

## Round 38

### 1. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

Who first suggested that radiant energy could exist only in discrete quanta which were proportional to the frequency in order to explain the frequency distribution of blackbody radiation?

- W) Isaac Newton
- X) Max Planck
- Y) Ernest Rutherford
- Z) Paul Dirac

Toss Up Answer: X

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Bonus: Short Answer

Later solved by Planck's quantum radiation formula, what asymptotic result of the classical Rayleigh-Jeans Law was the most troubling?

Bonus Answer: Ultraviolet Catastrophe

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### 2. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

What law most directly states that the total of the electric flux out of a closed surface is equal to the charge enclosed divided by the permittivity?

Bonus Answer: Gauss's Law

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Bonus: Short Answer

When a magnet is moved into a coil of wire, changing the magnetic field and magnetic flux through the coil, a voltage will be generated in the coil according to which law?

Bonus Answer: Faraday's Law

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### 3. PHYSICS

Writer: Shantanu Jha

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

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Bonus: Multiple Choice

What type of radiation originates from the electron cloud?

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

Bonus Answer: Y

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## 4. PHYSICS

Writer: Jan Wojcik

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

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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  $1.6 \times 10^{-19}$ , which of the following is the force of attraction felt by the two charges, rounded to one decimal place

W)  $4.8 \times 10^{-19}$  C

X)  $9.6 \times 10^{-19}$  C

Y)  $2.4 \times 10^{-19}$  C

Z)  $3.2 \times 10^{-19}$  C

Bonus Answer: Z

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## 5. PHYSICS

Writer: Raafiul Hossain

Toss Up: Short Answer

What is energy measured in?

Bonus Answer: Joules

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Bonus: Short Answer

What is the unit of charge?

Bonus Answer: Columbus

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## 6. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

What is the area of the circle  $x^2 + y^2 = 6/\pi^2$  in terms of  $\pi$

Bonus Answer:  $6/\pi$

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Bonus: Short Answer

What is the area of the circle  $x^2 - 4x + y^2 - 6y - 2 = 0$  in terms of  $\pi$

Bonus Answer:  $15\pi$

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## 7. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

What is the slope of the tangent line to  $e^{(2x)}$  at  $x=3$

Bonus Answer:  $2e^6$

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Bonus: Short Answer

What is the slope of the tangent line to  $\ln(2x)$  at  $x=3$

**Bonus Answer:  $1/3$**

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## 8. MATHEMATICS

**Writer: Jessica Titensky**

**Toss Up: Short Answer**

Convert CD from hexadecimal to decimal

**Bonus Answer: 205**

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**Bonus: Short Answer**

Convert CD from hexadecimal to binary

**Bonus Answer: 11001101**

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## 9. 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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## 10. BIOLOGY

**Writer: Jason Weng**

**Toss Up: Short Answer**

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

**Bonus Answer: Chief cells**

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**Bonus: Short Answer**

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

**Bonus Answer: Factor III; Tissue Factor; Thromboplastin**

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## 11. BIOLOGY

**Writer: Jason Weng**

**Toss Up: Short Answer**

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

**Bonus Answer: Renin**

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**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**

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## 12. BIOLOGY

**Writer: Jason Weng**

**Toss Up: Short Answer**

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

**Bonus Answer: Methyl group;  $-CH_3$**

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**Bonus: Short Answer**

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

**Bonus Answer: hypercythemia; erythrocythemia; hypererythrocythemia**

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### 13. BIOLOGY

**Writer: Jason Weng**

**Toss Up: Short Answer**

What organelle does the cisternal maturation model describe?

**Bonus Answer: Golgi apparatus; Golgi complex**

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**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**

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### 14. BIOLOGY

**Writer: Jason Weng**

**Toss Up: Short Answer**

Which glial cells secrete cerebrospinal fluid?

**Bonus Answer: Ependymal cells**

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**Bonus: Short Answer**

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

**Bonus Answer: Carbaminohemoglobin**

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### 15. BIOLOGY

**Writer: Jason Weng**

**Toss Up: Short Answer**

What substance protects the stomach from consuming itself?

**Bonus Answer: Mucus**

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**Bonus: Multiple Choice**

In which organs is thrombopoietin produced?

W) Heart and Liver

X) Liver and Kidney

Y) Kidney and Pancreas

Z) Pancreas and Liver

**Bonus Answer: X**

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### 16. BIOLOGY

**Writer: Nten Nylam**

**Toss Up: Short Answer**

What is it called when a species of animal becomes two separate species while inhabiting the same area?

**Bonus Answer: Sympatric speciation**

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**Bonus: Multiple Choice**

Cladograms are used to determine?

W) Taxonomy

X) Geographic Distribution

Y) Genotype

Z) Evolutionary relatedness

**Bonus Answer: Z**

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## 17. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

How does atropine counter the effects of nerve gas?

W) Atropine binds to the nerve gas and inactivates it

X) Atropine inactivates acetylcholinesterase and allows more acetylcholine to cross the synaptic cleft

Y) atropine blocks the acetylcholine receptor which blocks the excess acetylcholine lingering in the synaptic cleft

Z) atropine stimulates the production of an enzyme that breaks down the nerve gas

**Toss Up Answer: Y**

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**Bonus: Short Answer**

In order to flower, what does a short-day plant need?

**Bonus Answer: Night that is longer than a certain critical length**

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## 18. CHEMISTRY

**Writer: Ashneel Das**

**Toss Up: Multiple Choice**

The conjugate base of HCl is which of the following?

W) A weak acid

X) A strong acid

Y) A weak base

Z) A strong base

**Toss Up Answer: Y**

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**Bonus: Short Answer**

How many sigma and pi bonds does carbon dioxide have?

**Bonus Answer: 2 sigma, 2 pi**

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## 19. CHEMISTRY

**Writer: Ashneel Das**

**Toss Up: Multiple Choice**

In the reaction  $A + B \rightarrow C + D$ , which of the following occurs when reactant B is added?

W) The concentration of A decreases

X) The concentration of C decreases

Y) The concentration of D decreases

Z) The reaction shifts to the left

**Toss Up Answer: W**

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**Bonus: Short Answer**

Given the specific heat capacity of water is 4.18 Joule/gram\*°C, if you have 20 grams of water and want to heat it from 10 degrees C to 15 degrees C, how many joules must be added?

**Bonus Answer: 418 Joules**

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## 20. CHEMISTRY

**Writer: Ashneel Das**

**Toss Up: Multiple Choice**

Which of the following describes the carbon dioxide molecule?

- W) Polar and Linear
- X) Polar and Bent
- Y) Nonpolar and Linear
- Z) Nonpolar and Bent

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What hybridization is typically found in linear molecules?

**Bonus Answer: sp**

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## 21. CHEMISTRY

**Writer: Andrew Chen**

**Toss Up: Multiple Choice**

Why is diamond a thermal conductor, even though it isn't an electrical conductor?

- W) heat vibrations can move along the rigid structure
- X) carbon has a low heat capacity
- Y) there are no impurities which increase resistance
- Z) carbon has a high heat capacity

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Which of the following has the highest carbon content?

- W) wrought iron
- X) cast iron
- Y) pig iron
- Z) slag

**Bonus Answer: Y**

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## 22. CHEMISTRY

**Writer: Andrew Chen**

**Toss Up: Multiple Choice**

Which of the following exhibits diamagnetism?

- W) bronze
- X) water
- Y) liquid oxygen
- Z) diamond

**Toss Up Answer: X**

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**Bonus: Short Answer**

Order the following by second ionization energy, from lowest to highest: Sodium, Magnesium, Aluminum

**Bonus Answer: Magnesium, Aluminum, Sodium**

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## 23. EARTH and SPACE

**Writer: Shantanu Jha**

**Toss Up: Short Answer**

What physical quantity is the Schwarzschild radius of a Black Hole most dependent on?

**Bonus Answer: Mass**

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**Bonus: Multiple Choice**

If the event horizon of a black hole is 10 km, then what is the radius of its photon sphere?

- W) 10km
- X) 15km
- Y) 20km
- Z) 25km

**Bonus Answer: X**

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**24. EARTH and SPACE**

**Writer: Shantanu Jha**

**Toss Up: Short Answer**

What is the average temperature of the universe today to the nearest Kelvin?

**Bonus Answer: 3K**

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**Bonus: Short Answer**

What is the most common star in the Milky Way Galaxy?

**Bonus Answer: Red Dwarf**

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**25. EARTH and SPACE**

**Writer: Jan Wojcik**

**Toss Up: Multiple Choice**

Which of the following statements is FALSE regarding the volcano in each statement?

- W) Shield volcanoes can stretch up to 3 or 4 miles in diameter
- X) Cinder cone volcanoes rarely rise past 1,000 feet in elevation
- Y) Stratovolcanoes are some of the smallest volcanoes in the world
- Z) Volcanic domes commonly occur within the craters or on the flanks of large composite volcanoes

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Which of the following statements is true regarding stratovolcanoes?

- W) Most commonly occur at subduction zones
- X) They produce basaltic magma
- Y) Their eruptions are infrequent
- Z) They are never dormant

**Bonus Answer: W**

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