

## Round 13

### 1. PHYSICS

#### Toss Up: Short Answer

What is the name for the effect that explains the small attractive force that acts between two close parallel uncharged conducting plates in a vacuum?

**Bonus Answer: The Casimir Effect**

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#### Bonus: Multiple Choice

According to Beer's law:

- W) the energy of a photon of light is inversely proportional to its wavelength
- X) the concentration of a species that absorbs light can be measured by the amount of light absorbed
- Y) the energy of characteristic X-rays increases with increasing atomic number of the emitting element
- Z) excitation of the electrons in a molecule takes place on a shorter time scale than motion of the nuclei

**Bonus Answer: X**

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### 2. BIOLOGY

#### Toss Up: Multiple Choice

Which of these would not be found in a plant vacuole?

- W) pigments
- X) poisons
- Y) inorganic ions
- Z) smaller organelles

**Toss Up Answer: Z**

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#### Bonus: Short Answer

Which cytoskeletal element has a diameter of 7nm?

**Bonus Answer: Microfilament**

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### 3. PHYSICS

#### Toss Up: Short Answer

How many bosons are in a hydrogen atom?

**Bonus Answer: 1 (it's an electron)**

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#### Bonus: Short Answer

Two forces have magnitudes of 15 newtons and 5 newtons. Using interval notation, what is the range of the possible magnitudes of their sum?

**Bonus Answer: [10, 20], or "10 to 20" or something like that**

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### 4. MATHEMATICS

#### Toss Up: Multiple Choice

A right triangle has a hypotenuse of length 12. The altitude to the hypotenuse has a length of 8. What is the area of this triangle?

- W) 36
- X) 48
- Y) 60
- Z) The triangle is impossible to construct

**Toss Up Answer: Z**

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#### Bonus: Short Answer

Two REAL numbers  $x$  and  $y$  satisfy the system of equations:  $x + y = 12$ ;  $x^2 + y^2 = 64$ . Find the value of the product  $xy$ .

**Bonus Answer:** The system has no solutions.

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## 5. MATHEMATICS

**Toss Up: Short Answer**

In simplest terms, find the value of the limit as  $x$  approaches 0 of  $(4^x - 2^x) / x$

**Bonus Answer:**  $\ln(2)$  (do not accept  $\ln(4) - \ln(2)$ )

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**Bonus: Short Answer**

How many real solutions for  $x$  does the equation  $x = \ln(x) + 2$  have?

**Bonus Answer:** 2

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## 6. CHEMISTRY

**Toss Up: Multiple Choice**

Which compound, made from the indicated pairs of ions, will be insoluble?

- W) Iron (III) and phosphate ion
- X) Bromide ion and ammonium ion
- Y) Calcium ion and bromide ion
- Z) Bromide ion and iron (III)

**Toss Up Answer:** W

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**Bonus: Multiple Choice**

When the combustion reaction for benzene is properly balanced with the smallest whole-number coefficients, the sum of the coefficients is

- W) 15
- X) 12
- Y) 35
- Z) 17.5

**Bonus Answer:** Y

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## 7. EARTH and SPACE

**Toss Up: Multiple Choice**

You find a rock that contains sediments with large grain sizes and angular edges. This rock would most likely be:

- W) Shale
- X) Conglomerate
- Y) Hornfels
- Z) Breccia

**Toss Up Answer:** Z

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**Bonus: Short Answer**

During which two geologic periods did the largest number of species of marine and terrestrial organisms die off?

**Bonus Answer:** Permian and Triassic

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## 8. PHYSICS

**Toss Up: Multiple Choice**

In a simple, in-series circuit, which of these is equal among all resistors?

- W) Potential difference

- X) Resistance
- Y) Current
- Z) Capacitance

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

In a simple, parallel circuit, which of these is equal among all resistors?

- W) Potential difference
- X) Resistance
- Y) Current
- Z) Capacitance

**Bonus Answer: W**

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## 9. PHYSICS

**Toss Up: Short Answer**

Which principle of quantum mechanics allows for the quantum state of any particle to be expressed as a linear combination of distinct quantum states?

**Bonus Answer: Superposition principle**

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**Bonus: Short Answer**

A free electron has a momentum of  $5.0 \times 10^{-24}$  kg · m/s (read as 5.0 times 10 to the negative 24 kilogram times meter per second). The wavelength of its wave function in meters is:

**Bonus Answer:  $\sim 1.3 \times 10^{-10}$  meters (explanation: deBroglie wavelength)**

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## 10. PHYSICS

**Toss Up: Multiple Choice**

A magnetic field CANNOT:

- W) exert a force on a charged particle
- X) change the trajectory of a charged particle
- Y) change the kinetic energy of a charged particle
- Z) do no work on a charged particle

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

If a magnet and a conducting loop are placed next to each other at rest. If the magnet with the north pole facing left is put through the loop and is moved left in which direction will the induced current within the loop move with reference to the magnet?

- W) The loop will move with the magnet.
- X) Counter-clockwise
- Y) clockwise
- Z) There is no current.

**Bonus Answer: X**

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## 11. EARTH and SPACE

**Toss Up: Short Answer**

What are the brightest events in the universe?

**Bonus Answer: gamma ray bursts**

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**Bonus: Short Answer**

List the following classes of star from hottest to coolest. 1. Class K, 2. Class O, 3. Class A, 4. Class B

**Bonus Answer: 2, 4, 3, 1**

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## 12. CHEMISTRY

**Toss Up: Multiple Choice**

Which of the following is a correct formula?

W)  $\text{KH}_2\text{PO}_4$

X)  $\text{CaC}_2\text{H}_3\text{O}_2$

Y)  $\text{Na}_2\text{ClO}_4$

Z)  $\text{Ba}(\text{CO}_3)_2$

**Toss Up Answer: W**

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**Bonus: Short Answer**

What is the formula for the iodate ion?

**Bonus Answer:  $\text{IO}_3^-$**

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## 13. EARTH and SPACE

**Toss Up: Short Answer**

Which type of star will live for the longest period of time?

**Bonus Answer: Red Dwarfs (they can live for 1 trillion years or so)**

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**Bonus: Multiple Choice**

What resonance does Pluto have with Neptune which ensures that the celestial objects will never impact each other?

W) 2:1

X) 3:2

Y) 5:2

Z) 5:4

**Bonus Answer: X**

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## 14. CHEMISTRY

**Toss Up: Multiple Choice**

An electron is also called this in nuclear reactions.

W) Alpha particle

X) Positron

Y) Gamma Ray

Z) Beta Particle

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

In which of the following are nuclear particles listed in order of increasing penetrating power?

W) Alpha particles < beta particles < neutrons

X) Beta particles < alpha particles < neutrons

Y) Neutrons < alpha particles < beta particles

Z) Beta particles < neutrons < alpha particles

**Bonus Answer: W**

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## **15. BIOLOGY**

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

After three rounds of cell fractionation, the pellet would be rich in:

- W) nuclei
- X) microsomes
- Y) mitochondria
- Z) ribosomes

**Toss Up Answer: X**

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### **Bonus: Multiple Choice**

P53 is a

- W) tumor-inducing protein
- X) tumor-suppressing protein
- Y) tumor-inducing hormone
- Z) tumor-suppressing hormone

**Bonus Answer: X**

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## **16. EARTH and SPACE**

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

Which of the following rocks is responsible for the formation of black sand?

- W) Quartzite
- X) Schist
- Y) Basalt
- Z) Slate

**Toss Up Answer: X**

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### **Bonus: Short Answer**

What is the scale used to measure the hardness of minerals?

**Bonus Answer: Moh   Accept: Moh Scale**

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## **17. MATHEMATICS**

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

If the test scores of Mr. Coco's Calculus test are assumed to have a normal distribution, and if the mean test score was 91, what can be said about the median test score of that test?

- W) The median was lower than 91
- X) The median was higher than 91
- Y) The median was 91
- Z) The median cannot be determined

**Toss Up Answer: Y**

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### **Bonus: Multiple Choice**

The z-score for Shantanu's physics test grade was found to be 0.375. If he scored a 94 on the test, and the standard deviation was 8, what was the mean test score on the physics test?

- W) 91
- X) 95

Y) 92

Z) 98

**Bonus Answer: W**

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## 18. CHEMISTRY

**Toss Up: Multiple Choice**

Most elements in the periodic table are

W) metals

X) nonmetals

Y) liquids

Z) gases

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

In which of the following pairs of elements is the element with the lower boiling point listed first?

W) Na, Cs

X) Te, Se

Y) P, N

Z) Ba, Sr

**Bonus Answer: Z**

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## 19. BIOLOGY

**Toss Up: Multiple Choice**

Which experimental treatment would increase the rate of sucrose transport into a plant cell?

W) decreasing extracellular sucrose concentration

X) decreasing extracellular pH

Y) decreasing cytoplasmic pH

Z) adding a substance that makes the membrane more permeable to H<sup>+</sup> ions

**Toss Up Answer: X**

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**Bonus: Short Answer**

If the entire cell cycle in a certain cell takes 24 hours, how long does mitosis take?

**Bonus Answer: 2 hours**

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## 20. EARTH and SPACE

**Toss Up: Multiple Choice**

Which of the following is closest to the magnitude of a parsec?

W) 10<sup>18</sup> meters

X) 10<sup>16</sup> meters

Y) 10<sup>14</sup> meters

Z) 10<sup>12</sup> meters

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the name of the space probe that first orbited Saturn?

**Bonus Answer: Cassini-Huygens (Accept Cassini)**

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## 21. BIOLOGY

### Toss Up: Short Answer

The strongest known biological oxidizing agent plays a key role in photosynthesis. What is it called?

**Bonus Answer: P680**

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### Bonus: Short Answer

What was the phage that Hershey and Chase used in their experiments, and what two radioactive substances did they tag it with?

**Bonus Answer: T2, S35 and P32 (Do NOT accept Sulfur and Phosphorus)**

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## 22. CHEMISTRY

### Toss Up: Multiple Choice

Which electronic transition requires the addition of the most energy?

- W)  $n=1$  to  $n=3$
- X)  $n=5$  to  $n=2$
- Y)  $n=2$  to  $n=3$
- Z)  $n=4$  to  $n=1$

**Toss Up Answer: W**

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### Bonus: Multiple Choice

Which of the following is FALSE?

- W) The 4d orbitals are in the fourth period of the periodic table.
- X) The 7s orbitals are in the seventh period of the periodic table.
- Y) The 4f orbitals are in the sixth period of the periodic table.
- Z) The 6s orbitals are spherical in shape.

**Bonus Answer: W**

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## 23. BIOLOGY

### Toss Up: Multiple Choice

Which is not associated with the proteasomal degradation pathway?

- W) Response to oxidative stress
- X) Regulation of gene expression
- Y) Kinetochore attachment
- Z) The Cell cycle

**Toss Up Answer: Y**

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### Bonus: Short Answer

If a reaction with a  $\Delta G$  of +3.4 kcal/mol is coupled with ATP hydrolysis, what is the net  $\Delta G$ ?

**Bonus Answer: -3.9 kcal/mol**

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## 24. BIOLOGY

### Toss Up: Multiple Choice

Where might a proteasome be found?

- W) Nucleus
- X) Plasma membrane
- Y) Extracellular Matrix
- Z) Lysosome

**Toss Up Answer: W**

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**Bonus: Short Answer**

Which small protein tags other proteins for degradation?

**Bonus Answer: Ubiquitin**

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## **25. CHEMISTRY**

**Toss Up: Short Answer**

Order the following by the strength of their intermolecular forces, from strongest to weakest. 1. Methane, 2. Chloromethane, 3. Water, 4. Ethanol

**Bonus Answer: 3, 4, 2, 1**

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**Bonus: Short Answer**

What does naphthalene smell like?

**Bonus Answer: Mothball, insect killer, mold killer**

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