

Round 6

1. PHYSICS

Toss Up: Multiple Choice

What type of radiation is both the most penetrating and the most effectively stopped if blocked by a hydrogen-rich material?

- W) Alpha
- X) Beta
- Y) Gamma
- Z) Neutron

Toss Up Answer: Z

Bonus: Multiple Choice

What type of radiation originates from the electron cloud?

- W) Alpha
- X) Beta
- Y) X-Ray
- Z) Gamma

Bonus Answer: Y

2. PHYSICS

Toss Up: Multiple Choice

An electron is placed in a horizontally hollow cylindrical solenoid with the current moving clockwise around the solenoid. The electron is released from rest in the middle of the solenoid. What direction will the electron move in?

- W) To the left
- X) To the right
- Y) Stays in the same place
- Z) Oscillates between both ends

Toss Up Answer: X

Bonus: Multiple Choice

There are two charges, one with charge $+2Q$ and one with charge $-4Q$ a distance of 2 meters from each other. Assuming the universal charge constant is 1.6×10^{-19} , which of the following is the force of attraction felt by the two charges, rounded to one decimal place

- W) 4.8×10^{-19} C
- X) 9.6×10^{-19} C
- Y) 2.4×10^{-19} C
- Z) 3.2×10^{-19} C

Bonus Answer: Z

3. PHYSICS

Toss Up: Short Answer

What is energy measured in?

Bonus Answer: Joules

Bonus: Short Answer

What is the unit of charge?

Bonus Answer: Columbus

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4. PHYSICS

Toss Up: Short Answer

An educated guess or explanation for an observation or experimental result. Not yet fully accepted as fact is what?

Bonus Answer: Hypothesis

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Bonus: Short Answer

A systematic methodology for gathering, organizing and applying knowledge is?

Bonus Answer: A scientific method

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5. PHYSICS

Toss Up: Short Answer

The coefficient of linear expansion of a certain steel is 0.000034 per $^{\circ}\text{C}$ (READ AS: celsius degree). What is the exact coefficient of volume expansion, in $(^{\circ}\text{C})^{-1}$ (READ AS: celsius degree to the negative 1)?

Bonus Answer: 0.000102 (DO NOT ACCEPT APPROXIMATIONS)

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Bonus: Multiple Choice

The energy given off as heat by 300 g of an alloy as it cools through 50°C (READ AS: 50 celsius degree) raises the temperature of 300 g of water from 30°C (READ AS: 30 degrees celsius) to 40°C . The specific heat of the alloy (in $\text{cal/g} \cdot ^{\circ}\text{C}$) is:

W) 0.0015

X) 0.1

Y) 0.2

Z) 1

Bonus Answer: Y

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6. MATHEMATICS

Toss Up: Multiple Choice

Which of the following types of symmetry does $x^2 + (y-1)^2 = 36$ have?

W) Y-axis symmetry, only

X) X-axis symmetry, only

Y) Both x and y axis symmetry

Z) Neither x nor y axis symmetry

Toss Up Answer: Y

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Bonus: Multiple Choice

Which of the following types of symmetry does $x^2 - y^2 = 36$ have?

W) Y-axis symmetry, only

X) X-axis symmetry, only

Y) Both x and y axis symmetry

Z) Neither x nor y axis symmetry

Bonus Answer: Y

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7. MATHEMATICS

Toss Up: Multiple Choice

$f(x) = x^4 + 5x^8 + 7x^6 + 5$ Which of the following is true about $f(x)$?

- W) $f(x)$ is odd, only
- X) $f(x)$ is even, only
- Y) $f(x)$ is neither odd nor even
- Z) $f(x)$ is both even and odd

Toss Up Answer: X

Bonus: Short Answer

Simplify: $\cos(\sin^{-1}(3/5))$

Bonus Answer: 4/5

Solution:

Draw a 3-4-5 right triangle and find the angle that $\sin^{-1}(3/5)$ is equal to. Then, take its cosine.

8. MATHEMATICS

Toss Up: Short Answer

$(mn)^2 - p^2$

Bonus Answer: $(mn - p)(mn + p)$

Difference of Squares

Bonus: Short Answer

Factor $a^4 + 4b^4$

Bonus Answer: $(a^2 + 2b^2 + 2ab)(a^2 + 2b^2 - 2ab)$

Solution:

$a^4 + 4b^4 = a^4 + 4a^2b^2 + 4b^4 - 4a^2b^2$

$(a^2 + 2b^2)^2 - (2ab)^2 = (a^2 + 2b^2 + 2ab)(a^2 + 2b^2 - 2ab)$

Difference of Squares

(This is also the Sophie Germain Identity)

9. MATHEMATICS

Toss Up: Multiple Choice

If x is positive, what is the minimum value of $2x + (2/x)$?

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

Toss Up Answer: Z

Bonus: Multiple Choice

What is $f(15)$ if $f(x) = 2\sin(x)\cos(x)$, where x is in degrees?

- W) $(\sqrt{3})/2$
- X) $1/(\sqrt{3})$
- Y) $1/2$
- Z) 1

Bonus Answer: Y

10. BIOLOGY

Toss Up: Multiple Choice

Which of the following is present in plant cells but not animal cells?

W) Nuclei
X) Plasmodesmata
Y) Mitochondria
Z) Vacuoles
Toss Up Answer: X

Bonus: Short Answer

What is the name of the theory that explains the existence of mitochondria (and why they have their own DNA)?

Bonus Answer: Endosymbiotic Theory

11. BIOLOGY

Toss Up: Multiple Choice

Which of the following is a retrovirus?

- W) HIV
X) Hepatitis B virus
Y) Poliovirus
Z) Influenza A virus

Toss Up Answer: W

Bonus: Short Answer

Where do DNA viruses usually replicate?

Bonus Answer: In the nucleus.

12. BIOLOGY

Toss Up: Short Answer

What types of cells in the stomach are pepsins produced from?

Bonus Answer: Chief cells

Bonus: Short Answer

What factor of the blood clotting cascade converts prothrombin into active thrombin?

Bonus Answer: Factor III; Tissue Factor; Thromboplastin

13. BIOLOGY

Toss Up: Short Answer

What hormone released by juxtaglomerular cells of the kidney regulates blood pressure and filtration rate?

Bonus Answer: Renin

Bonus: Short Answer

What types of exocrine glands bud their secretions off along with a small portion of the cell itself?

Bonus Answer: Apocrine glands

14. BIOLOGY

Toss Up: Short Answer

What functional group normally allows the cell to differentiate old and new DNA strands in prokaryotes?

Bonus Answer: Methyl group; -CH₃

Bonus: Short Answer

What is it called when the hematocrit rises above normal levels?

Bonus Answer: hypercythemia; erythrocythemia; hypererythrocythemia

15. BIOLOGY

Toss Up: Short Answer

What organelle does the cisternal maturation model describe?

Bonus Answer: Golgi apparatus; Golgi complex

Bonus: Short Answer

What is the part on the retina where cones are tightly packed and creates a small depression?

Bonus Answer: Fovea; Fovea centralis

16. BIOLOGY

Toss Up: Short Answer

Which glial cells secrete cerebrospinal fluid?

Bonus Answer: Ependymal cells

Bonus: Short Answer

Oxygen attaches to hemoglobin to form oxyhemoglobin. What is the resultant molecule called when carbon dioxide attaches to hemoglobin?

Bonus Answer: Carbaminohemoglobin

17. CHEMISTRY

Toss Up: Multiple Choice

The shape of a PCl_3 molecule is described as

W) bent

X) trigonal pyramidal

Y) linear

Z) trigonal planar

Toss Up Answer: X

Bonus: Short Answer

Twenty-five percent of element X exists as ^{210}X and 75 percent of it exists as ^{214}X . What is the atomic weight of element X?

Bonus Answer: 211

18. CHEMISTRY

Toss Up: Short Answer

What are the numbers of sigma bonds and pi bonds, in ethyne, respectively?

Bonus Answer: 3 sigma bonds, 2 pi bonds

Bonus: Short Answer

Pi bonds are created by the overlap of what type of orbital?

Bonus Answer: p, p orbitals

19. CHEMISTRY

Toss Up: Multiple Choice

Which of the following has the largest ionic radius?

W) Li

X) Be

Y) Na

Z) Mg

Toss Up Answer: X

Bonus: Short Answer

Why does Oxygen have a smaller atomic radius than boron?

Bonus Answer: Effective nuclear charge

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

Which of the following describes the reaction that involves a hydrocarbon chain and H₂ gas yielding two shorter hydrocarbon chains?

W) Synthesis

X) Cracking

Y) Hydrocracking

Z) Substitution

Toss Up Answer: Y

Bonus: Short Answer

What electron geometry does ammonia(NH₃) have?

Bonus Answer: tetrahedral, tetrahedron also accepted

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

The relation between pressure and temperature of two ideal gases is stated in

W) Gay-Lussac's Law

X) Boyle's Law

Y) Charles's Law

Z) Avogadro's Law

Toss Up Answer: W

Bonus: Short Answer

What are the dimensions of the gas constant R in SI base units?

Bonus Answer: kg m² mol⁻¹ K⁻¹ s⁻² (accept as a fraction)

22. CHEMISTRY**Toss Up: Short Answer**

How many hydrogen atoms does a molecule of acetone have?

Bonus Answer: 6

Bonus: Short Answer

What is the electron configuration of Cr³⁺ using noble gas notation?

Bonus Answer: [Ar]3d³

23. EARTH and SPACE**Toss Up: Multiple Choice**

What happens as air rises?

W) It gets warmer

X) It gets colder

Y) The temperature fluctuates

Z) Nothing

Toss Up Answer: X

Bonus: Short Answer

How are winds named?

Bonus Answer: By the direction they are coming in

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24. EARTH and SPACE

Toss Up: Short Answer

What is the US state with the most glaciers?

Bonus Answer: Washington

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Bonus: Short Answer

How many glaciers are there in Hawaii rounded to the nearest 1000?

Bonus Answer: 0

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25. EARTH and SPACE

Toss Up: Multiple Choice

To the nearest order of magnitude, how thick are Saturn's rings?

W) 10 m

X) 100 m

Y) 1000 m

Z) 10000 m

Toss Up Answer: W

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Bonus: Short Answer

Which planets have active plate tectonics?

Bonus Answer: Earth

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