

## Round 21

### 1. PHYSICS

Writer: Elias Milborn

Toss Up: Short Answer

A train moving 35 meters per second emits a whistle with a frequency of 900 hertz. Assuming that the speed of sound in air is 350 meters per second, what is the frequency, in hertz, measured by a stationary observer in front of the train?

Bonus Answer: 1000

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Bonus: Multiple Choice

Which of the following has the highest vapor pressure at STP?

W) mercury

X) ethyl alcohol

Y) methyl alcohol

Z) acetone

Bonus Answer: Z

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### 2. CHEMISTRY

Writer: Andrew Chen (Senior)

Toss Up: Multiple Choice

In the following redox reaction:  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$  which compound is the oxidizing agent?

W)  $\text{O}_2$

X)  $\text{CH}_4$

Y)  $\text{CO}_2$

Z)  $\text{H}_2\text{O}$

Toss Up Answer: W

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Bonus: Short Answer

Given the organic molecule  $\text{C}_6\text{H}_{14}$  how many different structural isomers can be formed?

Bonus Answer: Five

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### 3. BIOLOGY

Writer: Yae June Lee

Toss Up: Short Answer

How many turns in the Calvin Cycle can it produce one PGAL molecule?

Bonus Answer: 2

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Bonus: Short Answer

What diffuses through the ATP synthases in the process of photosynthesis?

Bonus Answer: Hydrogen ions/protons. The protons in the thylakoids membrane is diffused out by the process of chemiosmosis.

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### 4. CHEMISTRY

Writer: Olivia Gallager

Toss Up: Short Answer

For E2 reactions to occur, the Hydrogen has to be what to the leaving group?

Bonus Answer: antiperiplanar

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Bonus: Short Answer

List the following formations in order of lowest stability to highest: Trans, Geminal, Cis

**Bonus Answer: cis, geminal, trans**

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## 5. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Acetone has a distinct smell, which many people associate with the smell of nail polish remover. What might the smell of acetone in the urine or on the breath of a patient indicate?

- W) The patient might be degrading too many amino acids from muscle proteolysis.
- X) The patient's body might be oxidizing too many fatty acids.
- Y) The patient might have enteritis and is absorbing endproducts of fermentation.
- Z) The patient might have fructose toxicity.

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Which description best describes what would happen to the carbon cycle if all detritivores suddenly went on "strike" and stopped working?

- W) Carbon would increase in inorganic mass, while the atmospheric reservoir of carbon would continue to increase and plants would not be jeopardized.
- X) Carbon would accumulate in organic mass, the atmospheric reservoir of carbon would decline, and plants would eventually be starved for CO<sub>2</sub>.
- Y) Carbon would increase in organic mass, while the atmospheric reservoir of carbon would increase and plant-life would be starved for CO<sub>2</sub>.
- Z) Carbon would decrease in organic mass, while the atmospheric reservoir of carbon would increase with the result that plant-life would be starved for CO<sub>2</sub>.

**Bonus Answer: X**

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## 6. EARTH and SPACE

**Writer: Benjamin Avrahami**

**Toss Up: Short Answer**

From least to greatest, order these minerals in order of pressure needed to create it: Schist, Phyllite, Gneiss, Slate

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

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**Bonus: Short Answer**

During what era did oxygen begin to enter the atmosphere in abundance?

**Bonus Answer: Early Proterozoic or Proterozoic**

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## 7. BIOLOGY

**Writer: Eric Chau**

**Toss Up: Short Answer**

Which scientist studied pea plants for years to conclude a pattern was in the height?

**Bonus Answer: Gregor Mendel.**

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**Bonus: Short Answer**

How is radiation harmful?

**Bonus Answer: It causes cells to mutate, or spontaneously die.**

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## 8. EARTH and SPACE

**Writer: Benjamin Avrahami**

**Toss Up: Multiple Choice**

At above what size does a rock need to be in order to be a boulder?

W) 15.3

X) 25.6

Y) 40.2

Z) 22.9

**Toss Up Answer: X**

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**Bonus: Short Answer**

At which two zones of Earth's atmosphere does the temperature rise as the altitude increases?

**Bonus Answer: Stratosphere and Thermosphere**

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## 9. MATHEMATICS

**Writer: Benjamin Avrahami**

**Toss Up: Short Answer**

In simplest form, express the surface area to volume ratio of a cube with side length  $s$ .

**Bonus Answer:  $6:s$**

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**Bonus: Short Answer**

Calculate the harmonic mean of the first two perfect numbers and 10.

**Bonus Answer:  $4 * \sqrt{105}$**

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## 10. EARTH and SPACE

**Writer: Olivia Gallager**

**Toss Up: Short Answer**

How many planets in our solar system have moons?

**Bonus Answer: 6**

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**Bonus: Short Answer**

What layer of the atmosphere lies between the troposphere and mesosphere?

**Bonus Answer: Stratosphere**

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## 11. BIOLOGY

**Writer: Eric Shau**

**Toss Up: Short Answer**

Which cell does HIV attack?

**Bonus Answer: The C4 Cells.**

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**Bonus: Short Answer**

What is the optimal pH for pepsin?

**Bonus Answer: Around 2-3 pH.**

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## 12. PHYSICS

**Writer: Yevgeniy Gorbachev**

**Toss Up: Short Answer**

Given a fuel flow rate of 5 kg/s and a thrust of 20 kN, what is the exhaust velocity of the thruster? Assume standard gravity to be  $10 \text{ m/s}^2$ .

**Bonus Answer: 4 km/s (also acceptable: 4000 m/s)**

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**Bonus: Short Answer**

If one of the engines of a single stage has a specific impulse of 40 seconds and a fuel flow rate of 2 kg/s, and the other engine has a specific impulse of 100 seconds and a fuel flow rate of 10 kg/s, what is the total thrust of the stage? Assume standard gravity to be 10 m/s<sup>2</sup>.

**Bonus Answer: 10800 N**

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**13. CHEMISTRY**

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

Which element breaks the octet rule?

W) Ga

X) Xe

Y) Cu

Z) F

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the empirical formula of C<sub>6</sub>H<sub>11</sub>?

**Bonus Answer: C<sub>6</sub>H<sub>11</sub>**

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**14. PHYSICS**

**Writer: Prangon Ghose**

**Toss Up: Short Answer**

A rock is thrown downward from the top of a tower with an initial speed of 12 m/s. If the rock hits the ground after 2 s, what is the speed of the rock as it hits the ground if air resistance is negligible to the nearest whole number?

**Bonus Answer: 32 m/s**

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**Bonus: Short Answer**

Human reaction time is usually greater 0.10 s. If someone holds a ruler between your finger and thumb and releases it without warning, how far can you expect the ruler to fall before you catch in cm to the 10th place?

**Bonus Answer: 4.9 cm**

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**15. BIOLOGY**

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Certain amino acids are considered essential in an animal's diet because they cannot be produced within the organism. Which of the following cellular processes would be most DIRECTLY affected by a dietary deficiency in essential amino acids?

W) Translation of mRNA

X) Cellular respiration

Y) Cell division

Z) Oxygen transport

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Integral transmembrane proteins are proteins embedded in the cell membrane. Which of the following amino acids would you MOST expect to find in the transmembrane region of such proteins?

W) Tryptophan

X) Lysine

Y) Arginine

Z) Serine

**Bonus Answer: W**

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## 16. PHYSICS

**Writer: Prangon Ghose**

**Toss Up: Short Answer**

A sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 90 km/hr in 8s. What is the acceleration of the car in  $\text{m/s}^2$  to the nearest whole number?

**Bonus Answer: 3  $\text{m/s}^2$**

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**Bonus: Short Answer**

A rock released at rest from the top of a tower hits the ground after falling for 2 s. What is the height of the tower if air resistance is negligible to the nearest whole number?

**Bonus Answer: 20 m**

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## 17. CHEMISTRY

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

Which of the following elements has the highest reflectivity?

W) Gold

X) Silver

Y) Mercury

Z) Gallium

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is Avogadro number to the nearest ten-thousandths?

**Bonus Answer:  $6.0221 \times 10^{23}$**

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## 18. MATHEMATICS

**Writer: Ashneel Das**

**Toss Up: Multiple Choice**

How many roots does the equation  $x^4 + 3x^3 + 2x^2 + 9x + 14 = 0$  have?

W) 1

X) 2

Y) 3

Z) 4

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the limit of  $(1 - 1/n)$  as  $n$  goes to infinity?

**Bonus Answer: 1**

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## 19. CHEMISTRY

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

Which of the following forces is the only force that bonds noble gases?

W) Dipole-Dipole

- X) Ionic
- Y) Covalent
- Z) London Dispersion Forces

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What term is used to describe the energy released by the bonding of gaseous ions to form one mole of a substance?

**Bonus Answer: lattice energy**

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## 20. PHYSICS

**Writer: Prangon Ghose**

**Toss Up: Short Answer**

Just before hitting a nail, a 2 kg hammer is moving at 10 m/s. If the wood exerts a constant 180 N force on the nail, how far does the nail go?

**Bonus Answer: 0.6 m**

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**Bonus: Short Answer**

What is the velocity of a particle after falling 10 m if its initial velocity is 10 m/s?

**Bonus Answer: 10rad(3) m/s**

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## 21. BIOLOGY

**Writer: Eric Shau**

**Toss Up: Short Answer**

What type of pathogen causes malaria?

**Bonus Answer: Parasites (or protists).**

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**Bonus: Short Answer**

When specialization is starting in the fetus, what three layers are formed (inner to outer)?

**Bonus Answer: Endoderm, Mesoderm, Ectoderm**

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## 22. MATHEMATICS

**Writer: Andrew Chen (Senior)**

**Toss Up: Short Answer**

A square is inscribed within a circle with a radius of 2.5 cm. To the nearest tenths place what is the area of the square?

**Bonus Answer: 12.5 cm<sup>2</sup>**

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**Bonus: Multiple Choice**

Given the parabola  $y=4x^2+2x-10$  what is the equation of the line tangent to it at the point (0,-10)?

W)  $y=2x+10$

X)  $y=2x-5$

Y)  $y=5x-8$

Z)  $y=2x-10$

**Bonus Answer: Z**

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## 23. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Concerning the generation of ATP by oxidative phosphorylation, all of the following are true EXCEPT:

- W) NADH produced in the cytosol of the cell will generate approximately 2.5 ATPs.
- X) NADH produced in the mitochondria will generate approximately 2.5 ATPs.
- Y) NADH produced by the succinate thiokinase reaction will generate approximately 1.5 GTPs.
- Z) FADH<sub>2</sub> produced in the mitochondria will generate approximately 1.5 ATPs.

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

What enzyme does a retrovirus primarily rely on to create a copy of its genome that is ready for integration into the host genome?

- W) DNA gyrase
- X) RNA polymerase
- Y) Reverse transcriptase
- Z) DNA polymerase

**Bonus Answer: Y**

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## 24. MATHEMATICS

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

A function with the zero  $1 + 23i$  must have a multiplicity of at least?

- W) 1
- X) 23
- Y) 4
- Z) 2

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Find the zeros of the function:  $0 = x^4 - 81$

**Bonus Answer:  $3i$ ,  $-3i$ ,  $3$ ,  $-3$**

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## 25. BIOLOGY

**Writer: Eric Chau**

**Toss Up: Short Answer**

What phylum are jellyfish in?

**Bonus Answer: Cnidaria.**

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**Bonus: Short Answer**

What order are humans in?

**Bonus Answer: Primates.**

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