

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

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

2. 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

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

3. 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 second²

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)

4. 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

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

5. 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

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

6. 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

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) $\frac{1}{3}$

X) $\frac{1}{6}$

Y) $\frac{1}{12}$

Z) $\frac{1}{24}$

Bonus Answer: X

7. 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

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

8. 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

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.

9. MATHEMATICS

Writer: Hanna Yang

Toss Up: Short Answer

$(mn)^2 - p^2$

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

Difference of Squares

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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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. 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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12. 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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13. BIOLOGY

Writer: Siam Muquit

Toss Up: Short Answer

The enzyme catalase is associated with which cell organelle?

Bonus Answer: Peroxisome

Bonus: Short Answer

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

Bonus Answer: Hydrogen peroxide

14. 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

Bonus: Multiple Choice

Which is not a part of the cytoskeleton?

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

Bonus Answer: Z

15. 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

Bonus: Short Answer

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

Bonus Answer: transmission electron microscope

16. BIOLOGY

Writer: Olivia Gallager

Toss Up: Short Answer

What hormone regulates sleep cycles?

Bonus Answer: Melatonin

Bonus: Short Answer

What blood type is considered the universal donor?

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

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17. BIOLOGY

Writer: Zoe Orlin

Toss Up: Short Answer

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

Bonus Answer: Cartilage

Bonus: Short Answer

How does one acquire an infection of the ear?

Bonus Answer: By a virus or bacteria

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18. 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

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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19. 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

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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20. 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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21. 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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22. CHEMISTRY

Writer: Nicholas Adit

Toss Up: Multiple Choice

Which of the following species is amphoteric?

W) Na_3PO_4

X) HSO_4^-

Y) KOH

Z) HNO_3

Toss Up Answer: X

Bonus: Short Answer

A 600-milliliter container holds 2 moles of O₂(g), 3 moles of H₂(g), and 1 mole of He(g). Total pressure within the container is 760 torr. What is the partial pressure of O₂?

Bonus Answer: 253 torr

23. 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

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

24. 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

Bonus: Short Answer

Which type of rock is formed from magma?

Bonus Answer: igneous rock

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

Bonus: Short Answer

In how many directions does muscovite break (cleave)?

Bonus Answer: 1 (one)
