf{k}$  cross  $4\mathbf{j}$ ?

ANSWER:  $-4\mathbf{i} + 20\mathbf{k}$

### TOSS-UP

23) Biology – *Short Answer* What is the term for mobile elements of DNA that can cut and paste themselves into new locations?

ANSWER: TRANSPOSONS

### BONUS

23) Biology – *Short Answer* Identify all of the following three statements that are true regarding plant hormones:

1) Auxin plays an important role in gravitropism; 2) Abscisic [*ab-SIH-zik*] acid inhibits primary and secondary growth; 3) Cytokinin [*sigh-toh-KYE-nin*] increases rate of leaf senescence [*sen-EH-sense*].

ANSWER: 1 AND 2