

## Round 15

### 1. 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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### 2. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

A heat engine does positive work  $W$  as it absorbs energy  $Q_h$  (READ AS:  $Q_{\text{sub } h}$ ) from a heat reservoir and transfers energy  $Q_c$  (READ AS:  $Q_{\text{sub } c}$ ) to a cold reservoir. What is the efficiency of the heat engine in terms of  $Q_h$ ,  $Q_c$ , and  $W$ ?

Bonus Answer:  $W/Q_h$

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Bonus: Multiple Choice

For Christmas, Bobby Tables got a heater with a coefficient of performance of 10. If the heater transfers 50 kilojoules of heat into the room in 2 seconds, what is the power of the heater in kilowatts?

- W) 1
- X) 2.4
- Y) 2.1
- Z) 2.5

Bonus Answer: Z

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### 3. EARTH and SPACE

Writer: Justin Lam

Toss Up: Multiple Choice

Which of the following is an extrusive igneous rock?

- W) Granite
- X) Obsidian
- Y) Slate
- Z) Diorite

Toss Up Answer: X

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Bonus: Multiple Choice

Which of the following minerals is the hardest?

- W) Quartz
- X) Talc
- Y) Feldspar

Z) Corundum

**Bonus Answer: Z**

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## 4. MATHEMATICS

**Writer: Hanna Yang**

**Toss Up: Multiple Choice**

What do the numbers in the  $n$ th row of Pascal's Triangle sum to?

Give your answer in terms of  $n$ .

W)  $2n$

X)  $2^n$

Y)  $n^2$

Z)  $n^3$

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Find the number of ordered pairs  $(a,b)$ , where  $a$  and  $b$  are nonnegative integers, such that  $a+b=10$ .

W) 100

X) 10

Y) 11

Z) 12

**Bonus Answer: Y**

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## 5. PHYSICS

**Writer: Andrew Chen (Senior)**

**Toss Up: Short Answer**

Given a 5 meter length of gold wire with a radius of 0.05 meters with a resistivity of  $2.2 \times 10^{-8}$ , find the resistance in the wire.

**Bonus Answer:  $4.4 \times 10^{-5}$  ohms**

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**Bonus: Multiple Choice**

Given the following quantities chose the answer that contains only vector quantities.

W) Length, force, momentum

X) Momentum, temperature, work

Y) displacement, acceleration, velocity

Z) entropy, pressure, mass

**Bonus Answer: Y**

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## 6. BIOLOGY

**Writer: Justin Lam**

**Toss Up: Multiple Choice**

Which of the following polysaccharides is commonly found in the exoskeleton of insects?

W) Cellulose

X) Chitin

Y) Starch

Z) Glycogen

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

In which stage of cellular respiration is glucose broken down into two pyruvate molecules?

- W) Krebs Cycle
- X) Electron Transport Chain
- Y) Glycolysis
- Z) Oxidative Phosphorylation

**Bonus Answer: Y**

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## 7. CHEMISTRY

**Writer: Hanna Yang**

**Toss Up: Multiple Choice**

Which of the following is a polar molecule?

- W) SO<sub>2</sub>
- X) CH<sub>4</sub>
- Y) SF<sub>6</sub>
- Z) BF<sub>4</sub>

**Toss Up Answer: W**

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**Bonus: Short Answer**

Fill in the blanks in the following statement to make it true. Ionic compounds are \_\_\_\_ conductors in their solid state, but \_\_\_\_ conductors when dissolved in water.

**Bonus Answer: poor; good**

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## 8. PHYSICS

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

Not all laws that hold in an inertial frame hold in a non-inertial frame. An obvious example is the law of inertia. Does the Work-Energy Theorem hold in a non-inertial frame?

- W) It only holds in inertial frames.
- X) It will not hold in a non-inertial frame unless there aren't any conservative forces at work.
- Y) It will hold in a non-inertial frame unless there are non-conservative forces.
- Z) It holds for any non-inertial frame.

**Toss Up Answer: Z**

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**Bonus: Short Answer**

An object is launched on a horizontal surface with an initial speed of 20 m/s, so that it covers a distance of 5 meters in the time interval 4 sec to 5 sec. What is the coefficient of friction between the object and the horizontal surface?

Assume gravitational acceleration is 10 m/s<sup>2</sup>

**Bonus Answer: 1/3**

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## 9. 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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## 10. BIOLOGY

**Writer: Justin Lam**

**Toss Up: Short Answer**

In photosynthesis, what are the three products released from hydrolysis?

**Bonus Answer: Hydrogen or Hydrogen Ions (H+) , Oxygen or Oxygen Gas , and Electrons**

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**Bonus: Multiple Choice**

Which of the following carbohydrates the human body can NOT digest?

W) Fructose

X) Cellulose

Y) Sucrose

Z) Dextrose

**Bonus Answer: X**

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## 11. MATHEMATICS

**Writer: Justin Lam**

**Toss Up: Short Answer**

Factor the following equation:  $x^3 + 8 ( x^2 ) + 8x + 64$

**Bonus Answer:  $( x + 8 ) ( x + 8 ) ( x^2 + 8 )$  or  $( x^2 + 8 ) [( x + 8 )^2]$**

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**Bonus: Multiple Choice**

Which of the following is a primitive Pythagorean triple?

W) 9 , 12 , 15

X) 10 , 24 , 26

Y) 3 , 4 , 5

Z) 16 , 30 , 34

**Bonus Answer: Y**

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## 12. 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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## 13. EARTH and SPACE

**Writer: Justin Lam**

**Toss Up: Multiple Choice**

Which of the following gases make up the majority of Earth's atmosphere?

W) Oxygen

X) Argon

Y) Carbon dioxide

Z) Nitrogen

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the name for the scientific theory that describes the movement of plates across the Earth's lithosphere?

**Bonus Answer: Plate tectonics**

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## 14. 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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## 15. PHYSICS

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

You decide to set off on a voyage to another star. To stop your muscles from atrophying, you want to generate artificial gravity by having your ship constantly accelerate at 1 g from your reference frame. Ignoring fuel requirements, is there a problem with generating artificial gravity this way over very long time frames?

W) Yes, this setup would not work to generate artificial gravity

X) Yes, 1 g isn't enough to prevent your muscles from atrophying

Y) No, this can be used indefinitely to generate artificial gravity

Z) Yes, eventually the ship would need to go faster than the speed of light, which is impossible

**Toss Up Answer: Y**

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**Bonus: Short Answer**

A box of mass 3 kg is placed on the edge of a merry-go-round of radius 4 m. The coefficient of static friction between the box and the merry-go-round is 0.4. What is the square of the merry-go-round's speed at the moment the box slides off?

**Bonus Answer: 12 (m/s)<sup>2</sup>**

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## 16. MATHEMATICS

**Writer: Justin Lam**

**Toss Up: Multiple Choice**

Which of the following are prime factors of the number 5304?

W) 19

X) 7

Y) 5

Z) 13

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What integer satisfies the equation  $y = x^3 - 1$  [Read as:  $x$  to the third power subtracted by 1] when  $y = 0$  ?

**Bonus Answer:  $x = 1$**

(Explanation: The factors of the equation is  $y = (x - 1)(x^2 + x + 1)$ . We want to find an integer solution, so we take the factor  $x - 1$  and set it to zero. By adding one to both sides, we see that  $x = 1$ .)

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## 17. PHYSICS

**Writer: Charles Zhang**

**Toss Up: Multiple Choice**

When  $^{236}\text{U}$  fissions, the products might be which of the following?

W) Ba-146 (READ AS: barium 146), Kr-89 (READ AS: krypton 89), and a proton

X) Ba-146 (READ AS: barium 146), Kr-89 (READ AS: krypton 89), and a neutron

Y) Cs-148 (READ AS: cesium 148) and Br-85 (READ AS: barium 85)

Z) two uranium nuclei

**Toss Up Answer: X**

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**Bonus: Short Answer**

In the proton-proton cycle, two hydrogen atoms initially react to form what 3 particles?

**Bonus Answer: Deuterium, a positron, and an electron neutrino (ACCEPT neutrino)**

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## 18. BIOLOGY

**Writer: Justin Lam**

**Toss Up: Multiple Choice**

Which of the following stages in cellular respiration generates the most ATP (Adenosine triphosphate) ?

W) Krebs Cycle

X) Glycolysis

Y) Electron Transport Chain

Z) Pyruvate Oxidation

**Toss Up Answer: Y**

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**Bonus: Short Answer**

In cellular respiration, there are two main electron carriers produced. What are their chemical formulas?

**Bonus Answer: NADH and FADH<sub>2</sub>** (Some may mention the "empty forms" of these electron carriers: NAD<sup>+</sup> and FAD ; those answers are acceptable as well).

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## 19. PHYSICS

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

An electrical current flows across an infinite rectilinear wire. If its intensity of is doubled, then the magnetic field at a generic point:

W) quadruples

X) doubles

Y) halves

Z) remains unchanged

**Toss Up Answer: X**

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**Bonus: Short Answer**

The current  $I(t)$  flowing for a wire for  $t \geq 0$  is given by  $I(t) = 2^{-(t)}$ . Find the total charge that will flow through the wire.

Bonus Answer: 1/(ln 2)

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## 20. BIOLOGY

Writer: Hanna Yang

Toss Up: Short Answer

What is the name of the process wherein osteoblasts lay down new bone material?

Bonus Answer: Ossification, Osteogenesis, Bone Tissue Formation

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Bonus: Short Answer

What is the name of the structure within a bone that creates a network containing blood vessels?

Bonus Answer: Haversian Canals

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## 21. 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:  $[\text{Ar}] 3d^5 4s^1$  (Also accept  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ )

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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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## 22. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

An individual suffers brain damage that results in respiratory failure. Which region of the brain was most likely damaged?

- W) Substantia nigra
- X) Pons
- Y) Red nucleus
- Z) Reticular formation

Toss Up Answer: X

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Bonus: Multiple Choice

A man and a woman get married and soon learn that they both have a rare, genetically inherited recessive disorder that makes them prone to dizziness. Worried about the fate of their children, they seek the advice of a genetic counselor. She sequences their genomes and assures them that none of their children will have the disorder. What information would she have to obtain from the sequencing procedure that allows her to make this claim?

- W) The dizziness phenotype in the man is due to a mutation in a gene other than the gene responsible for the woman's phenotype.
- X) The dizziness disorder is an autosomal recessive trait.
- Y) The man and the woman are related genetically causing the same dizziness phenotype.

Z) It is impossible for the man and the woman to have unaffected children - the genetic counselor is wrong.

**Bonus Answer: W**

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## 23. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Which of the following are characteristics of both bacteria and fungi?

- W) Cell wall, unicellularity, and mitochondria
- X) Cell wall, DNA, and plasma membrane
- Y) Nucleus, organelles, and unicellularity
- Z) Nucleus, RNA, and cell wall

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Terminally differentiated cells are most often found in which phase of the cell cycle?

- W) G0
- X) G1
- Y) G2
- Z) S

**Bonus Answer: W**

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## 24. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

What is the probability of obtaining offspring with the AAbbCCdd genotype from parents with the genotypes AaBbCcDd and AABbCcDd (assume independent assortment of all gene pairs)?

- W) 1/64
- X) 1/128
- Y) 3/128
- Z) none of the above

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

A red pigment is extracted from a marine alga. Which best supports the hypothesis that the pigment is involved in photosynthesis? The red pigment:

- W) has an absorption spectrum similar to the photosynthetic action spectrum for that same marine alga
- X) contains iron which is a transition element similar to magnesium.
- Y) has a molecular structure similar to that of chlorophyll.
- Z) is also found in land plants together with a variety of other pigments and specific enzymes that are related to the action spectrum for photosynthesis.

**Bonus Answer: W**

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## 25. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Short Answer**



After 12 weeks of gestation, what is the principal source of estrogen and progesterone to a human fetus?

**Bonus Answer: corpus luteum**

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**Bonus: Multiple Choice**

Fat enters the venous system from the digestive system via the:

W) hepatic artery

X) hepatic vein

Y) thoracic duct

Z) hepatic portal system

**Bonus Answer: Y**

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