

## Round 22

### 1. CHEMISTRY

Writer: Aaron Gee

Toss Up: Multiple Choice

Which of the following is NOT a colligative property?

- W) vapor pressure
- X) osmotic pressure
- Y) boiling point elevation
- Z) color fo solution

Toss Up Answer: Z

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Bonus: Multiple Choice

Which of the following is a type of colloid that is classified as a sol at room temperature?

- W) gelatin
- X) milk
- Y) whipped cream
- Z) marshmallow

Bonus Answer: W

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### 2. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Which of the following minerals has the highest number on the Mohs hardness scale?

- W) Apatite
- X) Fluorite
- Y) Quartz
- Z) Orthoclase

Toss Up Answer: Y

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Bonus: Short Answer

What are the three most abundant elements in Earth's crust?

Bonus Answer: Oxygen, Silicon, Aluminum

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### 3. CHEMISTRY

Writer: Mohammed Jamil

Toss Up: Multiple Choice

What suggests that metal, M, is not in Group I of the Periodic Table?

- W) M has a bright, silvery appearance and is a good conductor of electricity.
- X) M is hard and difficult to cut
- Y) M produces an alkaline solution when it reacts with water.
- Z) M produces hydrogen gas when it reacts with water.

Toss Up Answer: X

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Bonus: Multiple Choice

Lactic acid,  $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$ , causes pain when it builds up in muscles.

Which reagent reacts with both of the  $-\text{OH}$  groups in lactic acid?

- W) acidified potassium dichromate(VI)
- X) ethanol
- Y) sodium
- Z) sodium hydroxide

**Bonus Answer: Y**

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#### 4. EARTH and SPACE

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What are lines on a topographic map that connect points at the same elevation called?

**Bonus Answer: Contour lines**

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**Bonus: Multiple Choice**

In which state is the most bituminous coal produced?

- W) Kentucky
- X) Pennsylvania
- Y) Wyoming
- Z) West Virginia

**Bonus Answer: Z**

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#### 5. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

How many molecules of carbon dioxide are produced per turn of the Krebs cycle?

**Bonus Answer: 2**

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**Bonus: Multiple Choice**

A molecule of carbon dioxide is released in the Krebs cycle during the oxidation of which molecule?

- W) citrate
- X) succinyl CoA
- Y) malate
- Z) alpha-Ketoglutarate

**Bonus Answer: Z**

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#### 6. EARTH and SPACE

**Writer: Benjamin Avrahami**

**Toss Up: Multiple Choice**

Which of these is not equivalent to Euclid's parallel postulate?

- W) There exist 2 triangles which are similar but not congruent
- X) The Pythagorean Theorem
- Y) The interior angles of a quadrilateral add up to 360 degrees
- Z) The exterior angles of a polygon add up to 360 degrees

**Toss Up Answer: Z**

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**Bonus: Short Answer**

If there are two strings that are a fifth apart in pitch, what is the ratio of their lengths?

**Bonus Answer: 2:3 or 3:2**

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## 7. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Why are carbohydrates and fats considered high energy foods?

- W) They have a lot of oxygen atoms.
- X) They can have very long carbon skeletons.
- Y) They have a lot of electrons associated with hydrogen.
- Z) They are easily reduced.

Toss Up Answer: Y

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Bonus: Multiple Choice

Substrate-level phosphorylation accounts for approximately what percentage of the ATP formed by the reactions of glycolysis?

- W) 0
- X) 2
- Y) 10
- Z) 100

Bonus Answer: Z

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## 8. PHYSICS

Writer: Nicholas Adit

Toss Up: Short Answer

The mean distance from Saturn to the sun is 9 times greater than the mean distance from Earth to the sun. How long is a Saturn year?

Bonus Answer: 27 Earth years

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Bonus: Short Answer

An object moves at constant speed in a circular path. True statements about the motion include which of the following?

- I. The velocity is constant.
- II. The acceleration is constant.
- III. The net force on the object is zero since its speed is constant.

Bonus Answer: None of them (The vectors are changing)

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## 9. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

The majority of ATP molecules generated from cellular respiration comes from which process?

- W) glycolysis
- X) pyruvate oxidation
- Y) the Krebs cycle
- Z) chemiosmosis

Toss Up Answer: Z

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Bonus: Short Answer

How many ATP molecules on average does chemiosmosis produce per glucose?

Bonus Answer: Accept: 26, 28, or both.

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## 10. CHEMISTRY

Writer: Mohammed Jamil

Toss Up: Short Answer

What is the chemical equation(s) for the reversible reaction(s) in the contact process

Bonus Answer:  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$

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Bonus: Multiple Choice

Which set of conditions would promote the fastest rate for the converter reaction in the contact process?

W) No catalyst, high pressure, low temperature. Catalyst, high pressure, high temperature. Catalyst, low pressure, low temperature. Catalyst, low pressure, high temperature.

X) Catalyst, high pressure, high temperature.

Y) Catalyst, low pressure, low temperature

Z) No catalyst, high pressure, low temperature. Catalyst, high pressure, high temperature. Catalyst, low pressure, low temperature. Catalyst, low pressure, high temperature.

Bonus Answer: X

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## 11. PHYSICS

Writer: Nicholas Adit

Toss Up: Multiple Choice

A sphere of charge +Q is fixed in position. A smaller sphere of charge +q is placed near the larger sphere and released from rest. The small sphere will move away from the large sphere with

W) decreasing velocity and acceleration

X) decreasing velocity and increasing acceleration.

Y) increasing velocity and decreasing acceleration.

Z) increasing velocity and increasing acceleration.

Toss Up Answer: Y

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Bonus: Short Answer

If the distance between two positive point charges is tripled, then the strength of the electrostatic repulsion between them will decrease by a factor of

Bonus Answer: 9

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## 12. CHEMISTRY

Writer: Hanna Yang

Toss Up: Short Answer

What characteristic of water causes its temperature to change slowly in response to the environment?

Bonus Answer: High Specific Heat

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Bonus: Short Answer

What is the most abundant molecule in the human body?

Bonus Answer: Water

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## 13. PHYSICS

Writer: Nicholas Adit

Toss Up: Multiple Choice

Negative charges are accelerated by electric fields toward points

W) at lower electric potentials

X) at higher electric potentials

- Y) where the electric field is weaker
- Z) where the electric field is stronger

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

The potential at point A in an electric field is 10V higher than at point B. If a negative charge,  $q = -2 \text{ C}$ , is moved from point A to point B, then the potential energy of this charge will

- W) decrease by 20 J
- X) decrease by 5 J
- Y) increase by 5 J
- Z) increase by 20 J

**Bonus Answer: Z**

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## 14. MATHEMATICS

**Writer: Aaron Gee**

**Toss Up: Short Answer**

Subtract the following complex numbers, giving your answer in standard form:  $(11 - 4i) - (-3 + 3i)$

**Bonus Answer:  $12 - 7i$**

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**Bonus: Short Answer**

Solve the following inequality for  $x$ , giving your answer in fractional form,  $\frac{1}{3}x + \frac{2}{3}$  is less than  $\frac{5}{6}x - 2$ .

**Bonus Answer:  $x$  is greater than  $\frac{16}{3}$**

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## 15. PHYSICS

**Writer: Nicholas Adit**

**Toss Up: Multiple Choice**

For an ohmic conductor, doubling the voltage without changing the resistance will cause the current to

- W) decrease by a factor of 2
- X) decrease by a factor of 4
- Y) increase by a factor of 4
- Z) increase by a factor of 2

**Toss Up Answer: Z**

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**Bonus: Short Answer**

If a 60-watt lightbulb operates at a voltage of 120 V, what is the resistance of the bulb?

**Bonus Answer: 240 ohms**

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## 16. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Multiple Choice**

The majority of photosynthesis occurs in which part of the leaf?

- W) the veins
- X) the lower paliside layer
- Y) the upper paliside layer
- Z) the stomata

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What is the final electron receptor in photosynthetic light reactions?

**Bonus Answer: NADP+ (Accept: NADPH)**

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**17. MATHEMATICS**

**Writer: Aaron Gee**

**Toss Up: Short Answer**

If you roll 2 fair dice simultaneously, what is the probability, given as a fraction, that you will roll the number 6 on AT LEAST one die?

**Bonus Answer: 11/36**

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**Bonus: Short Answer**

Find the sum of all interior angles, in degrees, in a regular polygon having 14 sides

**Bonus Answer: 2160 degrees**

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**18. BIOLOGY**

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

The kinases that perform cellular activities throughout the cell cycle are allosterically regulated by what molecules?

**Bonus Answer: cyclins**

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**Bonus: Multiple Choice**

Synapsis begins during which stage of prophase I?

- W) leptotene
- X) zygotene
- Y) diplotene
- Z) diakinesis

**Bonus Answer: X**

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**19. PHYSICS**

**Writer: Nicholas Adit**

**Toss Up: Multiple Choice**

A charge of mass  $m$  and charge  $q$  is moving in a circle of radius  $r$  and speed  $v$  due to a uniform magnetic field  $B$ . If the speed is doubled to  $2v$ , what happens to the period,  $T$ ?

- W)  $T$  increases by a factor of 2
- X)  $T$  increases by a factor of 4
- Y)  $T$  stays the same
- Z)  $T$  decreases by a factor of 2

**Toss Up Answer: Y**

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**Bonus: Short Answer**

A particle of charge  $-0.04\text{ C}$  is projected with speed  $2 \times 10^4\text{ m/s}$  into a uniform magnetic field,  $B$ , of strength  $0.5\text{ T}$ . If the particle's velocity as it enters the field is perpendicular to  $B$ , what is the magnitude of the magnetic force on this particle?

**Bonus Answer: 400 N**

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**20. CHEMISTRY**

**Writer:** Hanna Yang

**Toss Up:** Short Answer

Name the polyatomic ion with formula  $\text{SO}_4^{2-}$

**Bonus Answer:** Sulfate

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**Bonus:** Multiple Choice

Which of the following is a base?

W)  $\text{C}_6\text{H}_{12}\text{O}_6$

X)  $\text{NaOH}$

Y)  $\text{HCl}$

Z)  $\text{PO}_4$

**Bonus Answer:** X

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## 21. PHYSICS

**Writer:** Nicholas Adit

**Toss Up:** Multiple Choice

What is the wavelength of a 5 Hz wave that travels with a speed of 10 m/s ?

W) 0.25 m

X) 0.5 m

Y) 1 m

Z) 2 m

**Toss Up Answer:** Z

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**Bonus:** Short Answer

A string, fixed at both ends, supports a standing wave with a total of 4 nodes. If the length of the string is 6 m, what is the wavelength of the wave?

**Bonus Answer:** 4 m

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## 22. MATHEMATICS

**Writer:** Aaron Gee

**Toss Up:** Short Answer

What function is the inverse of  $y = 3x + 4$ ?

**Bonus Answer:**  $y = x - \frac{4}{3}$

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**Bonus:** Short Answer

Giving your answer as an ordered pair, find the solution of the system of the following 2 equations:  $2x + 3y = 8$ , and  $3x - 2y = -1$

**Bonus Answer:** (1,2)

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## 23. BIOLOGY

**Writer:** Calvin Vuong

**Toss Up:** Short Answer

What cytoskeletal component forms the cleavage furrow during cytokinesis?

**Bonus Answer:** Microfilaments (Accept: actin)

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**Bonus:** Short Answer

Microtubules are composed of what subunits?

**Bonus Answer:** tubulin (accept: alpha and beta tubulin dimers)

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## 24. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Motor proteins transport vesicles along which cytoskeletal fiber?

Bonus Answer: microtubules

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Bonus: Short Answer

Shape abnormalities of the nuclear lamina are most likely a result of a defect in which cytoskeletal structure?

Bonus Answer: intermediate filaments

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## 25. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which transmembrane structures are responsible for communicating signals between the extracellular matrix and the internal microfilament cytoskeleton?

W) integrins

X) fibronectins

Y) proteoglycan complexes

Z) plasmodesmata

Toss Up Answer: W

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Bonus: Multiple Choice

The plasmodesmata of plant cells are most similar to which animal cell structure?

W) the plasma membrane

X) desmosomes

Y) gap junctions

Z) desmotubules

Bonus Answer: Y

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