

Round 18

1. PHYSICS

Writer: Aaron Gee

Toss Up: Multiple Choice

A certain spring is known to obey Hooke's Law. If a force of 10 newtons stretches the spring 2 meters, how far will a 30 newton force stretch the spring?

- W) 1 meter
- X) 60 meters
- Y) 6 meters
- Z) 16 meters

Toss Up Answer: Y

Bonus: Multiple Choice

A block of metal which weighs 60 newtons in air and 40 newtons under water has a density, in kilograms per meter cubed, of:

- W) 1000
- X) 3000
- Y) 5000
- Z) 7000

Bonus Answer: X

2. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

If θ is an angle such that $\sin(\theta) < 0$ and $\cos(\theta) = 0$, where in the coordinate plane is it located?

- W) Between the 2nd and 3rd quadrants
- X) Between the 3rd and 4th quadrants
- Y) Between the 1st and 4th quadrants
- Z) Between the 1st and 2nd quadrants

Toss Up Answer: Y

Bonus: Short Answer

What is the remainder of $x^{10} + x + 1$ divided by $(x-1)^2$?

Bonus Answer: $11x-8$

3. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

Block A, with a mass of 4 kg, is moving with a speed of 3.0 m/s while block B, with a mass of 8 kg, is moving in the opposite direction with a speed of 3.0 m/s. The center of mass of the two block-system is moving with a velocity of:

- W) 1.0 m/s in the same direction as B
- X) 1.3 m/s in the same direction as A
- Y) 4.0 m/s in the same direction as B
- Z) 6.0 m/s in the same direction as A

Toss Up Answer: W

Bonus: Multiple Choice

A 60kg hunter gets a rope around a 300kg polar bear. They are stationary, 12m apart, on frictionless level ice. When the hunter pulls the polar bear to him, the polar bear will move:

- W) 0.5 m
- X) 2 m
- Y) 4 m
- Z) 7m

Bonus Answer: X

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4. CHEMISTRY

Writer: Mohammed Jamil

Toss Up: Multiple Choice

What suggests that metal, M, is not in Group I of the Periodic Table?

- W) M has a bright, silvery appearance and is a good conductor of electricity.
- X) M is hard and difficult to cut
- Y) M produces an alkaline solution when it reacts with water.
- Z) M produces hydrogen gas when it reacts with water.

Toss Up Answer: X

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Bonus: Multiple Choice

Lactic acid, $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$, causes pain when it builds up in muscles.

Which reagent reacts with both of the $-\text{OH}$ groups in lactic acid?

- W) acidified potassium dichromate(VI)
- X) ethanol
- Y) sodium
- Z) sodium hydroxide

Bonus Answer: Y

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5. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What kind of lens has a different optical power and focal length in two orientations perpendicular to each other?

- W) Toric
- X) Parabolic
- Y) Cylindrical
- Z) Ellipsoid

Toss Up Answer: W

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Bonus: Multiple Choice

Einstein's Field Equations are a set of how many equations in his theory of general relativity?

- W) 7
- X) 9
- Y) 10
- Z) 11

Bonus Answer: Y

6. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

The amino acid sequences encoded by the red and green visual pigment genes in humans are 96% identical. These two loci are found close together on the X chromosome. What mechanism most likely led to the evolution of these two genes?

- W) Horizontal gene transfer followed by sequence divergence
- X) Gene duplication followed by sequence divergence
- Y) Inversion of the human X chromosome
- Z) Polyploidization

Toss Up Answer: X

Bonus: Multiple Choice

Genetic drift is best described as:

- W) evolutionary change due to natural selection.
- X) changes in the proportion of homozygous recessive individuals due to random mating.
- Y) a random change in allele frequencies that benefits the population.
- Z) evolutionary change due to random events.

Bonus Answer: Z

7. 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

Bonus: Short Answer

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

Bonus Answer: 58%

8. BIOLOGY

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

The structure of bone tissue suits the function. Which of the following bone tissues is adapted to support weight and withstand tension stress?

- W) Spongy bone
- X) Irregular bone
- Y) Compact bone
- Z) Trabecular bone

Toss Up Answer: Y

Bonus: Short Answer

Which hormone increases osteoclast activity to release more calcium ions into the bloodstream?

Bonus Answer: Parathyroid Hormone

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9. EARTH and SPACE

Writer: Andrew Chen (Senior)

Toss Up: Multiple Choice

There are many mineral categories. Which of the following mineral groups below is classified based on varying ratios of silicon and oxygen?

W) Sulfides

X) Phosphates

Y) Carbonates

Z) Silicates

Toss Up Answer: Z

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Bonus: Short Answer

Of the following minerals listed, which belong in the mineral group of silicates: Olivine, Mica, Topaz and Talc.

Bonus Answer: Olivine, Mica, Topaz (1, 2, 3)

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10. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

Which of the following cannot be the root of a polynomial with rational coefficients?

W) $5i + 6$

X) $\phi - 1/2$, where ϕ is the golden ratio

Y) $\sqrt{3+i}$

Z) $6 - \pi i$

Toss Up Answer: Z

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Bonus: Short Answer

What is the name given to a number that is not a root of any non-zero polynomial equation with rational coefficients?

Bonus Answer: Transcendental number (Accept transcendental)

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11. CHEMISTRY

Writer: Andrew Chen (Senior)

Toss Up: Multiple Choice

Choose the best choice below to fill in the blanks. When a system reaches equilibrium, the concentrations of the products and reactants are [blank] and the rate of the forward and reverse reactions are [blank].

W) constant, equal

X) equal, constant

Y) unequal, unconstant

Z) constant, unequal

Toss Up Answer: W

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Bonus: Short Answer

Which of the following acids are polyprotic: nitrous acid, nitric acid, sulfurous acid, sulfuric acid and hypochlorous acid.

Bonus Answer: 3 and 4 (sulfurous acid and sulfuric acid)

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12. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

Fermat's Last Theorem conjectures that no three positive integers a, b , and c can satisfy the equation $a^n + b^n = c^n$ for any integer value of n greater than 2. It went unproved for more than 300 years until it was finally proved in 1994 by a mathematician who received a substantial monetary prize only this year. What is the name of this mathematician?

- W) Grigori Perelman
- X) John Nash
- Y) Andrew Wiles
- Z) Terence Tao

Toss Up Answer: Y

Bonus: Short Answer

Prime numbers of the form $2^n + 1$, where n is a non-negative integer, are known as this.

Bonus Answer: Fermat Primes

13. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Which of the following elements is found in the earth's crust as a native element?

- W) argon
- X) silicon
- Y) chlorine
- Z) oxygen

Toss Up Answer: X

Bonus: Multiple Choice

In geological studies, cemented volcanic ash is called:

- W) caldera
- X) a-a
- Y) lava
- Z) tuff

Bonus Answer: Z

14. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Short Answer

Completely expand $(x-2y)^3$

Bonus Answer: $x^3 - 6x^2y + 12xy^2 - 8y^3$

Bonus: Short Answer

What is the sum of all the terms in the seventh row of Pascal's triangle?

Bonus Answer: 128

15. PHYSICS

Writer: Aaron Gee

Toss Up: Multiple Choice

The inelastic scattering of a photon by a free electron was first explained by which of the following scientists?

- W) Compton
- X) Hertz
- Y) Einstein
- Z) Newton

Toss Up Answer: W

Bonus: Multiple Choice

The Tesla and the Gauss are units of measure of

- W) magnetic field strength
- X) conductance
- Y) light
- Z) electrical current

Bonus Answer: W

16. CHEMISTRY

Writer: Olivia Gallager

Toss Up: Short Answer

For E2 reactions to occur, the Hydrogen has to be what to the leaving group?

Bonus Answer: antiperiplanar

Bonus: Short Answer

List the following formations in order of lowest stability to highest: Trans, Geminal, Cis

Bonus Answer: cis, geminal, trans

17. EARTH and SPACE

Writer: Matthew Lee

Toss Up: Short Answer

Identify on which days day and night are equal in length.

1) estival solstice 2) autumnal equinox 3) hibernal solstice 4) vernal equinox

Bonus Answer: 2 and 4

Bonus: Short Answer

Approximately how many degrees of latitude contain areas that will see a noon sun at the zenith during some point in the year?

Bonus Answer: ~47 degrees (between the Tropic of Cancer and the Tropic of Capricorn)

18. PHYSICS

Writer: Nicholas Adit

Toss Up: Multiple Choice

A light ray passes through a prism, causing a dispersion of light. Which color will have the greatest angle of deviation?

- W) Red
- X) Yellow
- Y) Green
- Z) Blue

Toss Up Answer: Z

Bonus: Short Answer

Put the following electromagnetic waves in order of increasing wavelength: Microwaves, Ultraviolet, Gamma Rays, Radio Waves, Visible Light, Infrared, X-rays.

Bonus Answer: Gamma Rays, X-rays, Ultraviolet, Visible Light, Infrared, Microwaves, Radio Waves

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19. 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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20. EARTH and SPACE

Writer: Janine Goh

Toss Up: Short Answer

Name 3 dwarf planets

Bonus Answer: Pluto, Ceres, Makemake, Eris, Haumea (any 3)

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Bonus: Short Answer

Which coloured stars are the hottest?

Bonus Answer: Blue

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21. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Motor proteins transport vesicles along which cytoskeletal fiber?

Bonus Answer: microtubules

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Bonus: Short Answer

Shape abnormalities of the nuclear lamina are most likely a result of a defect in which cytoskeletal structure?

Bonus Answer: intermediate filaments

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22. CHEMISTRY

Writer: Shantanu Jha

Toss Up: Multiple Choice

What term describes a particular way that ions and molecules bind metal ions?

- W) Chelation
- X) Supposition

- Y) Coordination
- Z) Fluxing

Toss Up Answer: W

Bonus: Multiple Choice

Crystals which acquire a charge when compressed, twisted or distorted are said to be what?

- W) Ceramic
- X) Transduced
- Y) Magnetostricted
- Z) Piezoelectric

Bonus Answer: Z

23. BIOLOGY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which of the following is true about population ecology?

- W) Carrying capacity is never exceeded.
- X) The maximum sustainable yield occurs at a population size of half the carrying capacity.
- Y) Humans are r-selecting species.
- Z) Exponential growth is modeled by the J curve.

Toss Up Answer:

Bonus: Short Answer

Who is known as the father of ecology?

Bonus Answer:

24. CHEMISTRY

Writer: Janine Goh

Toss Up: Multiple Choice

Who discovered electronegativity?

- W) Linus Pauling
- X) Ernest Rutherford
- Y) Harold Urey
- Z) Carl Bosch

Toss Up Answer: W

Bonus: Short Answer

List 2 gases used in the Miller-Urey experiment

Bonus Answer: Hydrogen, Water, Ammonia, Methane

25. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

How do macrophages recognize the pathogens that they engulf?

- W) using broad range pathogen-associated molecular patterns
- X) by discerning between self MHC molecules and pathogen MHC molecules
- Y) by using receptors that are specific to a particular pathogen
- Z) macrophages ingest cells randomly

Toss Up Answer: W

Bonus: Short Answer

Choose all of the following that are ways macrophages destroy the pathogens that they engulf.

- 1) Phagosomes fuse with lysosomes, killing the pathogen inside.
- 2) Oxide ion is produced by NADPH oxidase and is toxic to bacteria.
- 3) Hydrogen peroxide is produced by superoxide dismutase and is toxic to bacteria.
- 4) Hydroxyl radicals, hypochlorite, and hypobromite are produced by peroxidases and are toxic to bacteria.

Bonus Answer: 1, 3, 4
