

## Round 28

### 1. PHYSICS

Writer: Hanna Yang

Toss Up: Multiple Choice

Which of the following is true about a light wave?

- W) Its energy is directly proportional to its wavelength.
- X) Its energy is directly proportional to its frequency.
- Y) Its energy is directly proportional to its amplitude.
- Z) Its energy is not related to any other of its properties.

Toss Up Answer: X

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Bonus: Short Answer

Find the electrostatic force between two perfect spheres, both with charge 1 and are 1 meter apart from each other. Give your answer in scientific notation.

Bonus Answer:  $8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$

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### 2. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What type of damping provides the quickest approach to zero amplitude for a damped oscillator?

- W) Hyperdamping
- X) Overdamping
- Y) Critical Damping
- Z) Underdamping

Toss Up Answer: Y

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Bonus: Short Answer

What is the damping coefficient equal to for a critically damped spring system with a spring constant of 1000 Newtons/meters and oscillating mass of 10 kg?

Bonus Answer: 10Hz [at critical damping the damping coefficient is equal to the undamped resonant frequency, which is equal to the  $\sqrt{\text{spring constant/mass}}$  ]

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### 3. PHYSICS

Writer: Banpreet Singh

Toss Up: Short Answer

At what angle should a projectile be launched from a horizontal surface to have the maximum range?

Bonus Answer: 45 degrees

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Bonus: Short Answer

A mass of 8 kg is hanging vertically from the bottom of a spring with a spring constant of  $10^3 \text{ N/m}$ . To the nearest hundredths place, in meters, what is the displacement?

Bonus Answer: 0.08 meters

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### 4. PHYSICS

Writer: Jason Weng

Toss Up: Multiple Choice

What is the centripetal force if the mass of an object is 10 grams and its centripetal force is  $10 \text{ m/s}^2$ ?

- W) 100
- X) 10
- Y) 1

Z) 0.1

**Toss Up Answer: Z**

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**Bonus: Short Answer**

A man pulls a 5 kg object with 100 Newton of force forward across a flat plain at constant speed. If the coefficient of friction between the ground and the object is 1.0, what is the magnitude of the acceleration of the object? Use 10 m/s<sup>2</sup> for gravity.

**Bonus Answer: 10 m/s<sup>2</sup>**

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## 5. PHYSICS

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

Which of the following is the most correct statement of the equivalence principle?

W) General relativity is equivalent to Newtonian gravity under certain conditions

X) All kinds of energy are equivalent

Y) The effects of accelerating a frame are indistinguishable from gravitational forces

Z) The acceleration due to gravity is equivalent to  $GM/r$  under Newtonian conditions

**Toss Up Answer: Y**

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**Bonus: Short Answer**

When a particle collides with its corresponding antiparticle, they annihilate, producing photons with energy equal to their rest mass energy. Imagine that you had 1 g of hydrogen and 1 g of anti-hydrogen. If the energy released when they collide is in the form  $[a \times 10^k \text{ Joules}]$ , what's the value of k?

**Bonus Answer: 14**

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## 6. MATHEMATICS

**Writer: Henry Zheng**

**Toss Up: Multiple Choice**

What is the product of the following 2 values: (1) the greatest common divisor of 7 and 14; and (2) the least common multiple of 7 and 14?

W) 21

X) 49

Y) 98

Z) 196

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Multiply the following complex numbers, giving your answer in standard  $a + bi$  form:  $(6 + 3i)(4 + i)$

**Bonus Answer:  $21 + 18i$**

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## 7. MATHEMATICS

**Writer: Henry Zheng**

**Toss Up: Multiple Choice**

Which of the following numbers is evenly divisible by 4?

W) 1722

X) 2636

Y) 4114

Z) 6126

**Toss Up Answer: X**

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**Bonus: Short Answer**

Rounded to the nearest centimeter, if side A of a right triangle measures 2 centimeters and side B measures 10 centimeters, what is the length of the hypotenuse?

**Bonus Answer: 10**

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**8. MATHEMATICS**

**Writer: Henry Zheng**

**Toss Up: Short Answer**

If a 6-foot tall person who is standing next to a vertical pole casts a shadow of 8 feet and the pole casts a shadow of 40 feet, how many feet tall is the pole?

**Bonus Answer: 30**

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**Bonus: Short Answer**

Solve the following equation for x:  $(x+9) / (x+10) = 20 / 18$  (read as: the quantity x plus nine over the quantity x plus ten is equal to twenty over eighteen)

**Bonus Answer: -19**

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**9. MATHEMATICS**

**Writer: Henry Zheng**

**Toss Up: Short Answer**

Solve the following equation for x:  $-3|x| = -15$  (read as: minus 3 times the absolute value of x equals minus 15).

**Bonus Answer: 5 and -5**

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**Bonus: Short Answer**

One-half of a number added to one third of the same number is 68 less than the number. What is the number?

**Bonus Answer: 408**

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**10. BIOLOGY**

**Writer: Matthew Lee**

**Toss Up: Short Answer**

What is the process of breaking down fatty acids and converting them to acetyl CoA called?

**Bonus Answer: beta oxidation**

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**Bonus: Short Answer**

For every 6 molecules of carbon dioxide consumed for photosynthesis, how many molecules of water are consumed?

**Bonus Answer: 12**

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**11. BIOLOGY**

**Writer: Matthew Lee**

**Toss Up: Short Answer**

What molecule or one of its derivatives serves as the final electron acceptor in fermentation?

**Bonus Answer: Pyruvate**

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**Bonus: Short Answer**

In alcoholic fermentation, pyruvate is converted to a compound which acts as the final electron acceptor, being converted to ethanol in the process. What is this compound called?

**Bonus Answer: Acetaldehyde**

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## 12. BIOLOGY

Writer: Matthew Lee

Toss Up: Multiple Choice

During chemiosmosis, protons enter and exit which component of the ATP synthase complex?

- W) rotor
- X) internal rod
- Y) stator
- Z) catalytic knob

Toss Up Answer: Y

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Bonus: Short Answer

What is the name of the only member of the electron transport chain in cellular respiration that is not a protein?

Bonus Answer: Ubiquinone

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## 13. BIOLOGY

Writer: Matthew Lee

Toss Up: Multiple Choice

What enzyme, which can be inhibited or activated, serves as the point in which the cell is committed to performing glycolysis?

- W) Hexokinase
- X) Phosphoglucosomerase
- Y) Phosphoglycerokinase
- Z) Phosphofructokinase

Toss Up Answer: Z

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Bonus: Multiple Choice

The electrons from the electron carrier FADH<sub>2</sub> are initially shuttled to which complex in the electron transport chain?

- W) complex I
- X) complex II
- Y) complex III
- Z) complex IV

Bonus Answer: X

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## 14. BIOLOGY

Writer: Matthew Lee

Toss Up: Short Answer

What molecule is the phosphorylated intermediate of the ATP-coupled reaction derived from?

The reaction is glutamic acid + ammonia → glutamine. The free energy change is +3.4 kcal/mol.

Bonus Answer: Glutamic Acid

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Bonus: Short Answer

The evolution of enzymes was traced in an experiment with E. coli. What enzyme was mutated in the experiment?

Bonus Answer: beta-galactosidase

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## 15. BIOLOGY

Writer: Matthew Lee

**Toss Up: Multiple Choice**

Which of the following pairs of scientists elucidated the current model of the cell membrane?

- W) Frye and Edidin
- X) Davson and Danielli
- Y) Singer and Nicholson
- Z) Gorter and Grendel

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Which of the following allow the protist *Paramecium caudatum* to survive in their hypotonic environments? I. Plasma membrane II. Cell Wall  
III. Pseudopodia IV. Contractile Vacuole

**Bonus Answer: I and IV**

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**16. BIOLOGY**

**Writer: Matthew Lee**

**Toss Up: Short Answer**

What is the main fiber that makes up the extracellular matrix?

**Bonus Answer: Collagen**

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**Bonus: Multiple Choice**

Which of the following allow for cell signaling?

- I. Desmosomes II. Gap Junctions III. Tight Junctions IV. Plasmodesmata
- W) I, II, III
  - X) II and IV
  - Y) II and III
  - Z) I and IV

**Bonus Answer: X**

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**17. BIOLOGY**

**Writer: Matthew Lee**

**Toss Up: Short Answer**

What is the arrangement of microtubules in a motile cilium called?

**Bonus Answer: 9 + 2 ('nine plus two')**

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**Bonus: Short Answer**

What are the common large motor proteins that move flagella and motile cilia called?

**Bonus Answer: dyneins (accept: dynein)**

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**18. CHEMISTRY**

**Writer: Henry Zheng**

**Toss Up: Multiple Choice**

A lead chromate solution is typically what color?

- W) blue
- X) red
- Y) yellow
- Z) green

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Which of the following molecules exhibits a dipole moment?

- W) CH<sub>4</sub>
- X) H<sub>2</sub>S
- Y) CO<sub>2</sub>
- Z) SO<sub>3</sub>

**Bonus Answer: X**

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**19. CHEMISTRY**

**Writer: Jan Wojcik**

**Toss Up: Multiple Choice**

According to VSEPR theory, which of the following molecules DOES NOT have a trigonal pyramidal geometry?

- W) NH<sub>3</sub> (read as: Ammonia)
- X) BF<sub>3</sub> (read as: Barium trifluoride)
- Y) XeF<sub>3</sub> (read as: Xenon trifluoride)
- Z) PCl<sub>3</sub> (read as: Phosphorus trichloride)

**Toss Up Answer: X**

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**Bonus: Short Answer**

By name of number, which of the following molecules have a bent molecular structure? SO<sub>2</sub>, CO<sub>2</sub>, OF<sub>2</sub>

**Bonus Answer: SO<sub>2</sub> and OF<sub>2</sub> (accept 1 and 3)**

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**20. CHEMISTRY**

**Writer: Shihab Karim**

**Toss Up: Multiple Choice**

How many moles of nitrogen are in 35 grams of nitrogen?

- W) 3
- X) 3.5
- Y) 4
- Z) 2.5

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What group is Magnesium a part of?

**Bonus Answer: Alkaline Earth Metals**

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**21. CHEMISTRY**

**Writer: Shihab Karim**

**Toss Up: Short Answer**

What is the hybridization of CH<sub>4</sub>?

**Bonus Answer: sp<sup>3</sup>**

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**Bonus: Short Answer**

What intermolecular forces exist in HF?

**Bonus Answer: Hydrogen Bonding**

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**22. CHEMISTRY**

**Writer: Shihab Karim**

**Toss Up: Multiple Choice**

What is the name given to the equation  $P_1V_1=P_2V_2$ ?

W) Ideal Gas Law

X) Charles's Law

Y) Boyle's Law

Z) Gay-Lussac's Law

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What are bond angles of a tetrahedral?

**Bonus Answer: 109.5 degrees**

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## 23. EARTH and SPACE

**Writer: Nten Nylam**

**Toss Up: Multiple Choice**

What explains the lack of hydrogen in the atmosphere, despite its relative abundance in the universe?

W) most of it is used up in photosynthesis

X) most of it was an unstable isotope that decayed

Y) most of it escaped into space because of its low mass

Z) most of it is in water molecules

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What is the name of the underground surface that serves as the upper limit of the zone of saturation (the point in which all material below is saturated)?

**Bonus Answer: water table**

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## 24. EARTH and SPACE

**Writer: Andrew Chen (Senior)**

**Toss Up: Multiple Choice**

There are many mineral categories. Which of the following mineral groups below is classified based on varying ratios of silicon and oxygen?

W) Sulfides

X) Phosphates

Y) Carbonates

Z) Silicates

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Of the following minerals listed, which belong in the mineral group of silicates: Olivine, Mica, Topaz and Talc.

**Bonus Answer: Olivine, Mica, Topaz (1, 2, 3)**

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## 25. EARTH and SPACE

**Writer: Janine Goh**

**Toss Up: Short Answer**

Which scientist came up with the laws of planetary motion?

**Bonus Answer: Kepler**

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**Bonus: Short Answer**

Which constellation is the star that remains stationary in northern hemisphere part of?

**Bonus Answer: Ursa Minor**

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