

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

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

2. PHYSICS

Toss Up: Short Answer

How many bosons are in a hydrogen atom?

Bonus Answer: 1 (it's an electron)

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

3. 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

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

4. 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

Bonus: Short Answer

A free electron has a momentum of 5.0×10^{-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)

5. 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

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.

6. 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 $\ln(4) - \ln(2)$)

Bonus: Short Answer

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

Bonus Answer: 2

7. 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

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

8. 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

Bonus: Short Answer

Which cytoskeletal element has a diameter of 7nm?

Bonus Answer: Microfilament

9. 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

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

10. 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⁺ ions

Toss Up Answer: X

Bonus: Short Answer

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

Bonus Answer: 2 hours

11. BIOLOGY

Toss Up: Short Answer

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

Bonus Answer: P680

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)

12. 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

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

13. 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

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

14. CHEMISTRY**Toss Up: Multiple Choice**

Which of the following is a correct formula?

- W) KH_2PO_4
- X) $\text{CaC}_2\text{H}_3\text{O}_2$
- Y) Na_2ClO_4
- Z) $\text{Ba}(\text{CO}_3)_2$

Toss Up Answer: W

Bonus: Short Answer

What is the formula for the iodate ion?

Bonus Answer: IO₃⁻

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15. 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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16. 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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17. 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

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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18. 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

Bonus: Short Answer

What does naphthalene smell like?

Bonus Answer: Mothball, insect killer, mold killer

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19. 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

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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20. EARTH and SPACE**Toss Up: Short Answer**

What are the brightest events in the universe?

Bonus Answer: gamma ray bursts

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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21. 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)

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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22. 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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23. EARTH and SPACE

Toss Up: Multiple Choice

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

W) 10^{18} meters

X) 10^{16} meters

Y) 10^{14} meters

Z) 10^{12} 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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