

## Round 35

### 1. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

A helicopter is ascending vertically with a constant speed of 6 meters per second relative to the ground. At the instant the helicopter is 60 meters above the ground it releases a package.

What is the magnitude and direction of the velocity of the package, relative to the ground, the instant the package is released by the helicopter?

Bonus Answer: 6 meters/second up

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Bonus: Multiple Choice

If the resultant force acting on a body of constant mass is zero, the body's momentum is

- W) increasing
- X) decreasing
- Y) always 0
- Z) Constant!

Bonus Answer: Z

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### 2. MATHEMATICS

Writer: Jason Weng

Toss Up: Multiple Choice

What is the area of an equilateral triangle with side lengths 2?

- W) 1
- X)  $\sqrt{3}$
- Y)  $\sqrt{6}$
- Z) 2

Toss Up Answer: X

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Bonus: Multiple Choice

If the roots of  $P(x) = 64x^2 - 24x + 2$  are A and B, what is the harmonic mean of A and B in simplest fractional form?

- W)  $1/3$
- X)  $1/6$
- Y)  $1/12$
- Z)  $1/24$

Bonus Answer: X

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### 3. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

A box is initially at rest on a horizontal, frictionless table. If a force of 10 Newtons acts on the box for 3 seconds, what is the momentum of the box at the end of the 3 second interval?

Bonus Answer: 30 N (newton) seconds

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Bonus: Short Answer

A 10 kilogram body initially moving with a velocity of 10 meters per second makes a head-on collision with a 15 kilogram body initially at rest. The two objects stick together. What is the velocity of the combined system just after the

collision?

**Bonus Answer: 4 meters per seconds**

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## 4. MATHEMATICS

**Writer: Hanna Yang**

**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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## 5. PHYSICS

**Writer: Aaron Gee**

**Toss Up: Short Answer**

A toy train moves in a circle of 8 meters radius with a speed of 4 meters per second. What is the magnitude of the acceleration of the train?

**Bonus Answer: 2 meters per second<sup>2</sup>**

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**Bonus: Short Answer**

A certain machine exerts a force of 200 newtons on a box whose mass is 30 kilograms. The machine moves the box a distance of 20 meters along a horizontal floor. What amount of work does the machine do on the box?

**Bonus Answer: 4000 J (joules)**

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## 6. MATHEMATICS

**Writer: Hanna Yang**

**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**

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**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.

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## 7. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

A ball leaves a girl's hand with an upward velocity of 6 meters per second. What is the maximum height of the ball above the girl's hand?

Bonus Answer: 1.8 meters

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Bonus: Short Answer

A boy throws a ball vertically upward with a velocity of 6 meters per second. How long does it take the ball to return to the boy's hand?

Bonus Answer: 1.22 seconds

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## 8. MATHEMATICS

Writer: Hanna Yang

Toss Up: Short Answer

$(mn)^2 - p^2$

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

Difference of Squares

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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)

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## 9. PHYSICS

Writer: Aaron Gee

Toss Up: Multiple Choice

For an object moving in uniform circular motion, the direction of the instantaneous acceleration vector is:

W) tangent to the path of motion

X) equal to zero

Y) directed radially outward

Z) directed radially inward

Toss Up Answer: Z

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Bonus: Multiple Choice

A Newton is equal to which of the following?

W) kilogram-meter per second

X) meter per second squared

Y) kilogram-meter per second

Z) ) kilogram per meter-second

Bonus Answer: Y

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## 10. BIOLOGY

Writer: Ahmad Alnasser

Toss Up: Short Answer

An ecologist recorded 12 white-tailed deer, *Odocoileus virginianus*, per square mile in one woodlot and 20 per square mile in another woodlot. What was the ecologist comparing?

Bonus Answer: density

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Bonus: Short Answer

Why do populations grow more slowly as they approach their carrying capacity?

Bonus Answer: Density-dependent factors lead to fewer births and increased mortality. (Accept Density-Dependent factors)

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## 11. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Multiple Choice

Which of the following elements has the largest number of possible oxidation states?

- W) Fe
- X) Cl
- Y) Ca
- Z) Mn

Toss Up Answer: X

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Bonus: Multiple Choice

What is the minimum number of electrons needed to balance the following half-reaction with whole number coefficients?

$\text{IO}_3^- \rightarrow \text{I}_2$

- W) 1 e-
- X) 2 e-
- Y) 5 e-
- Z) 10 e-

Bonus Answer: Z

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## 12. BIOLOGY

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

A trend toward the decrease in the size of plants on the slopes of mountains as altitudes increase is an example of

- W) a cline
- X) a bottleneck
- Y) relative fitness
- Z) geographic variation

Toss Up Answer: W

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Bonus: Short Answer

If thermoregulation is considered to be a secondary function of the large ears of jackrabbits, then the primary function of the ears is

**Bonus Answer: to detect predators**

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### **13. CHEMISTRY**

**Writer: Nicholas Adit**

**Toss Up: Multiple Choice**

Which of the following is closest in mass to a proton?

- W) Alpha Particle
- X) Positron
- Y) Neutron
- Z) Hydrogen Molecule

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What is the amount of calories of heat transferred to the water is when the temperature of a 20-gram sample of water is increased from 10°C to 30°C?

**Bonus Answer: 400**

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### **14. BIOLOGY**

**Writer: Ahmad Alnasser**

**Toss Up: Multiple Choice**

What structure in plant cells is similar to gap junctions in animal cells?

- W) Cell wall
- X) Central Vacuole
- Y) Plasmodesmata
- Z) Thylakoid

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

If, on average, 46% of the loci in a species' gene pool are heterozygous, then the average homozygosity of the species should be

- W) 23%
- X) 46%
- Y) 54%
- Z) There is not enough information to say.

**Bonus Answer: Y**

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### **15. 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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## 16. 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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## 17. CHEMISTRY

**Writer: Prangon Ghose**

**Toss Up: Multiple Choice**

What is the correct term(s) used to determine if a system has come to equilibrium?

- W)  $K_a$  and  $Q$
- X)  $K_{sp}$
- Y)  $Q$
- Z)  $K_c$

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Chemical equilibrium may be used to describe

- W) gas phase chemical reactions
- X) acid and based ionization
- Y) Solubility
- Z) All of the Above

**Bonus Answer: Z**

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## 18. BIOLOGY

**Writer: Sean Vaysburd**

**Toss Up: Multiple Choice**

Which is not a part of the nucleus?

- W) nuclear envelope
- X) nucleolus
- Y) chromatin
- Z) plasmodesmata

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Which is not a part of the cytoskeleton?

- W) microfilaments
- X) intermediate filaments
- Y) microtubules
- Z) gap junctions

**Bonus Answer: Z**

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## 19. CHEMISTRY

**Writer: Nicholas Adit**

**Toss Up: Multiple Choice**

Which of the following species is amphoteric?

- W)  $\text{Na}_3\text{PO}_4$
- X)  $\text{HSO}_4^-$
- Y) KOH
- Z)  $\text{HNO}_3$

**Toss Up Answer: X**

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**Bonus: Short Answer**

A 600-milliliter container holds 2 moles of  $\text{O}_2(\text{g})$ , 3 moles of  $\text{H}_2(\text{g})$ , and 1 mole of  $\text{He}(\text{g})$ . Total pressure within the container is 760 torr. What is the partial pressure of  $\text{O}_2$ ?

**Bonus Answer: 253 torr**

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## 20. BIOLOGY

**Writer: Sean Vaysburd**

**Toss Up: Multiple Choice**

What is a technique for studying cell membrane structure and function?

- W) cell fractionation
- X) freeze fracture
- Y) cell centrifugation
- Z) inserting radioactive substances

**Toss Up Answer: X**

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**Bonus: Short Answer**

Which type of microscope is useful for studying the internal structure of cells?

**Bonus Answer: transmission electron microscope**

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## 21. EARTH and SPACE

**Writer: Shanjeed Ali**

**Toss Up: Multiple Choice**

Where is the Great Rift Valley located?

- W) Western Africa
- X) Eastern Asia
- Y) Eastern Africa
- Z) Western Asia

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Which of these countries does the Great Rift Valley not run through?

- W) Tanzania
- X) Kenya
- Y) Burundi
- Z) Angola

**Bonus Answer: Z**

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## 22. BIOLOGY

**Writer: Olivia Gallager**

**Toss Up: Short Answer**

What hormone regulates sleep cycles?

**Bonus Answer: Melatonin**

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**Bonus: Short Answer**

What blood type is considered the universal donor?

**Bonus Answer: O-, O-neg, O-negative**

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## 23. EARTH and SPACE

**Writer: Sean Vaysburd**

**Toss Up: Multiple Choice**

Which is not a type of rock?

- W) sedimentary
- X) metamorphic
- Y) igneous
- Z) elementary

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Which type of rock is formed from magma?

**Bonus Answer: igneous rock**

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## 24. BIOLOGY

**Writer: Zoe Orlin**

**Toss Up: Short Answer**

What is the material that makes up part of your nose and ears?

**Bonus Answer: Cartilage**

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**Bonus: Short Answer**

How does one acquire an infection of the ear?

**Bonus Answer: By a virus or bacteria**

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## 25. EARTH and SPACE

**Writer: Jan Wojcik**

**Toss Up: Multiple Choice**

Which of the following pairs of minerals share the same cleavage?

- W) Fluorite and Calcite
- X) Mica and Galena
- Y) Cryolite and Fluorite
- Z) Halite and Sylvite

**Toss Up Answer: Z**



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**Bonus: Short Answer**

In how many directions does muscovite break (cleave)?

**Bonus Answer: 1 (one)**

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