

## Round 17

### 1. PHYSICS

Writer: Aaron Gee

Toss Up: Multiple Choice

The process in which an atom reradiates a photon after interacting with an incident photon of the same energy is called:

- W) Cooleo Theorem
- X) the Cherenkov effect
- Y) Bragg's Law
- Z) Thomson scattering

Toss Up Answer: Z

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Bonus: Multiple Choice

A protanomalous person has decreased sensitivity of the red cones in his or her eyes. Which of the following color pairs will this person have difficulty distinguishing between:

- W) black and yellow
- X) blue green
- Y) purple blue
- Z) red and yellow

Bonus Answer: Y

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### 2. CHEMISTRY

Writer: Jason Mohabir

Toss Up: Multiple Choice

The Standard Gibb's free energy,  $\Delta G^\circ$ , is

- W) the residual energy present in the reactants at equilibrium
- X) the residual energy present in the products at equilibrium
- Y) the energy required to convert one mole of reactants to one mole of products
- Z) the difference in the residual energy of reactants and products at equilibrium

Toss Up Answer: X

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Bonus: Multiple Choice

If the enthalpy change for a reaction is zero,  $\Delta G^\circ$  is equal to

- W)  $T\Delta S^\circ$
- X)  $-T\Delta S^\circ$
- Y)  $-\Delta H^\circ$
- Z)  $\ln K_{eq}$

Bonus Answer: X

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### 3. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

A mutation in the ras gene

- W) immediately leads to cancer
- X) causes the cell to undergo apoptosis
- Y) leads to excessive cell division

Z) DNA breakage

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Ras functions as a G protein associated with what type of receptor?

**Bonus Answer: tyrosine kinase (ACCEPT: receptor tyrosine kinase)**

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## 4. CHEMISTRY

**Writer: Nicholas Adit**

**Toss Up: Multiple Choice**

What is the fourth most abundant element on Earth?

W) Oxygen

X) Carbon

Y) Sulfur

Z) Argon

**Toss Up Answer: X**

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**Bonus: Short Answer**

What metal forms compounds that give a grayish-white color?

**Bonus Answer: Lead**

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## 5. PHYSICS

**Writer: Jan Wojcik**

**Toss Up: Multiple Choice**

An electron is placed in a horizontally hollow cylindrical solenoid with the current moving clockwise around the solenoid. The electron is released from rest in the middle of the solenoid. What direction will the electron move in?

W) To the left

X) To the right

Y) Stays in the same place

Z) Oscillates between both ends

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

There are two charges, one with charge  $+2Q$  and one with charge  $-4Q$  a distance of 2 meters from each other.

Assuming the universal charge constant is  $1.6 \times 10^{-19}$ , which of the following is the force of attraction felt by the two charges, rounded to one decimal place

W)  $4.8 \times 10^{-19}$  C

X)  $9.6 \times 10^{-19}$  C

Y)  $2.4 \times 10^{-19}$  C

Z)  $3.2 \times 10^{-19}$  C

**Bonus Answer: Z**

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## 6. 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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## 7. MATHEMATICS

**Writer: Ivan Zhang**

**Toss Up: Short Answer**

What are all the rational roots of the polynomial  $y^3 + 10y^2 + 123y + 5$ ?

**Bonus Answer: There are none.**

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**Bonus: Short Answer**

What is the area of a equilateral triangle inscribed in a circle with a radius of 6?

**Bonus Answer:  $(27(\text{radical } 3))$**

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## 8. CHEMISTRY

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

Which of the following is the most acidic?

W) o-methoxy benzoic acid

X) benzoic acid

Y) m-methoxy benzoic acid

Z) p-methoxy benzoic acid

**Toss Up Answer: W**

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**Bonus: Short Answer**

What is the equivalent weight of  $\text{HNO}_3$  in the reaction: Cu reacts with  $\text{HNO}_3$  , forming  $\text{Cu}(\text{NO}_3)_2$  , NO and water.

**Bonus Answer: 84**

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## 9. PHYSICS

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

The driver of a car moving at a speed of 10 m/s sees a child and immediately applies brakes to bring the car to rest in 150 meters. If the combined mass of the car and the driver is 1200 kg, the magnitude of the retarding force on the vehicle is:

W) 300 N

X) 350 N

Y) 400 N

Z) 450 N

**Toss Up Answer: Y**

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**Bonus: Short Answer**

A body is projected upwards with twice the escape velocity on Earth, 11.2 km/s. Ignoring the presence of other heavenly bodies, what is the speed of the body at infinity? Give your answer in km/s rounded to one decimal point.

**Bonus Answer: 19.4 km/s**

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**10. CHEMISTRY**

**Writer: Olivia Gallager**

**Toss Up: Multiple Choice**

Which of the following has a coordinate covalent bond?

W) butanol

X) CO<sub>2</sub>

Y) Methane

Z) NH<sub>4</sub><sup>+</sup>

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the formal charge of Nitrogen in an ammonia molecule?

**Bonus Answer: 0**

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**11. PHYSICS**

**Writer: Charles Zhang**

**Toss Up: Short Answer**

A 12-N horizontal force is applied to a 40-N box resting on a rough horizontal floor. If the static coefficient of friction is 0.5 and the kinetic coefficient of friction is 0.4, the magnitude of the frictional force on the box is:

**Bonus Answer: 12**

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**Bonus: Multiple Choice**

What is the coefficient of static friction between the ground and the object if it object is moving in a horizontal circle with a speed of 20 m/s around a radius of 50 m? Assume that  $g = 10 \text{ m/s}^2$  (READ AS: meters per second squared)?

W) 0.3

X) 0.5

Y) 0.8

Z) 0.9

**Bonus Answer: Y**

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**12. BIOLOGY**

**Writer: Olivia Gallager**

**Toss Up: Multiple Choice**

Which of the following enzymes makes C<sub>4</sub> and CAM species more efficient in hotter, dryer climates?

W) phosphofructokinase

X) Rubisco

Y) DNA polymerase

Z) PEP Carboxylase

**Toss Up Answer: Z**

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**Bonus: Short Answer**

During the light dependent reactions, on what membrane does ATP synthesis take place via ATP Synthase?

**Bonus Answer: thylakoid, thylakoid membrane**

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## 13. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A 5 kg ball is ejected from a spring and it rolls 8m up a frictionless incline at 30 degrees before coming to a stop. Assuming that  $g = 10 \text{ m/s}^2$  (READ AS 10 meters per second squared) and that the spring constant is 100N/m, how far does the spring has to be compressed initially?

- W) 1m
- X) 2m
- Y) 4m
- Z) 6m

Toss Up Answer: X

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Bonus: Short Answer

The potential energy of a 1kg particle is represented by  $U(x,y,z) = 2xy + 3z^2$  (READ AS: U of x, y, z equals 2xy plus 3 z squared). What is the magnitude of the force acting on the particle at position (0,4,1)?

Bonus Answer: 10 N

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## 14. EARTH and SPACE

Writer: Matthew Lee

Toss Up: Short Answer

The time delay between maximum or minimum insolation and maximum or minimum air temperature is known as:

Bonus Answer: insolation-temperature lag (accept seasonal lag)

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Bonus: Short Answer

What area near the equator is known colloquially by sailors as the doldrums, where the trade winds meet?

Bonus Answer: Intertropical Convergence Zone

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## 15. MATHEMATICS

Writer: Andrew Chen (Senior)

Toss Up: Multiple Choice

Simplify the following expression:  $(x^3+27)/(x+3)$  if  $x=12$

- W) 125
- X) 117
- Y) 136
- Z) 109

Toss Up Answer: X

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Bonus: Short Answer

Find all the real solutions of  $x^4-18=-2$

Bonus Answer:  $x=2$ ,  $x=-2$

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## 16. BIOLOGY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which disease was famously eradicated in 1977?

- W) Polio
- X) Smallpox
- Y) Mumps
- Z) AIDS

**Toss Up Answer: X**

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**Bonus: Short Answer**

Which human body system is attacked by AIDS?

**Bonus Answer: Immune system**

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## 17. MATHEMATICS

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

How many roots (real or complex) does  $x^4 - x^3 - 9x^2 + 7x + 14 = 0$  have?

W) 1

X) 2

Y) 3

Z) 4

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Find all real roots of  $x^4 - x^3 - 9x^2 + 7x + 14 = 0$

**Bonus Answer: -1, 2, +/- (sqrt 7)**

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## 18. EARTH and SPACE

**Writer: George Papastefanou**

**Toss Up: Short Answer**

How long does it take for a satellite in geosynchronous orbit to travel once around the Earth?

**Bonus Answer: One day**

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**Bonus: Short Answer**

What is the orbital period, to the nearest year, of Halley's Comet?

**Bonus Answer: 75 years**

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## 19. 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**

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**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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## 20. EARTH and SPACE

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

New York City is primarily composed of sediments that were metamorphosed during the Taconic and Acadian orogenies roughly:

W) 450 million years ago

X) 550 million years ago  
Y) 650 million years ago  
Z) 750 million years ago  
**Toss Up Answer: W**

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**Bonus: Short Answer**

When the earth is closest to the sun, what season is it in the Southern Hemisphere?

**Bonus Answer: Summer**

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**21. PHYSICS**

**Writer: Shantanu Jha**

**Toss Up: Multiple Choice**

Who first suggested that radiant energy could exist only in discrete quanta which were proportional to the frequency in order to explain the frequency distribution of blackbody radiation?

- W) Isaac Newton
- X) Max Planck
- Y) Ernest Rutherford
- Z) Paul Dirac

**Toss Up Answer: X**

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**Bonus: Short Answer**

Later solved by Planck's quantum radiation formula, what asymptotic result of the classical Rayleigh-Jeans Law was the most troubling?

**Bonus Answer: Ultraviolet Catastrophe**

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**22. EARTH and SPACE**

**Writer: Zoe Orlin**

**Toss Up: Multiple Choice**

What was the magnitude of the largest earthquake ever?

- W) 9
- X) 9.1
- Y) 9.3
- Z) 9.6

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

How much north does the Earth's magnetic north pole move per year?

- W) 30 miles
- X) 35 miles
- Y) 40 miles
- Z) 50 miles

**Bonus Answer: Z**

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**23. BIOLOGY**

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

SNPs can be characterized by all of the following EXCEPT for:

- W) always causing diseases.

X) being common in a population.

Y) acting as a point mutation.

Z) acting as a transition mutation.

**Toss Up Answer: W**

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**Bonus: Short Answer**

Which of the following cells are phagocytic?

1. Megakaryocyte

2. Dendritic cells

3. Natural killer cells

4. Neutrophils

5. Monocytes

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

**(Dendritic cells, Neutrophils, Monocytes)**

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## 24. EARTH and SPACE

**Writer: George Papastefanou**

**Toss Up: Multiple Choice**

The North Pacific Gyre is mostly located within what latitudinal zone?

W) The North Frigid Zone

X) The Torrid Zone

Y) The Horse Latitudes

Z) The North Temperate Zone

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What ocean current keeps Western Europe relatively warm for its latitude?

**Bonus Answer: North Atlantic Current (accept North Atlantic Drift, but not Gulf Stream)**

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## 25. EARTH and SPACE

**Writer: Shantanu Jha**

**Toss Up: Short Answer**

What physical quantity is the Schwarzschild radius of a Black Hole most dependent on?

**Bonus Answer: Mass**

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**Bonus: Multiple Choice**

If the event horizon of a black hole is 10 km, then what is the radius of its photon sphere?

W) 10km

X) 15km

Y) 20km

Z) 25km

**Bonus Answer: X**

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