

## Round 6

### 1. MATHEMATICS

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

What is the y-intercept in the equation  $y = 4x + 3 - 2$

- W) 3
- X) 1
- Y) -2
- Z) 2

Toss Up Answer: X

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Bonus: Multiple Choice

If  $3x - y = 12$ , what is  $(8^x) / (2^y)$

- W)  $2^{12}$
- X)  $4^4$
- Y)  $8^3$
- Z) Cannot be determined

Bonus Answer: W

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### 2. CHEMISTRY

Writer: Andrew Chen

Toss Up: Short Answer

Assuming no double or triple bonds in the molecule, what form of hybridization does a ketone carbon have?

Bonus Answer: sp2

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Bonus: Multiple Choice

Which of the following is amphoteric?

- W) Zinc Oxide
- X) Aluminum Chloride
- Y) Acetic Acid
- Z) Magnesium Oxide

Bonus Answer: W

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### 3. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

Which of the following explains what happens when a negatively charged rod is held to the metal conductor of a leaf electroscope?

- W) The leaves close because electrons flow from the rod to the electroscope, resulting in a net negative charge in the electroscope.
- X) The leaves close because electrons flow from the electroscope to the rod, resulting in a net positive charge in the electroscope.
- Y) The leaves open because electrons flow from the rod to the electroscope, resulting in a net negative charge in the electroscope.
- Z) The leaves open because electrons flow from the electroscope to the rod, resulting in a net positive charge in the electroscope.

Toss Up Answer: Y

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**Bonus: Short Answer**

A positive charge of +5.3 Coulombs is placed in an electric field of 420. Newtons per Coulomb. Find the magnitude of the force the charge experiences in this electric field, rounded to two significant figures.

**Bonus Answer: 2200 N (Explanation:  $F = E \cdot q$ )**

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**4. CHEMISTRY**

**Writer: Andrew Chen**

**Toss Up: Short Answer**

To the nearest tenth of a liter, at standard conditions, how many liters does two moles of methane gas take up?

**Bonus Answer: 44.8**

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**Bonus: Multiple Choice**

What is the main method of helium production?

- W) Retrieval from the upper atmosphere
- X) Distillation from natural gas
- Y) Extraction from rock compounds
- Z) Distillation from the lower atmosphere

**Bonus Answer: X**

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**5. BIOLOGY**

**Writer: William Chan**

**Toss Up: Multiple Choice**

All of the following are examples of substances found in bacteria or archaea EXCEPT:

- W) peptidoglycan
- X) flagellin
- Y) chitin
- Z) phycobilin

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Which of the following groups of organisms lacks motility?

- W) Cellular slime molds
- X) Ciliates
- Y) Dinoflagellates
- Z) Apicomplexans

**Bonus Answer: Z**

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**6. CHEMISTRY**

**Writer: Andrew Chen**

**Toss Up: Short Answer**

If the molar mass of neon is 20 grams and the molar mass of argon is 40 grams, to the nearest tenth, what is the ratio of the rates of effusion of neon to argon?

**Bonus Answer: 1.4**

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**Bonus: Multiple Choice**

Which element has the highest second ionization energy?

- W) Lithium
- X) Hydrogen
- Y) Helium
- Z) Beryllium

**Bonus Answer: W**

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## 7. ENERGY

**Writer: Nicholas Parker Ng**

**Toss Up: Short Answer**

From what country does the US import the most coal?

**Bonus Answer: Columbia**

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**Bonus: Short Answer**

Rank the coal production of these states from lowest to highest: Wyoming, West Virginia, Illinois, Pennsylvania.

**Bonus Answer: Pennsylvania, Illinois, West Virginia, Wyoming.**

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## 8. BIOLOGY

**Writer: William Chan**

**Toss Up: Multiple Choice**

Genetic variation can be introduced into bacteria by all of the following methods EXCEPT:

- W) transfer of DNA between bacteria through pili
- X) mutation
- Y) transformation
- Z) DNA amplification

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

An mRNA actively being translated in the cytoplasm would have all of the following EXCEPT:

- W) a poly-A tail
- X) a 5' (read as 5 prime) cap
- Y) exons
- Z) introns

**Bonus Answer: Z**

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## 9. PHYSICS

**Writer: Shantanu Jha**

**Toss Up: Short Answer**

Which of the following units are a measure of magnetic field strength?

- 1 - Gauss
- 2 - Tesla
- 3 - Weber
- 4 - Henry

**Bonus Answer: 1,2 (Gauss, Tesla)**

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**Bonus: Multiple Choice**

If the axle of a wheel is moving at a velocity of  $v$ , what is the instantaneous velocity of the top of the wheel?

- W)  $-2v$

- X) 0
- Y) v
- Z) 2v

**Bonus Answer: Z**

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## 10. CHEMISTRY

**Writer: Andrew Chen**

**Toss Up: Short Answer**

How many nodes does a 3p orbital have?

**Bonus Answer: 2**

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**Bonus: Short Answer**

Name any amino acid that contains a phenyl group.

**Bonus Answer: Phenylalanine, Tyrosine, Tryptophan**

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## 11. EARTH and SPACE

**Writer: William Chan**

**Toss Up: Multiple Choice**

The time between two successive passages of the Sun across a given meridian is called a

- W) civil day
- X) conventional day
- Y) mean solar day
- Z) solar day

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the time from when a star crosses an observers meridian until the same star next crosses the observer's meridian called?

**Bonus Answer: sidereal day**

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## 12. MATHEMATICS

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What is the 3rd mersenne prime?

**Bonus Answer: 31**

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**Bonus: Multiple Choice**

How many terms does the 15th integral of  $\sin x$  dx have?

- W) 1
- X) 2
- Y) 15
- Z) 16

**Bonus Answer: Z**

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## 13. CHEMISTRY

**Writer: Andrew Chen**

**Toss Up: Multiple Choice**

Which element with no stable isotopes has the lowest atomic mass?

- W) Bismuth
- X) Technetium
- Y) Uranium
- Z) Radium

**Toss Up Answer: X**

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**Bonus: Short Answer**

What color is the H-alpha spectral line?

**Bonus Answer: Red**

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## 14. MATHEMATICS

**Writer: Steven Litvack-Winkler**

**Toss Up: Short Answer**

Tim is 5 times older than his younger brother. In 3 years Tim will be 3 times older than his younger brother. Compute the difference in the ages of Tim and his younger brother.

**Bonus Answer: 12**

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**Bonus: Short Answer**

How many positive integers  $n$  have no solutions to the following equation where  $a$  and  $b$  are nonnegative integers?

$$3a + 7b = n$$

**Bonus Answer: 6**

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## 15. EARTH and SPACE

**Writer: William Chan**

**Toss Up: Multiple Choice**

The best evidence of Earth's nearly spherical shape is obtained through

- W) telescopic observations of other planets
- X) photographs of Earth from an orbiting satellite
- Y) observations of the Sun's altitude made during the day
- Z) observations of the Moon made during solar eclipses

**Toss Up Answer: X**

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**Bonus: Short Answer**

Earth's spherical shape "bulges" very slightly at the Equator and is very slightly "flattened" at the poles. What is this shape called?

**Bonus Answer: oblate spheroid**

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## 16. CHEMISTRY

**Writer: Andrew Chen**

**Toss Up: Short Answer**

Which form of coal has the highest percentage of carbon?

**Bonus Answer: anthracite**

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**Bonus: Multiple Choice**

Which of the following is a salt?

- W) Water
- X) Soap
- Y) Plastic
- Z) Rust

**Bonus Answer: X**

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## **17. PHYSICS**

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What color is a mirror?

**Bonus Answer: green**

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**Bonus: Short Answer**

Using  $g = 10 \text{ m/s}^2$ , given the weight of an object is 2700 Newtons, what is the mass of the object on the Moon, if its gravitational force is  $\frac{1}{6}$  as strong as that on Earth? Round your answer to the first decimal place.

**Bonus Answer: 270 kg**

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## **18. MATHEMATICS**

**Writer: Shamaul Dilmohamed**

**Toss Up: Multiple Choice**

Given two attempts, what is the probability in a ratio of getting a multiple choice question correct, if there are 5 choices?

W) 1:3

X) 1:4

Y) 2:3

Z) 2:4

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

What percentage of data falls within 2 standard deviations of the mean, assuming a normal distribution?

W) 34.10%

X) 47.70%

Y) 68.20%

Z) 95.40%

**Bonus Answer: Z**

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## **19. BIOLOGY**

**Writer: William Chan**

**Toss Up: Multiple Choice**

The inheritance of skin color in humans is an example of which of the following?

W) pleiotropy

X) codominance

Y) epistasis

Z) polygenic inheritance

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

A human genetic defect that is caused by nondisjunction of the sex chromosomes is

W) sickle-cell disease

X) hemophilia

Y) red-green color blindness

Z) Turner syndrome

**Bonus Answer: Z**

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## 20. CHEMISTRY

**Writer: Nicholas Parker Ng**

**Toss Up: Multiple Choice**

Which type of nuclear reactor does not require a moderator?

W) Light Water Reactor

X) Heavy Water Reactor

Y) Graphite Moderated Reactor

Z) Fast Breeder Reactor

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Which types of fuel cells mainly use platinum catalysts?

PEMFC

PAFC

DMFC

MCFC

**Bonus Answer: 1 and 3**

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## 21. PHYSICS

**Writer: Shantanu Jha**

**Toss Up: Multiple Choice**

What is true about the capacitance of two parallel plates?

W) it is proportional to the square of the Area of the plates

X) it is proportional to the inverse of the Area of the plates

Y) it is proportional to the inverse of the plate separation

Z) it is proportional to the plate separation

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

A 200 farad capacitor is used in a circuit. The voltage difference between the plates of the capacitor is 10 volts. What is the magnitude of the charge on each of the capacitor's plates?

W) 100 Coulombs

X) 2000 Coulombs

Y) 10 Coulombs

Z) 200 Coulombs

**Bonus Answer: X**

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## 22. EARTH and SPACE

**Writer: William Chan**

**Toss Up: Multiple Choice**

Which observation provides the best evidence that Earth rotates?

- W) The position of the planets among the stars changes during the year.
- X) The location of the constellations in relationship to Polaris changes from month to month.
- Y) The length of the shadow cast by a flagpole at noontime changes from season to season.
- Z) The direction of swing of a freely swinging pendulum changes during the day.

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Earth's axis of rotation is tilted twenty three and a half degrees from a line perpendicular to the plane of its orbit. What would be the result if the tilt was increased to thirty three and a half degrees?

- W) an increase in the amount of solar radiation received by Earth.
- X) colder winters and warmer summers in New York State
- Y) less difference between winter and summer temperatures in New York State
- Z) shorter days and longer nights at the Equator

**Bonus Answer: X**

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## **23. PHYSICS**

**Writer: Shantanu Jha**

**Toss Up: Short Answer**

Given two frequencies of 410 Hertz and 412 Hertz, what is the period of the beats produced?

**Bonus Answer: .5 seconds**

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**Bonus: Short Answer**

A car is driving away at 50 meters/seconds from an observer at rest. The car is emitting a frequency at 80 Hz. What is the apparent frequency for the observer, given that the speed of sound is 350 meters/seconds? Give your answer to the nearest integer.

**Bonus Answer: 70 Hertz**

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## **24. EARTH and SPACE**

**Writer: William Chan**

**Toss Up: Multiple Choice**

Earth is farthest from the Sun during the Northern Hemisphere's summer, and Earth is closest to the Sun during the Northern Hemisphere's winter. During which season in the Northern Hemisphere is Earth's orbital velocity greatest?

- W) Winter
- X) Spring
- Y) Summer
- Z) Fall

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Which information about a nearby star must be known to determine its distance from an observer?

- W) size
- X) color
- Y) temperature
- Z) parallax

**Bonus Answer: Z**

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## 25. BIOLOGY

Writer: William Chan

### Toss Up: Multiple Choice

If a cell has 46 chromosomes at the beginning of mitosis, then at anaphase there would be a total of

- W) 23 chromatids
- X) 23 chromosomes
- Y) 46 chromosomes
- Z) 92 chromosomes

Toss Up Answer: Z

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### Bonus: Multiple Choice

All of the following statements are true EXCEPT:

- W) spindle fibers are composed largely of microtubules.
- X) centrioles consist of nine triplets of microtubules arranged in a circle.
- Y) all eukaryotic cells have centrioles
- Z) many of the microtubules in a spindle apparatus attach to kinetochores of chromosomes

Bonus Answer: Y

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