

## Round 31

### 1. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

A beam of white light hits the sharp end of a glass prism and is broken up into monochromatic components. Which of the following phenomenon is this a direct example of?

W) Refraction

X) Dispersion

Y) Rarefaction

Z) Diffraction

Toss Up Answer: X

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Bonus: Short Answer

A projectile whose mass is 9.4 kg is fired vertically upward. On its upward flight, an energy of 68 kJ is dissipated because of air resistance. How much higher would it have gone if the air resistance had been made negligible? Round to the nearest ten meters.

Bonus Answer: 740 m

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### 2. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

All electromagnetic waves have the same speed in:

W) Water

X) Air

Y) Glass

Z) Vacuum

Toss Up Answer: Z

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Bonus: Short Answer

A man raises a massless string tied at the bottom to a 16N steel ball, with an upward acceleration of 2 meters per second squared. Find the tension in the string, to the nearest whole number of Newtons. Assume gravitational acceleration is 10 meters per second squared.

Bonus Answer: 19 Newtons

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### 3. PHYSICS

Writer: William Xiang

Toss Up: Short Answer

A ball with a weight of 3.5 Newtons is thrown at an angle of 30 degrees above the horizontal with an initial speed of 16 meters per second. Give the magnitude and direction of the net force on the ball at its highest point.

Bonus Answer: 3.5 Newtons, downward

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Bonus: Short Answer

A car is traveling at 15 meters per second on a horizontal road. The brakes are applied and the car skids to a stop in 4 seconds. Assuming gravitational acceleration is 10 meters per second squared, find the coefficient of kinetic friction between the tires and road. Round your answer to the nearest tenth.

Bonus Answer: 0.38

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### 4. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

A vector extends 6 meters in the x direction and  $2\sqrt{3}$  meters in the y direction. The angle this vector makes with the positive x axis is:

- W) 30 degrees
- X) 60 degrees
- Y) 90 degrees
- Z) 180 degrees

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

A brick slides on a horizontal surface. Which of the following will increase the frictional force on it?

- W) Increasing the surface of contact
- X) Decreasing the surface of contact
- Y) Increasing the mass of the brick
- Z) Decreasing the mass of the brick

**Bonus Answer: Y**

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## 5. PHYSICS

**Writer: William Xiang**

**Toss Up: Multiple Choice**

A ball is thrown vertically up from the ground. Which of the following explains the ball's motion on its way up?

- W) The ball is decelerating.
- X) The ball's velocity is decreasing exponentially.
- Y) The change in the ball's displacement is decreasing exponentially.
- Z) The ball's velocity is constant.

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

A ball is thrown horizontally at the same speed from the same height, one on the Earth and one on the Moon. Which of the following statements is/are true?

- I. The horizontal distance traveled by the bullet is greater on the Moon.
  - II. The flight time is less for the bullet on the Earth.
  - III. The velocities of the bullets at impact are the same.
- W) III only
  - X) I and II only
  - Y) II and III only
  - Z) I, II, and III

**Bonus Answer: X**

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## 6. MATHEMATICS

**Writer: George Zhou**

**Toss Up: Multiple Choice**

$3^{12} = 27^x$ . What is the value of x?

- W)  $x=12$
- X)  $x=4$
- Y)  $x=6$

Z)  $x=3$

**Toss Up Answer: X**

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**Bonus: Short Answer**

$3^{12} + 3^{11} + 3^{10} = b \cdot 3^a$  What is the positive difference between the product and the sum of  $a$  and  $b$ ?

**Bonus Answer: 107**

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## 7. MATHEMATICS

**Writer: Yevgeniy Gorbachev**

**Toss Up: Multiple Choice**

If a regular hexagon has a side length of 2, what is its area?

W)  $3\sqrt{6}$

X)  $6\sqrt{3}$

Y)  $\sqrt{18}$

Z)  $6\sqrt{2}$

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

If  $f(x)$  is  $(\ln(x^2))/(e^x)$ , what is  $f'(x)$  in simplest form?

W)  $((x^2)/2x + \ln(x^2))/(e^{2x})$

X)  $((2/x) - \ln(x^2))/(e^2)$

Y)  $(\ln(4/x))/(e^{2x})$

Z)  $((2x/(x^2)) - \ln(x^2))/(e^{2x})$

**Bonus Answer: X**

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## 8. MATHEMATICS

**Writer: Ahmad Alnasser**

**Toss Up: Short Answer**

Write an equation for a sine function with an amplitude of  $5/3$ , a period of  $\pi/2$ , and a vertical shift of 4 units up.

**Bonus Answer:  $y = (5/3)\sin(4x) + 4$**

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**Bonus: Short Answer**

Two large and 1 small pumps can fill a swimming pool in 4 hours. One large and 3 small pumps can also fill the same swimming pool in 4 hours. How many hours will it take 4 large and 4 small pumps to fill the swimming pool.

**Bonus Answer: 1 hour and 40 minutes**

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## 9. MATHEMATICS

**Writer: Ahmad Alnasser**

**Toss Up: Short Answer**

Find the derivative of:  $4x^3 + 18x + 2$

**Bonus Answer:  $8x^2 + 18$**

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**Bonus: Short Answer**

At what point is the slope of the tangent line to the parabola  $y = 3x^2 + 5x + 23$  equal to 0?

**Bonus Answer:  $(-5/6, 441/36)$**

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## 10. BIOLOGY

**Writer: Henry Zheng**

**Toss Up: Multiple Choice**

The adult human of average age and size has approximately how many quarts of blood?

- W) 4
- X) 6
- Y) 8
- Z) 10

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

When a human donor gives a pint of blood, it usually requires how many weeks for the body RESERVE of red corpuscles to be replaced?

- W) 1 week
- X) 3 weeks
- Y) 7 weeks
- Z) 21 weeks

**Bonus Answer: Y**

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**11. BIOLOGY**

**Writer: Henry Zheng**

**Toss Up: Multiple Choice**

Robert Hooke coined the term 'cell' mostly because of

- W) his observations of red blood cells
- X) his observations of cork cells
- Y) his analysis of hundreds of different protozoans
- Z) his readings of the works of other early microscopists

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Who is known as the "father of microbiology"?

- W) Hans Jansen
- X) Robert Hooke
- Y) Antony van Leeuwenhoek
- Z) Hans Solo

**Bonus Answer: Y**

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**12. BIOLOGY**

**Writer: Henry Zheng**

**Toss Up: Short Answer**

Rough endoplasmic reticulum is named rough because it possesses what cellular structures?

**Bonus Answer: ribosomes**

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**Bonus: Short Answer**

What is the anatomical term for the specific section of the small intestine into which the pancreatic duct delivers its digestive enzymes?

Bonus Answer: duodenum

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### 13. BIOLOGY

Writer: Henry Zheng

Toss Up: Multiple Choice

The myofilaments of muscles consist primarily of two proteins. These two proteins are called

- W) actin and myosin
- X) progesterone and testosterone
- Y) progesterone and estrogen
- Z) estrogen and testosterone

Toss Up Answer: W

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Bonus: Short Answer

The alternative forms of gene at the same locus on homologous chromosomes are called what?

Bonus Answer: alleles

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### 14. BIOLOGY

Writer: William Xiang

Toss Up: Multiple Choice

Which of the following enzymes are not utilized by the human body to break down carbohydrates?

- W) Amylase
- X) Maltase
- Y) Lactase
- Z) Lipase

Toss Up Answer: Z

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Bonus: Multiple Choice

Which of the following is a valid difference between animal and plant cells?

- W) Animal cells have a cell membrane whereas plant cells do not.
- X) Animal cells contain mitochondria whereas plant cells cannot.
- Y) Animal cells can contain multiple vacuoles whereas plant cells cannot.
- Z) Animal cells are larger than plant cells.

Bonus Answer: Y

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### 15. BIOLOGY

Writer: George Papastefanou

Toss Up: Multiple Choice

What kind of typing is used to identify tissue-specific gene expression?

- W) Southern Blot
- X) Northern Blot
- Y) Western Blot
- Z) Radioactive Tracer

Toss Up Answer: X

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Bonus: Multiple Choice

Which genetic disorder is mainly characterized by an onset in middle age?

- W) Huntington's Disease

- X) Schizophrenia
- Y) Prader-Willi syndrome
- Z) Tay-Sachs Syndrome

**Bonus Answer: W**

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## 16. BIOLOGY

**Writer: George Papastefanou**

**Toss Up: Multiple Choice**

Rett syndrome displays which of the following inheritance patterns?

- W) Autosomal Dominant
- X) Autosomal Recessive
- Y) X-Linked Dominant
- Z) X-Linked Recessive

**Toss Up Answer: Y**

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**Bonus: Short Answer**

In the genetic disorder known as cri-du-chat, what chromosome is affected?

**Bonus Answer: Chromosome 5**

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## 17. BIOLOGY

**Writer: Shanjeed Ali**

**Toss Up: Short Answer**

Platelets are pieces of what type of cell?

**Bonus Answer: Megakaryocytes**

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**Bonus: Multiple Choice**

Where do erythrocytes develop?

- W) spleen
- X) trabecular bone
- Y) cortical bone
- Z) bone marrow

**Bonus Answer: Z**

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## 18. CHEMISTRY

**Writer: Olivia Gallager**

**Toss Up: Multiple Choice**

cis 1,2 chloro-ethene and trans 1,2 chloro-ethene differ in which of the following?

- W) electron geometry
- X) enthalpy
- Y) entropy
- Z) boiling point

**Toss Up Answer: Z**

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**Bonus: Short Answer**

In an acid/base reaction, which (acid or base) is the electrophile?

**Bonus Answer: acid**

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## 19. CHEMISTRY

**Writer: Olivia Gallager**

**Toss Up: Short Answer**

What is the name for a molecule with tetrahedral electron geometry but only three substituent groups?

**Bonus Answer: trigonal pyramidal**

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**Bonus: Multiple Choice**

Which of the following is not an ionic compound?

W) NaCl

X) HF

Y) FeCl<sub>3</sub>

Z) H<sub>2</sub>SO<sub>4</sub>

**Bonus Answer: X**

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## 20. CHEMISTRY

**Writer: Ahmad Alnasser**

**Toss Up: Multiple Choice**

A molecule is considered a lewis acid if

W) accepts a pair of electrons to form a bond

X) accepts a proton from water

Y) donates a pair of electrons to form a bond

Z) donates a proton to water

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Which of the following is a binary compound?

W) Hydrogen Sulfate

X) Hydrogen Sulfide

Y) Ammonium Sulfide

Z) Ammonium Sulfate

**Bonus Answer: X**

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## 21. CHEMISTRY

**Writer: Ahmad Alnasser**

**Toss Up: Short Answer**

At room temperature, what is the only metal that is in liquid form?

**Bonus Answer: Mercury (Hg)**

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**Bonus: Multiple Choice**

What is the third most common gas found in the air in the atmosphere?

W) Argon

X) Hydrogen

Y) Oxygen

Z) Helium

**Bonus Answer: W**

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## 22. CHEMISTRY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which of the following does not exhibit resonance stabilization?

W) Ozone

X) SO<sub>2</sub>

Y) NO<sub>3</sub>

Z) H<sub>2</sub>O

Toss Up Answer: Z

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Bonus: Short Answer

What is the bond order of H<sub>2</sub>O?

Bonus Answer: 2

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## 23. 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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## 24. 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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## 25. EARTH and SPACE

Writer: Yevgeniy Gorbachev



**Toss Up: Multiple Choice**

The square of a body's orbital period is proportional to:

W) The semi-major axis of the orbit

X) The square of the quotient of the apocenter and pericenter heights of the orbit

Y) The cube of the semi-major axis of the orbit

Z) The cube of the major axis of the orbit

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Specific orbital energy does not vary with time according to...

**Bonus Answer: Orbital Energy Conservation Equation (also acceptable: vis-viva equation)**

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