

## Round 8

### 1. PHYSICS

Writer: Brian Lim

Toss Up: Multiple Choice

What type of light cannot be given off by a laser?

W) ultraviolet

X) red

Y) green

Z) white

Toss Up Answer: Z

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Bonus: Short Answer

What is the term for the radiation of a perfectly opaque and non-reflective body?

Bonus Answer: blackbody radiation

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### 2. PHYSICS

Writer: Brian Lim

Toss Up: Multiple Choice

What best describes the index of refraction of air?

W) it is slightly greater than 0

X) it is slightly less than 0

Y) it is slightly greater than 1

Z) it is slightly less than 1

Toss Up Answer: Y

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Bonus: Short Answer

the speed of light in a particular medium is  $2.0 \times 10^8$  m/s. What is the index of refraction of the medium?

Bonus Answer: 1.5

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### 3. PHYSICS

Writer: Brian Lim

Toss Up: Multiple Choice

An object travels through a fluid. What is the relationship between drag force and speed?

W) linear relationship

X) square relationship

Y) exponential relationship

Z) no relationship

Toss Up Answer: X

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Bonus: Multiple Choice

A person holding a heavy ball with outstretched arms spins in place while sitting in a chair. The person brings the ball closer. What happens to the angular velocity of the person?

W) it increases

X) it decreases

Y) it stays constant

Z) it increases and then decreases

Bonus Answer: W

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## 4. PHYSICS

Writer: Brian Lim

Toss Up: Multiple Choice

For a solid sphere rotating about its center whose mass is uniformly distributed, what expression is equivalent to the moment of inertia?

- W)  $mr^2$
- X)  $\frac{1}{2}mr^2$
- Y)  $\frac{2}{3}mr^2$
- Z)  $\frac{2}{5}mr^2$

Toss Up Answer: Z

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Bonus: Multiple Choice

For a rod with uniformly distributed mass, what is the ratio between the moment of the inertia about its center to the moment of inertia about one of its ends?

- W)  $\frac{1}{4}$
- X)  $\frac{1}{2}$
- Y) 2
- Z) 4

Bonus Answer: W

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## 5. PHYSICS

Writer: Brian Lim

Toss Up: Short Answer

What is the term for the conditions at which a substance begins behaving like a supercritical fluid?

Bonus Answer: critical point

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Bonus: Multiple Choice

What property can be used to determine the amount of energy of a photon?

- W) speed
- X) direction
- Y) polarization
- Z) frequency

Bonus Answer: Z

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## 6. MATHEMATICS

Writer: Benjamin Avrahami

Toss Up: Short Answer

If the capstone is taken off the Great Pyramid of Giza, then it is no longer a pyramid but a what?

Bonus Answer: A frustum

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Bonus: Multiple Choice

Which one of these is Euclid's parallel postulate?

- W) If a line intersects one of two parallel lines, both of which are coplanar with the original line, then it will also intersect with the other line.
- X) If a line segment intersects two straight lines forming two interior angles on the same side that sum to less than two right angles, then the two lines, if extended indefinitely, meet on the side on which the angles sum to less than two right angles.

Y) In a plane, given a line and a point not on it, exactly one line parallel to the given line can be drawn through the point.

Z) For any acute angle A and any point D in the interior of angle A, there exists a line through D and not through A which intersects both sides of angle A.

**Bonus Answer: X**

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## 7. MATHEMATICS

**Writer: Benjamin Avrahami**

**Toss Up: Short Answer**

What is the volume of a hole 2 meters by 2 meters by 2 meters after 1 cubic meter of dirt has been added to it?

**Bonus Answer: 1 cubic meter**

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**Bonus: Multiple Choice**

Avogadro's number is approximately  $6.022 \times 10^{\text{what power}}$

W) -23

X) -11

Y) 11

Z) 23

**Bonus Answer: Z**

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## 8. MATHEMATICS

**Writer: Andrew Chen**

**Toss Up: Short Answer**

How many zeros are at the end of the number 25 factorial?

**Bonus Answer: 6**

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**Bonus: Short Answer**

What is the largest amount of money one can have, in cents, without being able to make change for a dollar? Half dollars don't count.

**Bonus Answer: 119**

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## 9. MATHEMATICS

**Writer: Andrew Chen**

**Toss Up: Short Answer**

What is the area of the ellipse given by the formula  $x^2 + \frac{1}{4}y^2 = 1$ ?

**Bonus Answer:  $2\pi$**

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**Bonus: Short Answer**

How many faces does the dual polyhedron of the octahedron have?

**Bonus Answer: 6**

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## 10. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Using accelerator mass spectrometry, the  $^{14}\text{C}$  atoms in a 2 mg bone fragment were directly counted and found to be  $\frac{1}{8}$  of those that would be present in a 2 mg bone fragment in 1950. What is the approximate age of this specimen?

- W) 1,540 years
- X) B. 5,730 years
- Y) C. 17,190 years
- Z) D. 22,920 years

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Positive cooperativity is an emergent property of what type of enzymatic regulatory mechanism?

- W) Allosteric interactions.
- X) Cellular compartmentalization.
- Y) Genetic regulatory mechanisms.
- Z) Second messenger systems.

**Bonus Answer: W**

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## 11. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Select the description that most correctly describes the term recessive:

- W) A weak phenotype.
- X) An allele that confers a weak phenotype.
- Y) A phenotype conferred when only one copy of an allele is present.
- Z) A phenotype conferred when two copies of an allele are present.

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Which of the following interactions is most responsible for the structural stability of soluble globular proteins?

- W) Dipole-dipole interactions.
- X) Electrostatic interactions.
- Y) Hydrogen bonds.
- Z) The Hydrophobic Effect.

**Bonus Answer: Z**

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## 12. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

The majority of proteins exist as homo-oligomers rather than hetero-oligomers. Which of the following is not a reason that quaternary structures are homo-oligomers?

- W) Aggregation of identical subunits gives rise to symmetry and possible allosteric interactions.
- X) A slow post-translational process favors a quaternary structure with the homo-oligomers held together by covalent bonds.
- Y) Homodimers may increase binding specificity and stability.
- Z) Homo-oligomerization results in a genetic savings with lower energy demand.

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Which of the following is not an action of epinephrine or norepinephrine?

- W) Glycogen broken down to glucose.
- X) Increased gastric motility and secretion.
- Y) Increased blood pressure.
- Z) Increased salivation.

**Bonus Answer: X**

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**13. BIOLOGY**

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

If active transport is inhibited, the passive sodium and potassium ion fluxes across the plasma membrane are still coupled. What makes these two passive ion fluxes dependent on each other?

- W) The membrane potential.
- X) The potassium channels.
- Y) The ratio of cholesterol to phospholipids in the membrane.
- Z) The pumping ratio of the Na<sup>+</sup>/K<sup>+</sup> ATPase.

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

If a carboxylic acid has a pKa of 3.9, what percentage of the functional group will carry a negative charge at pH 4.9?

- W) 10%
- X) 90.90%
- Y) 9.09%
- Z) 50%

**Bonus Answer: X**

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**14. BIOLOGY**

**Writer: Josh Tish**

**Toss Up: Short Answer**

During the late Carboniferous period, terrestrial arthropods such as Hexapoda, Myriapoda, and Arachnida showed great diversity in form and size. Why are modern day arthropods are much smaller than their Carboniferous ancestors?

**Bonus Answer: decreased volume of oxygen in the atmosphere in modern times versus comparatively higher volume of oxygen present during Carboniferous Era**

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**Bonus: Short Answer**

Arrange the following five events in the order that explains the bulk flow of substances in the phloem.

1. Sugar moves down the stem.
2. Leaf cells produce sugar by photosynthesis.

3. Sugar is transported from cell to cell via the apoplast and/or symplast.
4. Solutes are actively transported into sieve elements.
5. Water diffuses into the sieve tube elements.

**Bonus Answer: 2,3,4,1,5**

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## 15. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

In plant cells grown in the presence of a metabolic poison that specifically inhibits mitochondrial F1 ATP synthase, one would expect:

- W) the pH difference across the cristae to be greater than normal.
- X) the pH difference across the cristae to be less than normal.
- Y) the electron transport chain to become inoperative.
- Z) oxygen consumption to cease.

**Toss Up Answer: W**

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**Bonus: Short Answer**

With proofreading, what is approximately the error rate of DNA polymerase?

**Bonus Answer: One error in every  $10^9$  bases.**

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## 16. BIOLOGY

**Writer: Jason Weng**

**Toss Up: Short Answer**

The group of cells that break down bone cells are collectively called as what?

**Bonus Answer: Osteoclast**

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**Bonus: Short Answer**

What class of immunoglobulins are present in tears, saliva, etc?

**Bonus Answer: IGA**

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## 17. BIOLOGY

**Writer: Jason Weng**

**Toss Up: Short Answer**

What type of circulation is between the heart and the lungs?

**Bonus Answer: Pulmonary circulation**

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**Bonus: Short Answer**

As what form of ion does carbon dioxide travel as in the blood?

**Bonus Answer: Bicarbonate ion ( $\text{HCO}_3^-$ )**

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## 18. CHEMISTRY

**Writer: Nten Nylam**

**Toss Up: Multiple Choice**

Which of the following is true regarding activation energy?

- W) Activation energy is dependent on the pressure of a system
- X) Catalysts increase the activation energy of a reaction
- Y) The reaction rate decreases as the activation energy increases
- Z) If the activation energy of the forward reaction is greater than that of the reverse reaction then the reaction is exothermic

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What types of covalent bonds are present in CH<sub>2</sub>O?

**Bonus Answer: Single and double covalent bonds**

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## 19. CHEMISTRY

**Writer: Larry Wong**

**Toss Up: Multiple Choice**

A Geiger-Muller tube is a  
W) gas ionization detector  
X) cloud chamber  
Y) fluorescence detector  
Z) spectrophotometer

**Toss Up Answer: W**

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**Bonus: Short Answer**

The principle that states: If you disturb a system at equilibrium, the equilibrium moves in the direction that tends to reduce the disturbance is called?

**Bonus Answer: Le Chatelier's Principle**

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## 20. CHEMISTRY

**Writer: Larry Wong**

**Toss Up: Multiple Choice**

Which alcohol will most easily react with HCl to form an alkyl halide?

W) Primary alcohol  
X) Secondary alcohol  
Y) Tertiary alcohol  
Z) Quaternary alcohol

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

The mass defect for an isotope was found to be 0.410 amu/atom. Calculate the binding energy in kJ/mol of atoms.

W)  $3.69 \times 10^{10}$  kJ/mol  
X)  $1.23 \times 10^{20}$  kJ/mol  
Y)  $3.69 \times 10^{13}$  kJ/mol  
Z)  $1.23 \times 10^3$  kJ/mol

**Bonus Answer: W**

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## 21. CHEMISTRY

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

Which of the following element is not a newly named (as of November 2016) element?

W) nihonium  
X) paostinism  
Y) moscovium  
Z) tennessine

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Who reorganized the periodic table based on atomic number?

- W) Mendeleev
- X) Moseley
- Y) Pablo
- Z) Escobar

**Bonus Answer: X**

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**22. CHEMISTRY**

**Writer: Ivan Zhang**

**Toss Up: Short Answer**

What is the name given to the point at which a substance can exist in all 3 phases of matter?

**Bonus Answer: Triple Point**

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**Bonus: Short Answer**

What is the name given to group 16 elements?

**Bonus Answer: Chalcogens**

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**23. EARTH and SPACE**

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What is the most common galaxy shape in our universe?

**Bonus Answer: irregular**

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**Bonus: Multiple Choice**

Astronomers use cepheids principally as measures of what?

- W) size
- X) speed
- Y) chemical composition
- Z) distance

**Bonus Answer: Z**

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**24. EARTH and SPACE**

**Writer: Banpreet Singh**

**Toss Up: Short Answer**

What scientist first predicted the existence of black holes in 1916?

**Bonus Answer: Albert Einstein**

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**Bonus: Short Answer**

What probe was launched in 2011 to study Jupiter?

**Bonus Answer: The Juno probe**

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**25. EARTH and SPACE**

**Writer: Shamaul Dilmohamed**

**Toss Up: Multiple Choice**

Which of the following elements is found in the earth's crust as both



a native element and as a compound?

W) argon

X) copper

Y) chlorine

Z) silicon

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

In geological studies, cemented volcanic ash is called:

W) caldera

X) a-a

Y) lava

Z) tuff

**Bonus Answer: Z**

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