

## Round 41

### 1. MATHEMATICS

Writer: Calvin Aw

Toss Up: Short Answer

Find the limit of  $(x^2 - x - 2)/(x + 1)$  as  $x$  approaches  $-1$ .

Bonus Answer: -3

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Bonus: Short Answer

Find the limit of  $(x^2 + 6x + 5)/x^3$  as  $x$  approaches infinite

Bonus Answer: 0

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### 2. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

If a gene is fixed in a population:

- W) the gene cannot undergo mutation
- X) one allele exhibits complete dominance over the other allele of that gene
- Y) only one allele appears for that gene in the population
- Z) the gene is incapable of recombination

Toss Up Answer: Y

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Bonus: Multiple Choice

The Species-Area Relationship suggests that 10% of a given area supports:

- W) 90% of species
- X) 70% of species
- Y) 50% of species
- Z) 30% of species

Bonus Answer: Y

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### 3. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What is the Zeroth Law of Thermodynamics?

- W) Energy cannot be created or destroyed in an isolated system.
- X) Absolute Zero is the lowest temperature that is theoretically possible.
- Y) If two systems are at the same time in thermal equilibrium with a third system, they are in thermal equilibrium with each other.
- Z) The entropy of any isolated system always increases.

Toss Up Answer: Y

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Bonus: Short Answer

If the actual vapor density is  $5.8 \text{ g/m}^3$  and the saturation vapor density is  $10 \text{ g/m}^3$ , then what is the relative humidity?

Bonus Answer: 58%

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### 4. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

To the nearest order of magnitude, how thick are Saturn's rings?

- W) 10 m
- X) 100 m
- Y) 1000 m
- Z) 10000 m

**Toss Up Answer: W**

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**Bonus: Short Answer**

Which planets have active plate tectonics?

**Bonus Answer: Earth**

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## 5. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Natural selection is effective in the evolutionary process because it:

- W) causes evolution
- X) changes allele frequencies
- Y) increases the mean fitness of a population
- Z) leads to fixation or loss of particular alleles

**Toss Up Answer: Y**

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**Bonus: Short Answer**

You tie a ribbon to a tree trunk. The height measured from the ribbon to the ground is five feet. The tree grows at a rate of three feet per year. After 10 years, how far up from the ground will the ribbon be?

**Bonus Answer: Five feet. The elongation of a tree trunk occurs from the apical meristem up.**

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## 6. EARTH and SPACE

**Writer: Shamaul Dilmohamed**

**Toss Up: Multiple Choice**

What is the penultimate spectral type of a star?

- W) F
- X) G
- Y) K
- Z) M

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What spectral type is the Sun?

**Bonus Answer: G**

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## 7. CHEMISTRY

**Writer: Janine Goh**

**Toss Up: Multiple Choice**

Which of the following elements are Lanthanides?

- W) Lawrencium
- X) Meltnerium
- Y) Seaborgium
- Z) Terbium

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What unit does electronegativity use?

**Bonus Answer: No unit**

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## **8. EARTH and SPACE**

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

Which planet has the slowest rotation?

**Bonus Answer: Venus**

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**Bonus: Multiple Choice**

Which planet has the fastest rotation?

- W) Jupiter
- X) Saturn
- Y) Uranus
- Z) Neptune

**Bonus Answer: W**

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## **9. PHYSICS**

**Writer: Jessica Titensky**

**Toss Up: Short Answer**

What is the third derivative of displacement with respect to time

**Bonus Answer: Jerk**

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**Bonus: Short Answer**

What is the fourth derivative of displacement with respect to time

**Bonus Answer: jounce**

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## **10. MATHEMATICS**

**Writer: Calvin Aw**

**Toss Up: Short Answer**

What is the full name of the French mathematician who invented the Cartesian coordinate plane?

**Bonus Answer: Rene Descartes (You may also accept Descartes Rene, but do not accept Descartes or Rene)**

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**Bonus: Short Answer**

What is the name of the value of x in the ordered pair (x,y)

**Bonus Answer: Abscissa**

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## **11. PHYSICS**

**Writer: Jessica Titensky**

**Toss Up: Multiple Choice**

Which has the same units as joules?

- W) Newton / meter
- X) Pascal \* meter^2
- Y) Coulomb \* volt
- Z) Kilogram \* meter / second^2

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What is the derived unit for Newton / meter<sup>2</sup>?

**Bonus Answer: Pascal**

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## 12. CHEMISTRY

**Writer: Janine Goh**

**Toss Up: Short Answer**

Which group of elements has the lowest ionization energy?

**Bonus Answer: Alkali metals**

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**Bonus: Short Answer**

What are the elements in group 5 called?

**Bonus Answer: Pnictogens**

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## 13. PHYSICS

**Writer: Kerwin Chen**

**Toss Up: Multiple Choice**

If an object is located at the focal point of a concave mirror, what type of image will form?

W) real, inverted

X) virtual, inverted

Y) real, upright

Z) Image will not exist

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Cone cells in the retina allow a human being to perceive color. What are the photoreceptor proteins found in cone cells called?

**Bonus Answer: Photopsin**

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## 14. MATHEMATICS

**Writer: Calvin Aw**

**Toss Up: Multiple Choice**

Which three numbers satisfy the Pythagorean Theorem?

W) 1, 1, and sqrt3

X) 3, 4, and 5.01

Y) pi/3, pi/4, pi/5

Z) 1/3, 1/4, 5/12

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Triangle ABC has side lengths of 10, 10, and  $10\sqrt{2}$ . State all distinct median lengths of the triangle in increasing value.

**Bonus Answer:  $5\sqrt{2}$ ,  $5\sqrt{5}$  (only accept the numbers said in that order).**

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## 15. CHEMISTRY

**Writer: Janine Goh**

**Toss Up: Short Answer**

Which group of the periodic table has a fully filled d orbital?

**Bonus Answer: Group 12**

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**Bonus: Short Answer**

Name 2 elements that behave both as a metal and non-metal

**Bonus Answer:** Any 2: Boron, silicon, germanium, arsenic, antimony, tellurium, (polonium)

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## 16. PHYSICS

**Writer:** Ashneel Das

**Toss Up:** Multiple Choice

If on a certain planet, acceleration due to gravity is  $-5 \text{ m/s}^2$ , how long will a ball be in the air if thrown directly upward from the ground with a velocity of  $10 \text{ m/s}$ ?

- W) 2 seconds
- X) 4 seconds
- Y) 8 seconds
- Z) 16 seconds

**Toss Up Answer:** X

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**Bonus:** Multiple Choice

If Jim walks 10 meters north, then 5 meters southeast, then 5 meters northwest, then 5 meters south, what is his displacement?

- W) 25 meters north
- X) 15 meters north
- Y) 5 meters north
- Z) 5 meters south

**Bonus Answer:** Y

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## 17. MATHEMATICS

**Writer:** Calvin Aw

**Toss Up:** Short Answer

Find the product of all primes less than 11.

**Bonus Answer:** 210

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**Bonus:** Multiple Choice

Find the number of triangular numbers less than 2016.

- W) 58
- X) 60
- Y) 62
- Z) 64

**Bonus Answer:** Y

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## 18. CHEMISTRY

**Writer:** Calvin Aw

**Toss Up:** Short Answer

How many orientation of f orbitals are there?

**Bonus Answer:** 7

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**Bonus:** Short Answer

The Pauli Exclusion Principle states that at most how many electrons can occupy a single atomic orbital?

**Bonus Answer:** 2

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## 19. BIOLOGY

Writer: Josh Tish

Toss Up: Short Answer

Which three amino acids can most often be phosphorylated in eukaryotes?

**Bonus Answer: Serine, Threonine, Tyrosine**

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**Bonus: Short Answer**

After transforming the Ku11 gene into XL10 Gold E. coli and growing the bacteria for a day in selective media in the 25°C incubator, you notice that the colonies are much smaller than they should be. Why did this happen?

**Bonus Answer: 37°C is the optimal temperature for growing E. coli. The colonies were smaller because they grew more slowly.**

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## 20. CHEMISTRY

Writer: Calvin Aw

Toss Up: Multiple Choice

Which of the following is false about metals?

- W) Metals are malleable and ductile
- X) Metals tend to lose electrons to become cations
- Y) Metallic reactivity increases as you go down a group.
- Z) All metals are solid at room temperature

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Which of the following metals isn't solid at room temperature?

- W) Mercury
- X) Tantalum
- Y) Barium
- Z) Chromium

**Bonus Answer: W**

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## 21. BIOLOGY

Writer: Matthew Lee

Toss Up: Short Answer

The phenomenon where bacteria monitor the presence of secreted signaling molecules to determine the local density of cells is called?

**Bonus Answer: Quorum sensing**

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**Bonus: Short Answer**

Quorum sensing allows bacteria to coordinate their behaviors in synchrony. One example of said behavior is illustrated when you find them on your teeth when you wake up. What has formed on your teeth?

**Bonus Answer: biofilm**

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## 22. BIOLOGY

Writer: Matthew Lee

Toss Up: Short Answer

Certain proteins are released by virus-infected cells which induce neighboring cells to produce substances that will inhibit viral replication. What are these proteins called?

**Bonus Answer: Interferons**

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**Bonus: Short Answer**

What is the process by which antibodies cover a pathogen such that it is marked for destruction and forms a precipitate to be flushed out?

**Bonus Answer: Opsonization**

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**23. BIOLOGY**

**Writer: Matthew Lee**

**Toss Up: Multiple Choice**

Which of the following types of antibodies is typically used to fight parasitic infections?

W) E

X) M

Y) G

Z) A

**Toss Up Answer: W**

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**Bonus: Short Answer**

The immune response can include complement protein cascades, which form pores in the membrane of the target cell. The cell then swells and lyses due to water and ions rushing in. The type of complex that forms the pore in the membrane is called?

**Bonus Answer: membrane attack (accept: membrane attack complex)**

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**24. BIOLOGY**

**Writer: Matthew Lee**

**Toss Up: Short Answer**

HIV can be treated with a drug cocktail known as HAART. What does HAART stand for?

**Bonus Answer: Highly Active Anti-Retroviral Treatment**

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**Bonus: Short Answer**

AIDS patients may become afflicted with an extremely rare cancer caused by a certain herpesvirus. What is this cancer called?

**Bonus Answer: Kaposi's Sarcoma**

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**25. BIOLOGY**

**Writer: Matthew Lee**

**Toss Up: Short Answer**

In 1999, scientists discovered a fossil in China of what appeared to be an early chordate. This chordate had eyes and a brain but no skull, a derived feature of craniates. What was this fossil called?

**Bonus Answer: Haikouella**

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**Bonus: Short Answer**

What is the class of the most basal group of craniates?

**Bonus Answer: Myxini (accept: Hagfishes)**

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