

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 $5.0 \times 10^{(-24)} \text{ kg} \cdot \text{m/s}$ (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: Short Answer**

What is the inverse of the 2x2 matrix (row 1: 6 10), (row 2: 3 5)?

Bonus Answer: The matrix has no inverse (b.c. determinant = 0).

Bonus: Short Answer

The legs of an isosceles triangle have a length of 10, and the altitudes to the legs have a length of 6. In simplified radical form, what is the length of the altitude to the base of the triangle?

Bonus Answer: $3 * \sqrt{10}$ (Do not accept $\sqrt{90}$)

6. MATHEMATICS**Toss Up: Short Answer**

If n is a positive integer, what is the smallest value of n such that $n! + 1$ is a perfect square?

Bonus Answer: 4

Bonus: Short Answer

If $z_1 = 3 - 4i$ and $z_2 = 7 + i$, find the absolute value of $z_1 z_2$ in simplest terms.

Bonus Answer: $25\sqrt{2}$

7. 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.

8. 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

9. BIOLOGY

Toss Up: Short Answer

Which model is currently accepted as representative of the dynamic nature of the Golgi apparatus?

Bonus Answer: Cisternal Maturation model

Bonus: Short Answer

Which cytoskeletal element functions in cleavage furrow formation?

Bonus Answer: Microfilament

10. 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

11. 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

12. 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

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13. 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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14. 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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15. 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

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Bonus: Short Answer

What is the formula for the iodate ion?

Bonus Answer: IO_3^-

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16. 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

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

17. CHEMISTRY

Toss Up: Multiple Choice

Most elements in the periodic table are

- W) metals
- X) nonmetals
- Y) liquids
- Z) gases

Toss Up Answer: W

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

18. 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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19. 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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20. EARTH and SPACE

Toss Up: Short Answer

Thousands of rivers drain the continental United States. These rivers primarily drain into which three bodies of water?

Bonus Answer: GULF OF MEXICO, ATLANTIC OCEAN (ACCEPT: GULF OF ST. LAWRENCE), PACIFIC OCEAN (ACCEPT: SEA OF CORTEZ, GULF OF CALIFORNIA)

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Bonus: Short Answer

What is the longest Peninsula in the world?

Bonus Answer: Malay Peninsula

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21. EARTH and SPACE

Toss Up: Multiple Choice

The reason there aren't any active volcanoes in the Himalayan mountain range is because:

W) The Indian plate is composed of basaltic igneous rock, which only melts at higher temperatures.

X) It was formed by localized faults in the Earth's upper crust.

Y) It was formed by the collision of two continental plates with no significant density differences.

Z) It is composed of extinct volcanoes.

Toss Up Answer: Y

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Bonus: Short Answer

The South Georgia and the South Sandwich Islands were formed by the collision of which two tectonic plates?

Bonus Answer: South Sandwich Plate and South American Plate

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22. EARTH and SPACE

Toss Up: Multiple Choice

In the Bowen Reaction Series, which of the following minerals would solidify last in a mass of cooling magma?

W) Biotite Mica

X) Pyroxene

Y) Olivine

Z) Amphibole

Toss Up Answer: W

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Bonus: Short Answer

What is the name given to any fragmental material produced by a volcanic eruption regardless of composition and fragment size?

Bonus Answer: Tephra

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23. 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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24. 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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25. ENERGY

Toss Up: Short Answer

Which compound contributes the most to global warming?

Bonus Answer: water

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Bonus: Short Answer

What is China's largest renewable energy source?

Bonus Answer: Hydro

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