

## Round 2

### 1. BIOLOGY

#### Toss Up: Multiple Choice

Which of the following proteins is involved in forming the cleavage furrow of a cell during cytokinesis?

- W) G-coupled proteins
- X) Keratin
- Y) Myosin
- Z) Tubulin

**Toss Up Answer: Y**

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#### Bonus: Short Answer

Name the method in which a new species develops due to a population separated from one another by geographical isolation.

**Bonus Answer: Allopatric speciation (OR geographic speciation)**

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### 2. MATHEMATICS

#### Toss Up: Short Answer

What is the 5th non-triangular number?

**Bonus Answer: 8**

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#### Bonus: Short Answer

Name all the following that are true:

1. An icosahedron has 18 faces.
2. A regular hexahedron has 16 edges.
3. There are only nine regular polyhedra.
4. A regular octahedron has 4 times the volume of a regular tetrahedron with the same side length.

**Bonus Answer: 2,4 (an icosahedron has 20 faces; a cube has 12 edges)**

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### 3. PHYSICS

#### Toss Up: Multiple Choice

The rate of heat flow by conduction through a slab does NOT depend upon the

- W) temperature difference between opposite faces of the slab
- X) thermal conductivity of the slab
- Y) slab thickness
- Z) specific heat of the slab

**Toss Up Answer: Z**

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#### Bonus: Multiple Choice

Inside a room at a uniform comfortable temperature, metallic objects generally feel cooler to the touch than wooden objects do. This is because:

- W) a given mass of wood contains more heat than the same mass of metal
- X) metal conducts heat better than wood
- Y) the equilibrium temperature of metal in the room is lower than that of wood
- Z) the human body, being organic, resembles wood more closely than it resembles metal

**Bonus Answer: X**

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### 4. EARTH and SPACE

#### Toss Up: Short Answer

After reaching what mass can a white dwarf no longer remain stable?

**Bonus Answer: The Chandrasekhar Limit**

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**Bonus: Short Answer**

What is the pressure that prevents the gravitational collapse of a stable white dwarf?

**Bonus Answer: Electron degeneracy pressure**

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## 5. MATHEMATICS

**Toss Up: Short Answer**

Which of the following statements concerning prime numbers are true?

1. If  $a$  and  $n$  are relatively prime then there are infinitely many primes that leave a remainder of  $a$  when divided by  $n$ .
2. All integers less than  $p$  are quadratic residues modulo  $p$
3. There are infinitely many prime numbers

**Bonus Answer: 1 and 3**

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**Bonus: Short Answer**

If  $a_1 + a_2 + a_3 + a_4 + a_5 = 17$  for positive integers  $a_1, a_2, a_3, a_4, a_5$ , then maximize the product  $a_1 a_2 a_3 a_4 a_5$ ?

**Bonus Answer: 432**

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## 6. MATHEMATICS

**Toss Up: Multiple Choice**

A point with coordinates  $(3,5)$  is rotated 90 degrees clockwise about the point  $(2,1)$  and is then reflected across the  $y$ -axis. What are the coordinates of the resulting image?

- W)  $(-5,-3)$
- X)  $(-4,0)$
- Y)  $(-6,0)$
- Z)  $(-5,-1)$

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

$AC=BD=(AB)(\sqrt{2})$  [AC equals BD equals AB times the square root of 2]

- W) The circumcircle of ABC is centered at the midpoint of AC
- X) The midlines of ABCD are perpendicular
- Y) The perpendicular bisectors of AB and CD are the same line
- Z) None of the above.

**Bonus Answer: Z**

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## 7. EARTH and SPACE

**Toss Up: Short Answer**

What hypothetical structure is believed to mark the end of the Sun's Hill Sphere?

**Bonus Answer: Oort Cloud**

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**Bonus: Short Answer**

The time between two successive meridian transits of the Sun as observed from a stationary spot on the Earth's surface is called

**Bonus Answer: A day (a solar day)**

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## 8. BIOLOGY

### **Toss Up: Multiple Choice**

Which of the following is a neurotransmitter important for the functioning of myofilaments?

- W) Dopamine
- X) Acetylcholine
- Y) Serotonin
- Z) Acetaminophen

**Toss Up Answer: X**

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### **Bonus: Multiple Choice**

Which of the following is not a layer of the epidermis in thin skin?

- W) Stratum corneum
- X) Stratum lucidum
- Y) Stratum spinosum
- Z) Stratum basale

**Bonus Answer: X**

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## **9. EARTH and SPACE**

### **Toss Up: Short Answer**

What are the three types of asteroids, classified based on composition?

**Bonus Answer: C-type (accept carbonaceous), M-type (accept metal-rich), S-type (accept silicate)**

**(Accept in any order)**

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### **Bonus: Short Answer**

Order these three types of asteroid from most common to least common in the asteroid belt.

**Bonus Answer: C-type (accept carbonaceous), S-type (accept silicate), M-type (accept metal-rich)**

**About 75% of visible asteroids in the asteroid belt are carbonaceous, about 17% are silicate asteroids, and about 10% are metal-rich asteroids**

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## **10. BIOLOGY**

### **Toss Up: Multiple Choice**

Which of the following is a ground tissue with thick secondary cell walls reinforced with lignin?

- W) Collenchyma
- X) Parenchyma
- Y) Cleochema
- Z) Sclerenchyma

**Toss Up Answer: Z**

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### **Bonus: Short Answer**

What anatomical structure is a projection of the cell membrane used for phagocytosis?

**Bonus Answer: Pseudopods/pseudopodia**

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## **11. ENERGY**

### **Toss Up: Multiple Choice**

Which of the following is closest to the percentage of US electricity generated from natural gas in 2014?

- W) 5%
- X) 15%

Y) 25%

Z) 40%

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Which of these states contain the largest natural gas field in the US?

W) Pennsylvania

X) Texas

Y) Louisiana

Z) Colorado

**Bonus Answer: W**

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## 12. EARTH and SPACE

**Toss Up: Short Answer**

What paradox asks why we haven't found extraterrestrial life yet?

**Bonus Answer: Fermi Paradox**

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**Bonus: Short Answer**

If a star is said to be 1.4 times more massive than the Sun, respectively, what threshold is it said to have passed, and what will it become in the future?

**Bonus Answer: 1) Chandrasekhar limit, 2) supernova**

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## 13. PHYSICS

**Toss Up: Multiple Choice**

The zeroth law of thermodynamics allows us to define:

W) work

X) pressure

Y) temperature

Z) thermal equilibrium

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Which physicist contributed to the understanding of electrical circuits and coined the term "black body" radiation?

**Bonus Answer: Kirchoff**

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## 14. BIOLOGY

**Toss Up: Multiple Choice**

What structure is present in cilia and flagella?

W) 9+0

X) 9+1

Y) 9+2

Z) 9+3

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Dicots feature vascular bundles arranged in what formation within the stem?

**Bonus Answer: Arranged in a ring.**

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## 15. MATHEMATICS

### Toss Up: Multiple Choice

MULTIPLE CHOICE: tossup

For an infinite sequence of numbers  $a_0, a_1, \dots$ , which of the following best describes the polynomial  $P(x) = \sum_{i=0}^{\infty} a_i x^i$ .

- W) Reimann-Zeta function
- X) Generating function
- Y) Newtonian series
- Z) Tchebychev polynomial

**Toss Up Answer: X**

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### Bonus: Short Answer

In the Pell equation  $x^2 - 3y^2 = 1$  the smallest solution is  $x=2$  and  $y=1$ . The next smallest solution is  $x=7$  and  $y=4$ . Compute the third smallest solution.

**Bonus Answer:  $x=26, y=15$**

**Also accept (26,15)**

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## 16. CHEMISTRY

### Toss Up: Multiple Choice

Which of the following is not a reason for the use of nitrogen in many explosives?

- W) these explosives form gases, which expand
- X) the bond between two nitrogen atoms is very strong
- Y) these explosives form toxic compounds such as cyanide
- Z) nitrogen is widely available

**Toss Up Answer: Y**

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### Bonus: Multiple Choice

Which of the following is closest to the bond angle in ammonia?

- W) 120 degrees
- X) 109.5 degrees
- Y) 107 degrees
- Z) 100 degrees

**Bonus Answer: Y**

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## 17. PHYSICS

### Toss Up: Multiple Choice

In order for two sound waves to produce audible beats, it is essential that the two waves have:

- W) the same amplitude
- X) slightly different amplitudes
- Y) the same number of harmonics
- Z) slightly different frequencies

**Toss Up Answer: Z**

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### Bonus: Multiple Choice

A 200-cm organ pipe with one end open is in resonance with a sound wave of wavelength 270cm. The pipe is

- operating in its
- W) fundamental frequency
- X) second harmonic
- Y) third harmonic
- Z) fourth harmonic

**Bonus Answer: X**

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## 18. CHEMISTRY

### Toss Up: Multiple Choice

When the reaction of Silver Nitrate (aqueous) and Sodium Chloride (aqueous) goes to completion, what is formed?

- W) A Gas
- X) Water
- Y) An Acid
- Z) A Precipitate

**Toss Up Answer: Z**

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### Bonus: Multiple Choice

When does the value of pH equal the value of pKa?

- W) when  $[HA]=[A^-]$  (Read as: the molarity of the conjugate base equals the molarity of the conjugate acid)
- X) at the end point of a titration
- Y) everywhere in the buffer region
- Z) in the Henderson-Hasselbach equation

**Bonus Answer: W**

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## 19. PHYSICS

### Toss Up: Multiple Choice

A transverse traveling sinusoidal wave on a string has a frequency of 100Hz, a wavelength of 0.040m, and an amplitude of 2.0mm. The maximum velocity in m/s of any point on the string is

- W) 0.2
- X) 1.3
- Y) 4
- Z) 15

**Toss Up Answer: X**

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### Bonus: Multiple Choice

The time required for a small pulse to travel from A to B on a stretched cord shown is NOT altered by changing

- W) the linear mass density of the cord
- X) the length between A and B
- Y) the shape of the pulse
- Z) the tension in the cord

**Bonus Answer: Y**

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## 20. CHEMISTRY

### Toss Up: Multiple Choice

Which one of these metals doesn't produce a red flame in a flame test?

- W) Rubidium
- X) Strontium
- Y) Cesium
- Z) Lithium

**Toss Up Answer: Y**

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**Bonus: Short Answer**

A solution contains some BaSO<sub>4</sub> at 25° C. It is found to contain  $4 \times 10^{-5}$  mole/liter of Ba<sup>2+</sup> ions. What is the K<sub>sp</sub> of the BaSO<sub>4</sub> in scientific notation?

**Bonus Answer:  $1.6 \times 10^{-9}$**

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## 21. PHYSICS

**Toss Up: Multiple Choice**

Find the angular frequency of oscillations in a LC circuit if the total inductance is 2 henry and the total capacitance is 8 farad.

- W) 1/4
- X) 1/2
- Y) 1/3
- Z) 1/5

**Toss Up Answer: W**

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**Bonus: Short Answer**

An LC circuit has an inductance of 20mH and a capacitance of 5.0 μF. At time  $t = 0$  the charge on the capacitor is 3.0 μC and the current is 7.0mA. The total energy in joules is:

**Bonus Answer:  $9.0 \times 10^{-7}$  (accept equivalent forms)**

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## 22. CHEMISTRY

**Toss Up: Multiple Choice**

Which of the following salts is responsible for the browning of pretzels?

- W) Sodium Chloride
- X) Sodium Hydroxide
- Y) Potassium Chloride
- Z) Potassium Carbonate

**Toss Up Answer: X**

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**Bonus: Short Answer**

Consider the reaction  $A + 2B \rightleftharpoons 4C$ . Assume all species in the reaction are gaseous. If the reaction is at equilibrium, and the concentration of every species is 2 molar, calculate the equilibrium constant of the reaction.

**Bonus Answer: 2**

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## 23. CHEMISTRY

**Toss Up: Short Answer**

What is the oxidation state of chlorine in perchloric acid?

**Bonus Answer: +7**

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**Bonus: Short Answer**

The formula for the combustion of methane is  $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ . Given that the heat of formation of methane gas is -75 kilojoules per mole, the heat of formation of carbon dioxide is -400 kilojoules per mole, and the heat of formation of water is -300 kilojoules per mole, find the heat of combustion for methane.

**Bonus Answer: 925kJ/mol**

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## 24. CHEMISTRY

### Toss Up: Multiple Choice

Which noble gas is the most reactive?

W) Xenon

X) Radon

Y) Helium

Z) Argon

**Toss Up Answer: W**

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### Bonus: Short Answer

How many carbon atoms are in a single molecule of trinitrotolulene, or TNT?

**Bonus Answer: 7**

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## 25. CHEMISTRY

### Toss Up: Short Answer

Which nitrogen hydride is the most stable?

**Bonus Answer: ammonia**

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### Bonus: Multiple Choice

Why isn't silicon a suitable candidate for life like carbon is?

W) Silicon is too heavy

X) Silicon atoms are too big to form pi bonds

Y) Silicon is more reactive

Z) Silicon is rarer in the earth's crust

**Bonus Answer: X**

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