

## Round 19

### 1. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

A standard 1-kg mass is attached to a compressed spring and the spring is released. If the mass initially has an acceleration of  $5.6\text{m/s}^2$ , the force of the spring has a magnitude of:

- W) 0N
- X) 2.8N
- Y) 5.6N
- Z) 11.2N

Toss Up Answer: Y

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Bonus: Multiple Choice

A 42-kg man stands in an elevator that has a downward acceleration of  $3.4\text{m/s}^2$ . The force exerted by him on the floor is about:

- W) 12N
- X) 270N
- Y) 340N
- Z) 412N

Bonus Answer: X

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### 2. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What Irish physicist, living from 1805-1865, made important contributions to classical mechanics optics and algebra?

- W) William Parsons
- X) William Hamilton
- Y) Francis Beaufort
- Z) George Boole

Toss Up Answer: X

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Bonus: Multiple Choice

What is generated by a Van de Graff generator?

- W) Static Charge
- X) Current
- Y) Nuclear Decay
- Z) Radiation

Bonus Answer: W

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### 3. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

What fuel is mostly used in a nuclear power-generation station?

Bonus Answer: Uranium-235 (Do not accept: Uranium or Uranium-238)

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Bonus: Multiple Choice

Dark energy and dark matter comprise approximately how much of the known universe?

- W) 50%
- X) 75%
- Y) 95%
- Z) 99%

**Bonus Answer: Y**

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## 4. PHYSICS

**Writer: Shantanu Jha**

**Toss Up: Multiple Choice**

What is the magnitude of the magnetic force on a point charge with a charge of 1 Coulomb and velocity of 2 meters per second traveling perpendicular to a magnetic field of 2 Tesla?

- W) -1 Newtons
- X) -2 Newtons
- Y) 2 Newtons
- Z) 4 Newtons

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the name of the force that is the combination of electric and magnetic force on a point charge due to electromagnetic fields?

**Bonus Answer: Lorentz Force**

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## 5. PHYSICS

**Writer: Shantanu Jha**

**Toss Up: Multiple Choice**

What German physicist developed the 2nd law of thermodynamics, showing that the universe's entropy always increases?

- W) Wilhelm Röntgen
- X) Rudolf Clausius
- Y) Wilhelm Weber
- Z) Hermann von Helmholtz

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

What German physicist, who died in 1855, formulated separate electrostatic and electrodynamical laws?

- W) James Clerk Maxwell
- X) Johann Gauss
- Y) Frederick Beck
- Z) Max von Laue

**Bonus Answer: X**

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## 6. MATHEMATICS

**Writer: Calvin Aw**

**Toss Up: Short Answer**

Compute the number of diagonals in a convex 30-sided polygon.

**Bonus Answer: 435**

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**Bonus: Short Answer**

Find the number of way 30 people can shake hands if each person shakes hands with everyone else, excluding themselves.

**Bonus Answer: 435**

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**7. MATHEMATICS**

**Writer: Calvin Aw**

**Toss Up: Short Answer**

In interval notation, find the domain of  $\frac{1}{\sqrt{x^2+5x+4}} \geq 0$  (1 over the square root of  $x^2+5x+4$  is greater than or equal to 0.)

**Bonus Answer:  $(-\infty, -4) \cup (-1, \infty)$**

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**Bonus: Short Answer**

If  $x^2+7x-5=0$ , find  $(\sqrt{1} + \sqrt{2})^2$

**Bonus Answer: 49**

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**8. MATHEMATICS**

**Writer: Ahmad Alnasser**

**Toss Up: Multiple Choice**

Which of the following the derivative with the highest degree?

W)  $X^2$  (x squared)

X) 20

Y) 104

Z)  $3x$

**Toss Up Answer: W**

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**Bonus: Short Answer**

Find  $y' = \frac{dy}{dx}$  for  $x^3 + y^3 = 4$ . (x cubed + y cubed)

**Bonus Answer:  $-\frac{x^2}{y^2}$  (negative x squared over y squared)**

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**9. MATHEMATICS**

**Writer: Yevgeniy Gorbachev**

**Toss Up: Short Answer**

What is the integral from 1 to 4 of  $4x^3$ ?

**Bonus Answer: 255**

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**Bonus: Multiple Choice**

What is  $\frac{d}{dx} \tan x / \sec x$ , in simplest form?

W)  $\sec^2 x - \tan x$

X)  $\sec^2 x - \tan^2 x$

Y)  $\sec^3 x - \tan^2 x \sec x$

Z)  $(\sec x - \tan x)^2$

**Bonus Answer: X**

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**10. BIOLOGY**

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Which of these is not a viral disease?

- W) Dutch elm disease
- X) Yellow fever
- Y) Mumps
- Z) Rubella

**Toss Up Answer: W**

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**Bonus: Short Answer**

In which viral reproductive cycle is the viral DNA incorporated into the host DNA?

**Bonus Answer: Lysogenic**

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## 11. BIOLOGY

**Writer: Siam Muquit**

**Toss Up: Short Answer**

What does the Shannon Index quantify?

**Bonus Answer: Biodiversity of a community (accept similar responses)**

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**Bonus: Short Answer**

What would be the Simpson's Index value for a population with infinite biodiversity?

**Bonus Answer: 0**

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## 12. BIOLOGY

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Bottom-heavy age structure diagrams are characteristic of populations in:

- W) Developed countries
- X) Developing countries
- Y) Stable populations
- Z) Populations with high numbers of elderly

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the expression for doubling time of a population given that it grows at constant annual rate of  $r\%$ ?

**Bonus Answer:  $70/r$**

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## 13. BIOLOGY

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Nitrifying bacteria convert

- W) Atmospheric Nitrogen to Ammonia
- X) Ammonia to Nitrite
- Y) Nitrite to Nitrate
- Z) Nitrate to Nitrite

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the shape of the curve of a population growing in ideal conditions?

**Bonus Answer: J-curve**

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## 14. BIOLOGY

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Which of these is not characteristic of an r-selecting species?

- W) Small physical size
- X) Short life span
- Y) Parental care
- Z) Variable and unpredictable mortality

**Toss Up Answer: Y**

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**Bonus: Short Answer**

For each of the following, state whether it is an r-strategist or k-strategist: Oyster, Garden weeds, Desert flowers, Humans

**Bonus Answer: Oyster: r-strategist; Garden weeds: r-strategist; Desert flowers: r-strategist; Humans: k-strategist**

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**15. BIOLOGY**

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

HIV is an example of which type of shape of virus?

- W) Spiral
- X) Polyhedral
- Y) Spherical
- Z) Complex

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Which of the following types of virus is HIV associated with? Type IV, Type V, Type VI

**Bonus Answer: Type VI only (3 only)**

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**16. BIOLOGY**

**Writer: Ahmad Alnasser**

**Toss Up: Multiple Choice**

Which of the following choices would most likely promote random distribution?

- W) flocking and schooling behaviors
- X) homogeneous chemical and physical factors in the environment
- Y) spacing during the breeding season
- Z) territorial species

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

The Allee effect is used to describe a population that

- W) has become so large that it will have difficulty surviving and reproducing.
- X) has exceeded its carrying capacity.
- Y) has become so small that it will have difficulty surviving and reproducing.
- Z) is in crash decline

**Bonus Answer: Y**

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**17. BIOLOGY**

**Writer: Ahmad Alnasser**

**Toss Up: Short Answer**

In marine sponges, intracellular digestion of peptides is usually immediately preceded by

**Bonus Answer: Endocytosis**

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**Bonus: Short Answer**

The large surface area in the gut directly facilitates

**Bonus Answer: Absorption**

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## 18. CHEMISTRY

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

The last electron of lanthanum enters in the:

- W) d orbital
- X) s orbital
- Y) p orbital
- Z) f orbital

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Which of the following is true for B<sub>3</sub>N<sub>3</sub>H<sub>6</sub>

- W) Its name is Nitroborane
- X) All the atoms are sp-hybridised
- Y) It has 3 lone pairs of electrons
- Z) It is isostructural with benzene

**Bonus Answer: Z**

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## 19. CHEMISTRY

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

Which of the following is the most acidic?

- W) o-methoxy benzoic acid
- X) benzoic acid
- Y) m-methoxy benzoic acid
- Z) p-methoxy benzoic acid

**Toss Up Answer: W**

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**Bonus: Short Answer**

What is the equivalent weight of HNO<sub>3</sub> in the reaction: Cu reacts with HNO<sub>3</sub>, forming Cu(NO<sub>3</sub>)<sub>2</sub>, NO and water.

**Bonus Answer: 84**

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## 20. CHEMISTRY

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

Which of the following compounds does not exist?

- W) PF<sub>5</sub>
- X) P<sub>4</sub>O<sub>10</sub>
- Y) P<sub>4</sub>O<sub>6</sub>
- Z) PH<sub>5</sub>

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Order the following hydrogen halides from the one with the lowest boiling point to one with the highest: HI, HCl, HBr, HF

**Bonus Answer: HCl, HBr, HI, HF (2, 3, 1, 4)**

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**21. CHEMISTRY**

**Writer: Olivia Gallager**

**Toss Up: Multiple Choice**

Which of the following has a coordinate covalent bond?

W) butanol

X) CO<sub>2</sub>

Y) Methane

Z) NH<sub>4</sub><sup>+</sup>

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the formal charge of Nitrogen in an ammonia molecule?

**Bonus Answer: 0**

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**22. CHEMISTRY**

**Writer: Banpreet Singh**

**Toss Up: Short Answer**

At what temperature Kelvin does water freeze?

**Bonus Answer: 273 K**

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**Bonus: Short Answer**

Who came up with the caloric theory?

**Bonus Answer: Antoine Lavoisier**

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**23. EARTH and SPACE**

**Writer: Prangon Ghose**

**Toss Up: Short Answer**

What is the name of the largest volcanic mountain on Mars?

**Bonus Answer: Olympus Mons**

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**Bonus: Short Answer**

Which spacial event marks the beginning of spring in the Northern Hemisphere

**Bonus Answer: Vernal Equinox (Accept: Spring Equinox)**

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**24. EARTH and SPACE**

**Writer: Yevgeniy Gorbachev**

**Toss Up: Short Answer**

What is the most geologically active object in the solar system and why?

**Bonus Answer: Io, because of tidal forces from Jupiter, Europa, Ganymede, and Callisto.**

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**Bonus: Short Answer**

What is Io's surface primarily composed of?

**Bonus Answer: Silicates and sulfur compounds.**

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## 25. EARTH and SPACE

Writer: Mohammed Haque

Toss Up: Multiple Choice

How many moons does Neptune have?

W) 22

X) 34

Y) 14

Z) 12

Toss Up Answer: Y

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Bonus: Multiple Choice

What is Saturn's atmosphere mostly composed of?

W) Helium

X) Amonia

Y) Hydrogen

Z) Carbon

Bonus Answer: Y

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