

## Round 23

### 1. PHYSICS

Writer: Brian Lim

Toss Up: Short Answer

What are the fundamental forces of the Universe?

Bonus Answer: Gravitation, Electromagnetic, Weak, Strong

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Bonus: Multiple Choice

The tau particle belongs to which class of particles?

W) Quarks

X) Hadrons

Y) Bosons

Z) Leptons

Bonus Answer: Z

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### 2. PHYSICS

Writer: Yevgeniy Gorbachev

Toss Up: Short Answer

Which type of transfer orbit from one circular orbit to another is the most energy-efficient?

Bonus Answer: Hohmann transfer orbit

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Bonus: Multiple Choice

In which orbit are natural objects least common?

W) A planet's L1 point

X) A planet's L3 point

Y) A planet's L5 point

Z) A planet's L4 point

Bonus Answer: W

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### 3. PHYSICS

Writer: Brian Lim

Toss Up: Multiple Choice

Water is flowing through a horizontal pipe. As the pipe becomes narrower, what is true about the speed and the pressure of the water?

W) Both the speed and the pressure increase

X) Both the speed and the pressure decrease

Y) The speed increases and the pressure decreases

Z) The speed decreases and the speed increases

Toss Up Answer: Y

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Bonus: Short Answer

In a heat engine, hot steam at a temperature of 227 degrees Celsius does useful work before being released at a temperature of 127 degrees Celsius. What is the efficiency of the engine?

Bonus Answer: 20% or 0.2

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### 4. PHYSICS

Writer: Brian Lim

Toss Up: Short Answer

Given the acceleration due to gravity as 10.0 meters per square second, what is the water pressure in pascals at the bottom of a pool that has a depth of 5 meters?

**Bonus Answer: 50000 Pa**

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**Bonus: Short Answer**

A pendulum with a radius of 0.1 meters is released from rest at an angle of 30 degrees below the horizontal. Given the acceleration due to gravity as 10.0 meters per square second, what is the maximum speed of the pendulum assuming no energy is lost to friction?

**Bonus Answer: 1 m/s**

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## 5. PHYSICS

**Writer: Yevgeniy Gorbachev**

**Toss Up: Multiple Choice**

If an object has a mass of 10 kg and a velocity of  $1.5 \cdot 10^8$  m/s, what is its kinetic energy in terms of  $c$ ?

W)  $40(c^2)/3$

X)  $(c^2)/3$

Y)  $10c/3$

Z)  $10(c^2)/3$

**Toss Up Answer: Z**

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**Bonus: Short Answer**

If an object has a kinetic energy of  $6 \cdot 10^{16}$  joules and a velocity of  $.5c$ , what is its mass?

**Bonus Answer: Answer: 2kg**

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## 6. MATHEMATICS

**Writer: Nten Nylam**

**Toss Up: Multiple Choice**

What is the range of  $f(x) = x^2$

W) All real numbers greater than 0

X) All real numbers

Y) All real numbers greater than or equal to 0

Z) All real numbers except -1

**Toss Up Answer: Y**

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**Bonus: Short Answer**

$1/3$  of a number plus twice half of a number equals 36. What is the number?

**Bonus Answer: 27**

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## 7. MATHEMATICS

**Writer: Nten Nylam**

**Toss Up: Multiple Choice**

A card is randomly drawn from a 52 card deck, what is the probability that the card is either a spade or a 4?

W)  $4/13$

X)  $7/52$

Y)  $17/52$

Z)  $2/13$

**Toss Up Answer: W**

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**Bonus: Short Answer**

What is the value of  $(10! / 3!) \times 0!$

Bonus Answer: 604,800

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## 8. MATHEMATICS

Writer: Justin Lam

Toss Up: Short Answer

What is the volume of a sphere if the radius is 7 inches? (use  $22 / 7$  for  $\pi$ ) You may either use fractions or decimals rounded to the nearest hundredth as your answer.

Bonus Answer:  $V = 4312 / 3$  cubic inches

or  $V = 1437.33$  cubic inches

(they must include the correct units)

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Bonus: Short Answer

Find the surface area of a rectangular prism if the length is 2 inches, the width is 3 inches, and the height is 2 inches.

Bonus Answer:  $V = 32$  square inches

(they must include the correct units)

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## 9. MATHEMATICS

Writer: Justin Lam

Toss Up: Short Answer

On which point does  $y = 10x + 8$  and  $y = x + 5$  intersect?

Bonus Answer:  $(-1/3, 14/3)$

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Bonus: Short Answer

How many roots does the cubic equation  $y = x^3 - 4x^2 + 4x$  have?

Bonus Answer: It has 2 roots.

(Explanation: It intersects the x-axis twice, once at  $x = 0$  and once at  $x = 2$ .)

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## 10. BIOLOGY

Writer: Ivan Zhang

Toss Up: Multiple Choice

What enzyme in the digestive system first breaks down starches?

W) protease

X) secretin

Y) cholecystokinin

Z) amylase

Toss Up Answer: Z

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Bonus: Short Answer

What cavity is used cnidarians in digestion?

Bonus Answer: gastrovascular cavity

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## 11. BIOLOGY

Writer: Ivan Zhang

Toss Up: Multiple Choice

Which of the following is the largest patch containing lymphocytes?

W) lymph nodes

X) spleen

Y) thymus

Z) tonsils

Toss Up Answer: Z

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**Bonus: Short Answer**

What mineral deficiency is associated small sex glands and growth failure?

**Bonus Answer: Zinc**

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**12. BIOLOGY**

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

What hormone is released by the kidneys in response to oxygen deficiency?

W) erythropoietin

X) Renin

Y) calcitonin

Z) Leptin

**Toss Up Answer: W**

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**Bonus: Short Answer**

By what type of system is RBC numbers regulated?

**Bonus Answer: negative-feedback system**

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**13. BIOLOGY**

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

What is the name given to a "free-for-all" competition for resources?

W) contest competition

X) scramble competition

Y) intraspecific competition

Z) random competition

**Toss Up Answer: X**

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**Bonus: Short Answer**

What form of mimicry is described as a "wolf-in-sheep's-clothing" approach?

**Bonus Answer: aggressive mimicry**

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**14. BIOLOGY**

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

What is the name given to the crosses that occur when maternal and paternal DNA intertwine?

W) polymerase

X) chiasmata

Y) zona pellucida

Z) cambium

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the name given to the follicle cells surrounding an egg that has left the ovary?

**Bonus Answer: corona radiata**

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**15. BIOLOGY**

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Which of the following is a way in which the cell increases gene expression in the nucleus?

- W) Acetylation of histone tails
- X) DNA methylation
- Y) Locating a gene within heterochromatin
- Z) Dephosphorylating DNA

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Which of the following chemicals or groups of chemicals is not a major determinant of flower color?

- W) Flavonols
- X) Carotenoids
- Y) Cyanidin
- Z) Phytoalexins

**Bonus Answer: Z**

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## 16. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

You have a multicellular organism that reproduces asexually by fission. When you excise a ~10,000 cell portion of its body, both the original organism and the excised portion grow into fully formed, healthy organisms. You take one of the offspring and repeat the procedure for one hundred and twenty-three generations. Each time, the resulting organisms are healthy. What must be true of the nuclei of this species?

- W) The cells contain plasmids
- X) The cells have multiple forms of DNA polymerase.
- Y) The cells have the majority of their genome stored in circular DNA
- Z) The cells contain active telomerase.

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Which of the following oligonucleotides would have the highest melting point when paired with the proper complementary strand?

- W) 5'-AAAAAAA-3'
- X) 5'-ATGCATGC-3'
- Y) 5'-CGCGCGCG-3'
- Z) 5'-TTTTGGGG-3'

**Bonus Answer: Y**

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## 17. BIOLOGY

**Writer: Nten Nylam**

**Toss Up: Short Answer**

Of the following, name the conifers: pine, hemlock, palm, maple, cedar

**Bonus Answer: pine, hemlock, and cedar or 1, 2, and 5 (in any order)**

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**Bonus: Multiple Choice**

What pigment is responsible for the red coloring of cranberries and the purple coloring of eggplant?

- W) lycopene

- X) anthocyanin
- Y) carotene
- Z) zeaxanthin

**Bonus Answer: X**

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## 18. CHEMISTRY

**Writer: Andrew Chen (Senior)**

**Toss Up: Short Answer**

Each element has its own electron configuration. What is the electron configuration of chromium (Cr).

**Bonus Answer: [Ar] 3d<sup>5</sup> 4s<sup>1</sup> (Also accept 1s<sup>2</sup> 2s<sup>2</sup> 2p<sup>6</sup> 3s<sup>2</sup> 3p<sup>6</sup> 3d<sup>5</sup> 4s<sup>1</sup>)**

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**Bonus: Multiple Choice**

There are various numbers of pi and sigma bonds in certain compounds. Which of the choices below best describes the number of pi and sigma bonds ethyne (acetylene) has?

- W) 2 pi bonds and 1 sigma bonds
- X) 3 pi bonds and 2 sigma bonds
- Y) 2 pi bonds and 3 sigma bonds
- Z) 4 pi bonds

**Bonus Answer: Y**

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## 19. CHEMISTRY

**Writer: Janine Goh**

**Toss Up: Short Answer**

What colour does Xenon release when energised?

**Bonus Answer: White light (all colours)**

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**Bonus: Short Answer**

What is the difference between electronegativity and electron affinity?

**Bonus Answer: Electron affinity: the amount of energy in kJ/mol needed to add an electron to an element**

**Electronegativity: how much an atom wants an electron (no unit)**

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## 20. CHEMISTRY

**Writer: Janine Goh**

**Toss Up: Short Answer**

What activates pepsinogen to change into pepsin?

**Bonus Answer: Hydrochloric acid**

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**Bonus: Short Answer**

What is the pH of gastric juice?

**Bonus Answer: 1.5 to 2.5 (or any number in between)**

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## 21. CHEMISTRY

**Writer: Andrew Chen (Senior)**

**Toss Up: Multiple Choice**

Certain atoms exhibit paramagnetic or diamagnetic bonding. Of the following below which choice is classified as paramagnetic?

- W) Zinc (Zn)
- X) Krypton (Kr)

Y) Helium (He)

Z) Oxygen (O)

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Melting point is effected by bond strength. Order the following compounds in increasing order of melting point: graphite, methane, lithium, sodium chloride.

**Bonus Answer: Methane, lithium, sodium chloride, graphite (2, 3 , 4, 1)**

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## 22. CHEMISTRY

**Writer: Kerwin Chen**

**Toss Up: Short Answer**

Which group of elements produce colored ions?

**Bonus Answer: Transition metals**

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**Bonus: Short Answer**

Which scientist won a Nobel prize in Physics in 1918, whose constant is used to determine the amount of energy, given the wavelength of a wave?

**Bonus Answer: Max Planck, Planck**

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## 23. 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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## 24. EARTH and SPACE

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What is the name of Uranus' smallest moon, which is best known for the idea that it was shattered in a collision billions of years ago and reformed?

**Bonus Answer: Miranda**

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**Bonus: Short Answer**

Which two moons in the solar system are bigger than the smallest planet?

**Bonus Answer: Ganymede and Titan**

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## 25. EARTH and SPACE

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What are two general types of soils that have developed in the United States?

**Bonus Answer: pedocals and pedalfers**

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**Bonus: Short Answer**

What are the two most prominent elements dissolved in seawater?

**Bonus Answer: Chlorine and Sodium**

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