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

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 × 10^9 N•m2/C2

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2. 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

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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3. 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

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(spring constant/mass)]

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4. 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

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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5. 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

Bonus: Short Answer

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

Bonus Answer: 0.08 meters

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6. 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

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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7. 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 m/s^2?

W) 100

X) 10

Y) 1

Z) 0.1

Toss Up Answer: Z

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^2 for gravity.

Bonus Answer: 10 m/s^2

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8. 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

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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9. 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

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 x 10^k Joules], what's the value of k?

Bonus Answer: 14

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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

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. 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

Bonus: Multiple Choice

Which of the following molecules exhibits a dipole moment?

W) CH4

X) H2S

Y) CO2

Z) SO3

Bonus Answer: X

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12. 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

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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13. 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) NH3 (read as: Ammonia)

X) BF3 (read as: Barium trifluoride)

Y) XeF3 (read as: Xenon trifluoride)

Z) PCl3 (read as: Phosphorus trichloride)

Toss Up Answer: X

Bonus: Short Answer

By name of number, which of the following molecules have a bent molecular structure? SO2, CO2, OF2

Bonus Answer: SO2 and OF2 (accept 1 and 3)

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14. 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

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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15. 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

Bonus: Short Answer

What group is Magnesium a part of?

Bonus Answer: Alkaline Earth Metals

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16. 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) Phosphoglucoisomerase

Y) Phosphoglycerokinase

Z) Phosphofructokinase

Toss Up Answer: Z

Bonus: Multiple Choice

The electrons from the electron carrier FADH2 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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17. CHEMISTRY

Writer: Shihab Karim

Toss Up: Short Answer

What is the hybridization of CH4?

Bonus Answer: sp3

Bonus: Short Answer

What intermolecular forces exist in HF?

Bonus Answer: Hydrogen Bonding

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18. 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

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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19. CHEMISTRY

Writer: Shihab Karim

Toss Up: Multiple Choice

What is the name given to the equation P1V1=P2V2?

W) Ideal Gas Law

X) Charles's Law

Y) Boyle's Law

Z) Gay-Lusacc's Law

Toss Up Answer: Y

Bonus: Short Answer

What are bond angles of a tetrahedral?

Bonus Answer: 109.5 degrees

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20. 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

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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21. 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

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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22. BIOLOGY

Writer: Matthew Lee

Toss Up: Short Answer

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

Bonus Answer: Collagen

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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23. 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

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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24. 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')

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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25. EARTH and SPACE

Writer: Janine Goh

Toss Up: Short Answer

Which scientist came up with the laws of planetary motion?

Bonus Answer: Kepler

Bonus: Short Answer

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

Bonus Answer: Ursa Minor

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