

Round 21

1. BIOLOGY

Writer: Matthew Lee

Toss Up: Short Answer

The phenomenon where bacteria monitor the presence of secreted signaling molecules to determine the local density of cells is called?

Bonus Answer: Quorum sensing

Bonus: Short Answer

Quorum sensing allows bacteria to coordinate their behaviors in synchrony. One example of said behavior is illustrated when you find them on your teeth when you wake up. What has formed on your teeth?

Bonus Answer: biofilm

2. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

If we could observe all forms of radiation, what would the brightest star be?

Bonus Answer: Betelgeuse

Bonus: Multiple Choice

In 12000 years, which star will take the place of our North Star?

W) Aldebaran

X) Vega

Y) Sirius

Z) Rigel

Bonus Answer: X

3. CHEMISTRY

Writer: Siam Muquit

Toss Up: Multiple Choice

What is the principal quantum number of Sodium?

W) 0

X) 1

Y) 2

Z) 3

Toss Up Answer: Z

Bonus: Short Answer

What are the possible angular momentum quantum numbers for sodium?

Bonus Answer: 0, 1, 2

4. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What spectral type does the star Betelgeuse fall into?

Bonus Answer: M

Bonus: Multiple Choice

When was the last major supernova in the Milky Way detected?

- W) 1604
- X) 1863
- Y) 1973
- Z) 1989

Bonus Answer: W

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5. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

How many distinct roots does $x^3 - 6x^2 + 32$ have

Bonus Answer: 2

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Bonus: Short Answer

What is the remainder when $x^3 - 6x^2 + 32$ is divided by $x - 1$

Bonus Answer: 27

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6. ENERGY

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

In a typical power plant used to generate electricity in the U.S., the percentage of energy in the fuel that is converted to electricity is about:

- W) 60%
- X) 90%
- Y) 20%
- Z) 35%

Toss Up Answer: Z

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Bonus: Short Answer

The Nuclear Waste Policy Act of 1982 and amendments require what

Federal agency to site, construct and operate a geologic repository for disposal of high-level nuclear waste?

Bonus Answer: U.S. Department of Energy

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7. MATHEMATICS

Writer: Janine Goh

Toss Up: Short Answer

In what type or types of triangle can the angle bisector, the altitude and the median be the same line?

Bonus Answer: Isosceles and equilateral triangle

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Bonus: Short Answer

Find the other roots of $x^3 + 6x^2 - 13x - 42$ if one of them is -2

Bonus Answer: $-7, 3$

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8. CHEMISTRY

Writer: Hanna Yang

Toss Up: Multiple Choice

Which of the following reactions is expected to produce a precipitate?

- W) $\text{CdSO}_4 + \text{K}_2\text{S} \rightarrow \text{CdS} + \text{K}_2\text{SO}_4$
- X) $\text{CoCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{CoSO}_4 + \text{NaCl}$
- Y) $\text{HI} + \text{Zn}(\text{NO}_3)_2 \rightarrow \text{ZnI} + \text{H}(\text{NO}_3)_2$

Z) $\text{Pb}(\text{NO}_3)_2 + \text{K}_2\text{SO}_4 \rightarrow 2\text{KNO}_3 + \text{PbSO}_4$

Toss Up Answer: W

Bonus: Short Answer

Name the precipitate for the following reaction: $3\text{CaCl}_2 + 2\text{Na}_3\text{PO}_4 \rightarrow ? + ?$

Bonus Answer: $\text{Ca}_3(\text{PO}_4)_2$ (Calcium Phosphate)

9. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What type of radiation is both the most penetrating and the most effectively stopped if blocked by a hydrogen-rich material?

- W) Alpha
- X) Beta
- Y) Gamma
- Z) Neutron

Toss Up Answer: Z

Bonus: Multiple Choice

What type of radiation originates from the electron cloud?

- W) Alpha
- X) Beta
- Y) X-Ray
- Z) Gamma

Bonus Answer: Y

10. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Which of the following is a way in which the cell increases gene expression in the nucleus?

- W) Acetylation of histone tails
- X) DNA methylation
- Y) Locating a gene within heterochromatin
- Z) Dephosphorylating DNA

Toss Up Answer: W

Bonus: Multiple Choice

Which of the following chemicals or groups of chemicals is not a major determinant of flower color?

- W) Flavonols
- X) Carotenoids
- Y) Cyanidin
- Z) Phytoalexins

Bonus Answer: Z

11. 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%

12. MATHEMATICS

Writer: Hanna Yang

Toss Up: Multiple Choice

For which of the following values of x is $(x^2+x+4)/(x)$ an integer?

W) 3

X) 4

Y) 5

Z) 6

Toss Up Answer: X

Bonus: Short Answer

Find the remainder when $343x^3+49x^2+14x+1$ is divided by $7x - 1$.

Bonus Answer: 5

13. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which molecule or molecules tags proteins for degradation by proteasomes?

W) ubiquinone

X) ubiquitin

Y) control elements

Z) spliceosomes

Toss Up Answer: X

Bonus: Short Answer

Name all of the following RNA molecules that can perform post-transcriptional and translational modifications on mRNA.

(1) siRNA

(2) piRNA

(3) miRNA

(4) snRNA

Bonus Answer: 1, 2, 3, 4 (all of them)

14. 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

15. CHEMISTRY

Writer: Shanjeed Ali

Toss Up: Multiple Choice

Which element has the highest ionization energy?

- W) Chlorine
- X) Bromine
- Y) Selenium
- Z) Technetium

Toss Up Answer: W

Bonus: Short Answer

What are the periodic table trends for ionization energy?

Bonus Answer: Increases left to right and decreases from the top to the bottom

16. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

A step-down transformer has a turns ratio less than

Bonus Answer: One

Bonus: Multiple Choice

By design, wires with the highest resistance are built into

- W) Clocks
- X) Toasters
- Y) Telephones
- Z) Stereo Speakers

Bonus Answer: X

17. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which of the following antibody functions is the most effective against viruses and bacterial exotoxins?

- W) opsonization
- X) neutralization
- Y) complement activation
- Z) cell mediated immunity

Toss Up Answer: X

Bonus: Multiple Choice

What is the main function of the complement system in innate immunity?

- W) destroy pathogens by lysing their cell walls
- X) mark cells for destruction by cytotoxic T cells
- Y) coat the pathogen surface to better enable phagocytes to engulf and destroy the bacteria
- Z) recruit neutrophils and other granulocytes

Bonus Answer: Y

18. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What type of damping provides the quickest approach to zero amplitude for a damped oscillator?

- W) Hyperdamping
- X) Overdamping
- Y) Critical Damping
- Z) Underdamping

Toss Up Answer: Y

Bonus: Short Answer

What is the damping coefficient equal to for a critically damped spring system with a spring constant of 1000 Newtons/meters and oscillating mass of 10 kg?

Bonus Answer: 10Hz [at critical damping the damping coefficient is equal to the undamped resonant frequency, which is equal to the $\sqrt{\text{spring constant/mass}}$]

19. CHEMISTRY

Writer: Mohammed Jamil

Toss Up: Short Answer

Calculate the approximate amount of heat necessary to raise the temperature of 72 grams of liquid water from 13.0°C to 43.0°C. (The specific heat of water liquid is 4.18 J/g°C.)

Bonus Answer: 9028.8

Bonus: Short Answer

The molarity of a solution obtained when 500.0 mL of 6.0 M HCl is diluted to a final volume of 750.0 mL is

Bonus Answer: 4.0 M

20. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What French physicist, living from 1623-1662, discovered the basic principles of pressures on fluids?

- W) Andre Marie Ampere
- X) Charles-Augustin de Coulomb
- Y) Joseph-Louis Lagrange
- Z) Blaise Pascal

Toss Up Answer: Z

Bonus: Multiple Choice

Supersymmetry is a proposed extension of space-time symmetry relating what 2 basic classes of elementary particles?

- W) Bosons and Fermions
- X) Hadrons and Leptons
- Y) Leptons and Mesons
- Z) Fermions and Mesons

Bonus Answer: W

21. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

The majority of ATP molecules generated from cellular respiration comes from which process?

- W) glycolysis
- X) pyruvate oxidation
- Y) the Krebs cycle
- Z) chemiosmosis

Toss Up Answer: Z

Bonus: Short Answer

How many ATP molecules on average does chemiosmosis produce per glucose?

Bonus Answer: Accept: 26, 28, or both.

22. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

For the hydrogen atom, which series describes electron transitions to the N=1 orbit, the lowest energy electron orbit?

Bonus Answer: Lyman series

Bonus: Short Answer

Electric current may be expressed in which one of the following units?

Bonus Answer: coulombs/second

23. CHEMISTRY

Writer: Josh Tish

Toss Up: Multiple Choice

Which of the following is a nonelectrolyte in aqueous solution?

- W) H₂SO₄
- X) NaC₂H₃O₂
- Y) K₂CO₃

Z) CH₂O

Toss Up Answer: Z

Bonus: Multiple Choice

An aqueous solution of potassium sulfate has a freezing point of -2.24°C . What is its molality?

($K_f = 1.86^{\circ}\text{C}\cdot\text{m}^{-1}$)

W) 0.401 m

X) 0.602 m

Y) 1.20 m

Z) 4.17 m

Bonus Answer: W

24. BIOLOGY

Writer: Josh Tish

Toss Up: Short Answer

During the late Carboniferous period, terrestrial arthropods such as Hexapoda, Myriapoda, and Arachnida showed great diversity in form and size. Why, in terms of abiotic environmental factors, are modern day arthropods are much smaller than their Carboniferous ancestors?

Bonus Answer: decreased volume of oxygen in the atmosphere in modern times versus comparatively higher volume of oxygen present during Carboniferous Era

Bonus: Short Answer

Arrange the following five events in the order that explains the bulk flow of substances in the phloem.

1. Sugar moves down the stem.
2. Leaf cells produce sugar by photosynthesis.
3. Sugar is transported from cell to cell via the apoplast and/or symplast.
4. Solutes are actively transported into sieve elements.
5. Water diffuses into the sieve tube elements.

Bonus Answer: 2,3,4,1,5

25. CHEMISTRY

Writer: George Papastefanou

Toss Up: Short Answer

Using noble gas abbreviation, what is the electron configuration of a silver atom?

Bonus Answer: [Kr] 4d¹⁰ 5s¹

Bonus: Short Answer

What is the most electropositive element in group 1A?

Bonus Answer: Francium
