

Round 5

1. PHYSICS

Writer: Ahmad Alnasser

Toss Up: Short Answer

A car accelerates from rest at 4 (m/s)^2 . What is the distance traveled by the car in 3 seconds?

Bonus Answer: 18 meters (m)

Bonus: Multiple Choice

A motor scooter travels east at a speed of 13 m/s. The driver then reverses direction and heads west at 17 m/s. What was the change in velocity of the scooter?

W) 13 m/s

X) 17 m/s

Y) 30 m/s

Z) 4 m/s

Bonus Answer: Y

2. PHYSICS

Writer: Sean Vaysburd

Toss Up: Short Answer

A car with a mass of one ton collides with a truck with a mass of ten tons. Which applies the greatest force on the other, in Newtons?

Bonus Answer: They both apply an equal force.

Bonus: Short Answer

Which experiences greater acceleration in the collision from a car with a mass of one ton colliding with a truck with a mass of ten tons, and by how many times greater.

Bonus Answer: The car, it will accelerate ten times as much.

3. PHYSICS

Writer: Sean Vaysburd

Toss Up: Short Answer

If the acceleration is always perpendicular to an object's velocity, what can be deduced about the object's motion?

Bonus Answer: It is circular motion.

Bonus: Short Answer

If the acceleration of an object is opposite its velocity, what can be said about the object's velocity over time? Assume that the direction of the velocity is positive.

Bonus Answer: It is decreasing.

4. PHYSICS

Writer: George Papastefanou

Toss Up: Multiple Choice

What is the fundamental frequency, in Hz, for a string with a Tension of 250 N, a mass per length of .25 grams per meter, and a length of 50 cm?

W) 1200

X) 5000

Y) 1000

Z) 250

Toss Up Answer: Y

Bonus: Short Answer

Will a projectile fired at a 30 degree angle at 55 m/s clear a 25-meter fence located 50 meters away?

Bonus Answer: No (height at that point is ~23.5 m)

5. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

What is the slope of the tangent line to $e^{(2x)}$ at $x=3$

Bonus Answer: $2e^6$

Bonus: Short Answer

What is the slope of the tangent line to $\ln(2x)$ at $x=3$

Bonus Answer: $1/3$

6. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

What is the area of the circle $x^2+y^2=6/\pi^2$ in terms of π

Bonus Answer: $6/\pi$

Bonus: Short Answer

What is the area of the circle $x^2-4x+y^2-6y-2=0$ in terms of π

Bonus Answer: 15π

7. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

How many distinct roots does x^3-6x^2+32 have

Bonus Answer: 2

Bonus: Short Answer

What is the remainder when x^3-6x^2+32 is divided by $x-1$

Bonus Answer: 27

8. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

How many seconds are in a day

Bonus Answer: 86400

Bonus: Multiple Choice

How many days are in a second

W) $1.16 \cdot 10^{-3}$

X) $1.16 \cdot 10^{-4}$

Y) $1.16 \cdot 10^{-5}$

Z) $1.16 \cdot 10^{-6}$

Bonus Answer: Y

9. BIOLOGY

Writer: Hanna Yang

Toss Up: Multiple Choice

What transmissible agent causes Mad Cow Disease (BSE)?

- W) Viron
- X) Virus
- Y) Bacteria
- Z) Prion

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the following are prions made up of?

- W) Proteins, only
- X) Nucleic Acids, only
- Y) Proteins and Nucleic Acids, only
- Z) Proteins and Carbohydrates, only

Bonus Answer: W

10. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Exocytotic vesicles are most frequently exported via the

- W) endoplasmic reticulum
- X) the nuclear envelope
- Y) the trans Golgi
- Z) the cis Golgi

Toss Up Answer: Y

Bonus: Multiple Choice

Endosomes formed as a result of receptor-mediated endocytosis are most frequently coated with which type of proteins?

- W) G proteins
- X) clathrins
- Y) pseudopodium
- Z) microtubules

Bonus Answer: X

11. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Name all of the following that are amphipathic: integral proteins, cholesterol, phospholipids, triacylglycerol, mannose

Bonus Answer: integral proteins and phospholipids

Bonus: Multiple Choice

Which of the following is not true about a part of the phospholipid?

- W) They contain two fatty acid chains.

- X) Their heads contain a net charge.
- Y) They have a phosphate group in their heads.
- Z) They have a choline group in their heads.

Bonus Answer: X

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12. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Cellulose and glycogen differ in

- W) their alpha/beta glucose configurations
- X) branching
- Y) their ability to be metabolized
- Z) all of the above

Toss Up Answer: Z

Bonus: Short Answer

N-Acetylglucosamine is the monomer of which common polysaccharide?

Bonus Answer: Chitin

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13. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which of the following intermolecular interactions is not exclusive to a single polypeptide's tertiary structure?

- W) hydrophobic interactions
- X) polar interactions
- Y) hydrogen bonding
- Z) disulfide bridges

Toss Up Answer: Y

Bonus: Short Answer

Polypeptide folding is aided by which type of cavity-structured proteins?

Bonus Answer: Chaperonins

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14. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Neurotransmitters are received by which kinds of receptors?

- W) G protein coupled receptors
- X) receptor tyrosine kinases
- Y) ion gated channels
- Z) intracellular receptors

Toss Up Answer: Y

Bonus: Multiple Choice

Which of the following is the immediate effect of a signal molecule binding to a receptor tyrosine kinase molecule?

- W) It forms a dimer with another receptor tyrosine kinase.
- X) It initiates a phosphorylation cascade.
- Y) It becomes activated with phosphate groups.

Z) It attaches to a scaffolding protein.

Bonus Answer: W

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15. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Of the following, which is a second messenger used in cell signaling?

W) G protein

X) Protein kinase A

Y) adenylyl cyclase

Z) cAMP

Toss Up Answer: Z

Bonus: Short Answer

Adjacent plant cells most commonly communicate via what intercellular junction?

Bonus Answer: Plasmodesmata (ACCEPT: desmotubule)

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16. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Introns are hydrolyzed and removed from pre-mRNA by

W) exons

X) spliceosomes

Y) small nuclear ribonucleoproteins

Z) nucleotide-pair substitution

Toss Up Answer: X

Bonus: Short Answer

Okazaki fragments on the lagging strand of DNA are joined by which protein?

Bonus Answer: DNA ligase (ACCEPT: ligase)

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17. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which of the following is a storage protein?

W) aquaporin

X) actin

Y) ovalbumin

Z) AP2

Toss Up Answer: Y

Bonus: Short Answer

Which of the following amino acids has a sulfhydryl group in its side chain?

Bonus Answer: cysteine

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18. CHEMISTRY

Writer: Andrew Chen

Toss Up: Multiple Choice

Why is diamond a thermal conductor, even though it isn't an electrical conductor?

- W) heat vibrations can move along the rigid structure
- X) carbon has a low heat capacity
- Y) there are no impurities which increase resistance
- Z) carbon has a high heat capacity

Toss Up Answer: W

Bonus: Multiple Choice

Which of the following has the highest carbon content?

- W) wrought iron
- X) cast iron
- Y) pig iron
- Z) slag

Bonus Answer: Y

19. CHEMISTRY

Writer: Jason Weng

Toss Up: Short Answer

What is the oxidation number of chromium in the dichromate ion?

Bonus Answer: +6

Bonus: Short Answer

Name the following: CuCr_2O_7 .

Bonus Answer: Copper (II) dichromate; or Cupric dichromate

20. CHEMISTRY

Writer: Jason Weng

Toss Up: Multiple Choice

What is the most reasonable pH of the solution when the salt formed by reacting hydrochloric acid and aluminum hydroxide is dissolved in water?

- W) 7
- X) 4
- Y) 10
- Z) 0

Toss Up Answer: X

Bonus: Short Answer

125 mL from a 4M perchloric acid stock solution is reacted with excess sodium hydroxide. How many moles of the salt are formed if the system is 50% efficient?

Bonus Answer: 0.25 mol; 1/4 mol

21. CHEMISTRY

Writer: Jason Weng

Toss Up: Short Answer

How many hydrogen atoms does a molecule of acetone have?

Bonus Answer: 6

Bonus: Short Answer

What is the electron configuration of Cr^{3+} using noble gas notation?

Bonus Answer: [Ar]3d³

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22. CHEMISTRY

Writer: Calvin Vuong

Toss Up: Multiple Choice

The relation between pressure and temperature of two ideal gases is stated in

W) Gay-Lussac's Law

X) Boyle's Law

Y) Charles's Law

Z) Avogadro's Law

Toss Up Answer: W

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Bonus: Short Answer

What are the dimensions of the gas constant R in SI base units?

Bonus Answer: kg m² mol⁻¹ K⁻¹ s⁻² (accept as a fraction)

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23. EARTH and SPACE

Writer: Andrew Chen

Toss Up: Multiple Choice

How many comet-like bodies are estimated to exist in the Oort cloud?

W) a billion

X) a trillion

Y) a quadrillion

Z) a quintillion

Toss Up Answer: X

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Bonus: Short Answer

What is the name of the telescope which has produced the most scientific papers out of all telescopes on the ground, located in the Atacama desert?

Bonus Answer: Very Large Telescope

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24. EARTH and SPACE

Writer: Andrew Chen

Toss Up: Short Answer

What compound are most cave stalagmites and stalactites made of?

Bonus Answer: Calcium Carbonate, CaCO₃, limestone, calcite, dolomite, marble, chalk, etc.

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Bonus: Multiple Choice

Why do many rivers around the world meander when a straight path would be shorter?

W) curves create eddies, which are more stable configurations

X) a slight curve has faster moving water on the outside, which further erodes and enlargens the curve

Y) there are slightly elevated regions that prevent a straight path

Z) random drift

Bonus Answer: X

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25. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

Which planet has the slowest rotation?

Bonus Answer: Venus

Bonus: Multiple Choice

Which planet has the fastest rotation?

W) Jupiter

X) Saturn

Y) Uranus

Z) Neptune

Bonus Answer: W
