

## Round 25

### 1. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

If a wheel is turning at  $3.0/\pi$  rad/s, what is its period?

- W) 3.14
- X) 6.58
- Y) 8.73
- Z) 9.67

Toss Up Answer: X

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Bonus: Multiple Choice

What is the total energy of a block attached to a spring with spring constant of 5 N/m if the block's velocity corresponds to the equation,  $v(t) = 10\sin(2t)$  (READ AS:  $v$  of  $t$  equals 10 times sin of quantity  $2t$ )?

- W) 100 J
- X) 125 J
- Y) 250 J
- Z) 500 J

Bonus Answer: Y

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### 2. EARTH and SPACE

Writer: Matthew Lee

Toss Up: Multiple Choice

Which of the following is not a typical storm track in the United States?

- W) from Alberta straight to Maine
- X) from the Gulf states northward along the eastern seaboard
- Y) from Colorado to the Appalachian Mountains
- Z) from the Pacific Northwest to the Southeastern US by way of Texas

Toss Up Answer: Z

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Bonus: Multiple Choice

Present day weather predictions are based primarily upon

- W) land and sea breezes
- X) cloud height
- Y) air mass movements
- Z) ocean currents

Bonus Answer: Y

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### 3. PHYSICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

Suppose all the resistors in the world were only 10,000 Ohm resistors. What is the minimum number of resistors needed to make an equivalent resistance of 600 Ohms.

- W) 8
- X) 6
- Y) 4

Z) 3

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Two wires of the same material and equal length are joined in parallel. If one of them has half the thickness of the other, and the thinner wire has a resistance of 8 Ohms, what is the resistance of the parallel combination?

**Bonus Answer: 1.6 Ohms**

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## 4. EARTH and SPACE

**Writer: Jan Wojcik**

**Toss Up: Multiple Choice**

Which of the following is NOT true regarding cirrus clouds?

- W) They are typically found between 10,000 feet and 15,000 feet above sea level
- X) They can be formed from any cloud that goes under glaciation
- Y) They cover 25% of the Earth and have a heating effect
- Z) They have been seen forming on other planets such as Mars and Jupiter

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

The most common cloud source for a majority of tornadoes is:

- W) Cumulus
- X) Nimbostratus
- Y) Altostratus
- Z) Cumulonimbus

**Bonus Answer: Z**

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## 5. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Short Answer**

During the late Carboniferous period, terrestrial arthropods such as Hexapoda, Myriapoda, and Arachnida showed great diversity in form and size. Why, in terms of abiotic environmental factors, are modern day arthropods are much smaller than their Carboniferous ancestors?

**Bonus Answer: decreased volume of oxygen in the atmosphere in modern times versus comparatively higher volume of oxygen present during Carboniferous Era**

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**Bonus: Short Answer**

Arrange the following five events in the order that explains the bulk flow of substances in the phloem.

1. Sugar moves down the stem.
2. Leaf cells produce sugar by photosynthesis.
3. Sugar is transported from cell to cell via the apoplast and/or symplast.
4. Solutes are actively transported into sieve elements.
5. Water diffuses into the sieve tube elements.

**Bonus Answer: 2,3,4,1,5**

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## 6. EARTH and SPACE

**Writer: Yae June Lee**

### **Toss Up: Multiple Choice**

What is the relationship between size of a particle and the capillarity of soil?

- W) As soil particle increases, capillarity increases.
- X) As soil size increases, capillarity decreases.
- Y) As soil size increases, capillarity stays the same.
- Z) As soil size increases, the capillarity curves in a parabola.

**Toss Up Answer: X**

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### **Bonus: Short Answer**

Why do polar jet streams vary throughout the seasons?

**Bonus Answer: The rays of the sun shift north of the equator during the summer.**

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## **7. PHYSICS**

**Writer: Aaron Gee**

### **Toss Up: Short Answer**

For the hydrogen atom, which series describes electron transitions to the N=1 orbit, the lowest energy electron orbit?

**Bonus Answer: Lyman series**

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### **Bonus: Short Answer**

Electric current may be expressed in which one of the following units?

**Bonus Answer: coulombs/second**

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## **8. EARTH and SPACE**

**Writer: Jan Wojcik**

### **Toss Up: Short Answer**

Name the soil horizon that contains a mixture of organic matter and highly altered mineral matter and is dark in color.

**Bonus Answer: A-horizon**

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### **Bonus: Short Answer**

By name or number, which of the following phenomena cause acidification in agricultural soils:

- 1) Leaching of excess nitrate
- 2) Build-up in mostly plant-based organic matter
- 3) Removal of plant and animal products
- 4) Addition of nitrogen based fertilisers

**Bonus Answer: All of them (accept 1,2,3,4)**

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## **9. MATHEMATICS**

**Writer: Steven Litvack-Winkler**

### **Toss Up: Short Answer**

which of the following are true about the number and nature of the roots of the polynomial

$$x^3 - 29x^2 + 229x$$

- I. 0 is a root
- II. There must be a real, positive root
- III. There must be three real roots

**Bonus Answer: I**

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**Bonus: Short Answer**

Solve the following linear system of equations in 3 variables:

$$2x + y + 4z = 9$$

$$-x + 2y + 5z = -11$$

$$5x + 3y + 3z = -4$$

**Bonus Answer:**  $x=4, y=-11, z=3$

**Also accept** (4,-11,3)

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**10. BIOLOGY**

**Writer:** Calvin Vuong

**Toss Up:** Short Answer

Which cyclin-Cdk complex triggers the cell's passage past the G2 checkpoint into mitosis?

**Bonus Answer:** MPF (ACCEPT: mitosis promoting factor, maturation promoting factor)

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**Bonus: Short Answer**

In which cell cycle phase does the most important checkpoint, also called the restriction point, occur?

**Bonus Answer:** G1 (ACCEPT: between G1 and S)

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**11. CHEMISTRY**

**Writer:** Prangon Ghose

**Toss Up:** Short Answer

What is the element formed by the beta decay of Carbon-14?

**Bonus Answer:** Nitrogen-14

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**Bonus: Short Answer**

If the abundance of Lithium-6 (6.0 amu) is 7.500% and the abundance of Lithium-7 (7.0 amu) is 92.500%, what is the average atomic mass to the tenth place?

**Bonus Answer:** 6.9 amu

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**12. MATHEMATICS**

**Writer:** Steven Litvack-Winkler

**Toss Up:** Multiple Choice

To test products, there is a test that identifies 95% of defective products as defective, but also labels 10% of all working products as defective. If 85% of the products made are not defective, what probability of products the test determines to be defective are actually defective?

W) 39%

X) 84%

Y) 67%

Z) 42%

**Toss Up Answer:** Y

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**Bonus: Short Answer**

Compute the surface area of a cylinder with radius 8 and height 2

**Bonus Answer:** 160pi

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**13. PHYSICS**

**Writer:** Seiji Yawata

**Toss Up:** Multiple Choice

You decide to set off on a voyage to another star. To stop your muscles from atrophying, you want to generate artificial gravity by having your ship constantly accelerate at 1 g from your reference frame. Ignoring fuel requirements, is there a problem with generating artificial gravity this way over very long time frames?

W) Yes, this setup would not work to generate artificial gravity

X) Yes, 1 g isn't enough to prevent your muscles from atrophying

Y) No, this can be used indefinitely to generate artificial gravity

Z) Yes, eventually the ship would need to go faster than the speed of light, which is impossible

**Toss Up Answer: Y**

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**Bonus: Short Answer**

A box of mass 3 kg is placed on the edge of a merry-go-round of radius 4 m. The coefficient of static friction between the box and the merry-go-round is 0.4. What is the square of the merry-go-round's speed at the moment the box slides off?

**Bonus Answer: 12 (m/s)<sup>2</sup>**

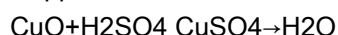
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## 14. CHEMISTRY

**Writer: Mohammed Jamil**

**Toss Up: Short Answer**

Copper sulfate can be made by warming copper oxide with sulfuric acid. The equation for the reaction is:



Calculate the maximum mass of copper oxide which can react with 9.8 g of sulfuric acid in this reaction.

(Relative atomic masses: H=1, O=16, Cu=64)

**Bonus Answer: 8g**

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**Bonus: Short Answer**

It takes 83ml of a 0.45M NaOH solution to neutralize 235mL of an HCl solution. What is the concentration of the HCl solution ?

**Bonus Answer: 0.16 M**

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## 15. PHYSICS

**Writer: Charles Zhang**

**Toss Up: Multiple Choice**

Two trucks are 50 kilometers apart and traveling toward each other. One automobile is moving at 60km/h and the other is moving at 40km/h . How long will it take for them meet?

W) 15 minutes

X) 20 minutes

Y) 24 minutes

Z) 30 minutes

**Toss Up Answer: Z**

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**Bonus: Short Answer**

The position of a particle in meters is given by  $x(t) = 25t - 3t^3$  (READ AS: 16 times t minus 3 times t cubed) , where the time t is in seconds. The particle is momentarily at rest at what time t rounded to the nearest hundredth?

**Bonus Answer: 1.67 seconds, accept 1.67**

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## 16. CHEMISTRY

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Under what conditions do gases act more ideal?

W) Higher pressure, Higher temperature

- X) Higher pressure, Lower temperature  
Y) Lower Pressure, Higher temperature  
Z) Lower pressure, Lower temperature

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Rank the following gases in order from most ideal to least ideal:

1. He
2. N<sub>2</sub>
3. HCl
4. SF<sub>6</sub>

**Bonus Answer: He, N<sub>2</sub>, SF<sub>6</sub>, HCl (accept 1,2,4,3)**

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## 17. PHYSICS

**Writer: Charles Zhang**

**Toss Up: Multiple Choice**

A hose has a diameter of 2 inches and its nozzle is 0.2 inches in radius. If water flows at 4 m/s in the hose, then how fast will it leave the nozzle?

- W) 4 m/s  
X) 1 m/s  
Y) 100 m/s  
Z) 200 m/s

**Toss Up Answer: Y**

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**Bonus: Short Answer**

To measure moderately low pressures, oil with a density of  $8.5 \times 10^2 \text{ kg/m}^3$  (READ AS: 8.5 times 10 to the -2 kilogram per cubic meter) is used in place of mercury in a barometer. If the height of the oil column changes by 1.0mm, find the change in the pressure, assuming  $g = 10 \text{ m/s}^2$ .

**Bonus Answer: 8.5 Pa**

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## 18. MATHEMATICS

**Writer: Steven Litvack-Winkler**

**Toss Up: Short Answer**

Tim is 5 times older than his younger brother. In 3 years Tim will be 3 times older than his younger brother. Compute the difference in the ages of Tim and his younger brother.

**Bonus Answer: 12**

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**Bonus: Short Answer**

How many positive integers  $n$  have no solutions to the following equation where  $a$  and  $b$  are nonnegative integers?  
 $3a + 7b = n$

**Bonus Answer: 6**

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## 19. BIOLOGY

**Writer: Shanjeed Ali**

**Toss Up: Short Answer**

What term describes the number of times a normal human cell population can divide?

**Bonus Answer: Hayflick limit**

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**Bonus: Multiple Choice**

What controls the Hayflick limit?

- W) apoptosis
- X) length of telomeres
- Y) genomic instability
- Z) genetic drift

**Bonus Answer: X**

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## 20. MATHEMATICS

**Writer: Steven Litvack-Winkler**

**Toss Up: Multiple Choice**

Which of the following is not a group?

- W) the integers under multiplication
- X) the integers under addition
- Y) the symmetries of a regular n-gon
- Z) the permutations of integers between 1 and n

**Toss Up Answer: W**

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**Bonus: Short Answer**

find the smallest positive solution to the following congruences.

x congruent to 3 mod 13

x congruent to 8 mod 11

**Bonus Answer: x=107**

**Also accept: 107**

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## 21. CHEMISTRY

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Which of the following does not exhibit resonance stabilization?

- W) Ozone
- X) SO<sub>2</sub>
- Y) NO<sub>3</sub>
- Z) H<sub>2</sub>O

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the bond order of H<sub>2</sub>O?

**Bonus Answer: 2**

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## 22. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

An individual suffers brain damage that results in respiratory failure. Which region of the brain was most likely damaged?

- W) Substantia nigra
- X) Pons
- Y) Red nucleus
- Z) Reticular formation

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

A man and a woman get married and soon learn that they both have a rare, genetically inherited recessive disorder that makes them prone to dizziness. Worried about the fate of their children, they seek the advice of a genetic counselor. She sequences their genomes and assures them that none of their children will have the disorder. What information would she have to obtain from the sequencing procedure that allows her to make this claim?

- W) The dizziness phenotype in the man is due to a mutation in a gene other than the gene responsible for the woman's phenotype.
- X) The dizziness disorder is an autosomal recessive trait.
- Y) The man and the woman are related genetically causing the same dizziness phenotype.
- Z) It is impossible for the man and the woman to have unaffected children - the genetic counselor is wrong.

**Bonus Answer: W**

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**23. CHEMISTRY**

**Writer: Hanna Yang**

**Toss Up: Short Answer**

Name the polyatomic ion with formula  $\text{SO}_4^{2-}$

**Bonus Answer: Sulfate**

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**Bonus: Multiple Choice**

Which of the following is a base?

- W)  $\text{C}_6\text{H}_{12}\text{O}_6$
- X)  $\text{NaOH}$
- Y)  $\text{HCl}$
- Z)  $\text{PO}_4$

**Bonus Answer: X**

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**24. BIOLOGY**

**Writer: Calvin Vuong**

**Toss Up: Multiple Choice**

The majority of ATP molecules generated from cellular respiration comes from which process?

- W) glycolysis
- X) pyruvate oxidation
- Y) the Krebs cycle
- Z) chemiosmosis

**Toss Up Answer: Z**

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**Bonus: Short Answer**

How many ATP molecules on average does chemiosmosis produce per glucose?

**Bonus Answer: Accept: 26, 28, or both.**

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