

## Round 9

### 1. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

In a rate law, what are the units of  $k$  when the order is 1?

Bonus Answer:  $s^{-1}$

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Bonus: Short Answer

In a rate law, what are the units of  $k$  when the order is 5?

Bonus Answer:  $L^4 mol^{-4} s^{-1}$

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### 2. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

Besides solid, liquid, and gas, what is the fourth form of matter?

Bonus Answer: Plasma

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Bonus: Short Answer

In Einstein's universe, what is the fourth dimension?

Bonus Answer: Time

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### 3. CHEMISTRY

Writer: Olivia Gallager

Toss Up: Multiple Choice

Which of the following has the largest ionic radius?

W) Li

X) Be

Y) Na

Z) Mg

Toss Up Answer: Y

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Bonus: Short Answer

Why does Oxygen have a smaller atomic radius than boron?

Bonus Answer: Effective nuclear charge

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### 4. MATHEMATICS

Writer: William Xiang

Toss Up: Short Answer

Find the first derivative of  $10x^3 + 3x^2 + 3$  in the simplest form.

Bonus Answer:  $30x^2 + 6x$

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Bonus: Short Answer

How many points of inflection does the graph  $x^3 + 5$  have?

Bonus Answer: 1

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### 5. CHEMISTRY

Writer: Ivan Zhang

Toss Up: Multiple Choice

What does Pauli's Exclusion Principle state?

- W) Electrons of an atom must have the same spin
- X) No two electrons of an atom travel in the same orbital
- Y) no two electrons in an atom can be at the same time in the same state or configuration
- Z) Electrons can switch spin automatically

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What law states that electrons in the same orbitals reorganize themselves to maximize spin?

**Bonus Answer: Hund's law**

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## 6. PHYSICS

**Writer: Mohammed Jamil**

**Toss Up: Short Answer**

A bulldozer does 30,000 joules of work to push another boulder a distance of 20 meters. How much force is applied to push the boulder?

**Bonus Answer: 1,500 N**

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**Bonus: Short Answer**

A 450-newton gymnast jumps upward a distance of 0.50 meters to reach the uneven parallel bars. How much work, in joules, did she do before she even began her routine ?

**Bonus Answer: 225**

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## 7. MATHEMATICS

**Writer: Andrew Chen (Senior)**

**Toss Up: Short Answer**

What is the sum of the interior angles of a nonagon?

**Bonus Answer: 1260 degrees**

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**Bonus: Short Answer**

How many edges does an octahedral prism have?

**Bonus Answer: 24 edges**

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## 8. PHYSICS

**Writer: William Xiang**

**Toss Up: Multiple Choice**

Vectors A and B each have magnitude L. What is the cross product of these vectors if the angle between them when drawn with their tails at the same point is 60 degrees.

- W) Zero
- X)  $L/2$
- Y)  $L^2$
- Z)  $(L^2)/2$

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Which of the following is true when a system is at equilibrium?

- W) The object is at rest.
- X) The object is not accelerating.
- Y) The object is at constant velocity.
- Z) Internal forces sum to zero.

**Bonus Answer: X**

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## **9. EARTH and SPACE**

**Writer: Janine Goh**

**Toss Up: Short Answer**

What is the closest star to the solar system, 4.25 light years away from the sun?

**Bonus Answer: Proxima Centauri**

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**Bonus: Short Answer**

On approximately which two days of the Gregorian calendar do full moons most commonly appear?

**Bonus Answer: 15th and 16th of each month**

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## **10. BIOLOGY**

**Writer: Shanjeed Ali**

**Toss Up: Short Answer**

Through what process do cells engulf extracellular particles?

**Bonus Answer: Phagocytosis**

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**Bonus: Multiple Choice**

Which of the following is not a function of the Golgi Body?

W) separates proteins and lipids according to their destination

X) modifies certain molecules

Y) manufacturing ribosomes

Z) packaging materials into vesicles for transport outside the cell

**Bonus Answer: Y**

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## **11. PHYSICS**

**Writer: Aaron Gee**

**Toss Up: Short Answer**

A quarter of a wavelength is equal to how many degrees of phase?

**Bonus Answer: 90 degrees**

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**Bonus: Short Answer**

Davisson and Germer scattered electrons from a crystal of nickel. The scattered electrons formed a strong diffraction pattern. What important conclusion was drawn from this experiment?

**Bonus Answer: Electrons act like waves**

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## **12. BIOLOGY**

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Which of these does not result in recombinant bacteria?

W) Transformation

X) Insertion

Y) Transduction

Z) Conjugation

**Toss Up Answer: X**

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**Bonus: Short Answer**

What serves as the vector for bacterial transduction?

**Bonus Answer: Virus (accept viruses, phages, bacteriophages)**

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### 13. PHYSICS

**Writer: Elias Milborn**

**Toss Up: Short Answer**

A train moving 35 meters per second emits a whistle with a frequency of 900 hertz. Assuming that the speed of sound in air is 350 meters per second, what is the frequency, in hertz, measured by a stationary observer in front of the train?

**Bonus Answer: 1000**

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**Bonus: Multiple Choice**

Which of the following has the highest vapor pressure at STP?

- W) mercury
- X) ethyl alcohol
- Y) methyl alcohol
- Z) acetone

**Bonus Answer: Z**

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### 14. BIOLOGY

**Writer: Zoe Orlin**

**Toss Up: Multiple Choice**

Every cell in a puppy's skin, eyes, and leg muscles contains

- W) equal amounts of ATP
- X) identical genetic information
- Y) proteins that are all identical
- Z) organelles for the synthesis of glucose

**Toss Up Answer: X**

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**Bonus: Short Answer**

Oxygenated blood contains a high percentage of what tetramer protein?

**Bonus Answer: Oxyhemoglobin (DO NOT ACCEPT: hemoglobin)**

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### 15. EARTH and SPACE

**Writer: Janine Goh**

**Toss Up: Short Answer**

What is the angle of insolation?

**Bonus Answer: The angle at which light hits the earth.**

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**Bonus: Multiple Choice**

Which of the following locations can have an angle of insolation of 90 degrees?

- W) 20 degrees N
- X) 40 degrees N
- Y) 60 degrees N
- Z) 30 degrees S

**Bonus Answer: W**

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### 16. MATHEMATICS

**Writer: Shantanu Jha**

**Toss Up: Multiple Choice**

Which of the following sets has the greatest cardinality?

- W) The set of all real numbers
- X) The set of all integers
- Y) The set of all rational numbers
- Z) They all have the same cardinality

**Toss Up Answer: W**

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**Bonus: Short Answer**

If set A has a cardinality of 5, set B has a cardinality of 6, and set A and B are disjoint sets, what is the cardinality of the union of set A and B?

**Bonus Answer: 11**

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## 17. PHYSICS

**Writer: Aaron Gee**

**Toss Up: Multiple Choice**

Aaron, whose mass is 45 kilograms, is riding his 5.0 kilogram skateboard down the sidewalk with a constant speed of 6.0 meters per second when he rolls across a 10.0 meter long patch of sand on the pavement. The sand provides force of friction of 6.0 newtons. What is Aaron's speed in meters per second as he emerges from the sand?

- W) 0
- X) 1.8
- Y) 3.8
- Z) 5.8

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Which of the following contains a scalar quantity? Force, energy, or acceleration?

**Bonus Answer: Energy**

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## 18. CHEMISTRY

**Writer: Prangon Ghose**

**Toss Up: Multiple Choice**

The term(s) most useful in determining the solubility of a substance is (are)

- W)  $K_a$  and  $Q$
- X)  $K_{sp}$
- Y)  $Q$  and Le Chatelier's Principle
- Z)  $K_c$

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

The effect of temperature on a chemical system is best described using

- W)  $K_a$  and  $Q$
- X)  $K_{sp}$
- Y) Le Chatelier's Principle
- Z)  $K_c$

**Bonus Answer: Y**

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## 19. MATHEMATICS

Writer: Hussain Waris

Toss Up: Multiple Choice

Which of the following best characterizes every transcendental number?

W) Irrational

X) A linear combination of e or pi in which the coefficients are non-zero

Y) A real number that is not a root of any non-zero polynomial with rational coefficients

Z) e or pi

Toss Up Answer: W

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Bonus: Short Answer

Which of the following numbers are transcendental numbers: 1) e; 2)  $\sqrt{2}$ ; 3)  $i^i$ ; 4) pi?

Bonus Answer: e,  $i^i$ , pi [Accept any permutation of 1, 3, and 4]

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## 20. CHEMISTRY

Writer: Nicholas Adit

Toss Up: Multiple Choice

A solution of  $\text{H}_2\text{SO}_3$  is found to have a hydrogen ion concentration of  $1 \times 10^{-3}$  molar at  $25^\circ\text{C}$ . What is the hydroxide ion concentration in the solution?

W)  $1 \times 10^{-1}$

X)  $1 \times 10^{-3}$

Y)  $1 \times 10^{-11}$

Z)  $1 \times 10^{-13}$

Toss Up Answer: Y

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Bonus: Short Answer

If the pH of a solution is changed from 1 to 3 with the addition of an antacid, what percentage of  $[\text{H}^+]$  was neutralized?

Bonus Answer: 99%

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## 21. EARTH and SPACE

Writer: Shanjeed Ali

Toss Up: Short Answer

In the stratosphere, what happens to the temperature as altitude increases?

Bonus Answer: increases

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Bonus: Short Answer

What does radar stand for?

Bonus Answer: RAdio Detection And Ranging

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## 22. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Which of the following would lead to a DECREASE in activity of the Anterior Pituitary gland?

W) A lack of receptors for Cortisol on the Hypothalamus.

X) A lack of receptors for Cortisol on the Anterior Pituitary.

Y) Intravenous injection of a large amount of ACTH.

Z) A tumor of the Hypothalamus causing it to secrete excess Corticotropin- Releasing Hormone

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

What would happen if the Adrenal Cortex was artificially stimulated to produce large amounts of Cortisol?

W) Less Corticotropin-Releasing Hormone would be released.

X) More ACTH would be released.

Y) The activity of the Hypothalamus would increase.

Z) The activity of the Anterior Pituitary would increase.

**Bonus Answer: W**

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**23. EARTH and SPACE**

**Writer: Matthew Lee**

**Toss Up: Short Answer**

A time difference of 5 hours separates London and New York City. What is the longitude of New York City?

**Bonus Answer: 75 degrees west (accept 74 if they actually know that by heart)**

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**Bonus: Short Answer**

Any location north of the equator has latitude equal to the angle what star makes above the horizon at said location?

**Bonus Answer: Polaris (accept: The North Star)**

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**24. BIOLOGY**

**Writer: Siam Muquit**

**Toss Up: Short Answer**

The enzyme catalase is associated with which cell organelle?

**Bonus Answer: Peroxisome**

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**Bonus: Short Answer**

What dangerous product of fatty acid oxidation does catalase act on?

**Bonus Answer: Hydrogen peroxide**

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**25. BIOLOGY**

**Writer: Yae June Lee**

**Toss Up: Short Answer**

Why is oxygen required for cellular respiration?

**Bonus Answer: Oxygen is the final electron acceptor for cellular respiration.**

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**Bonus: Short Answer**

The chemical structures of saturated and unsaturated fats differ in what respect?

**Bonus Answer: Number of bonds (single, double, etc) between carbons.**

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