

Round 20

1. CHEMISTRY

Writer: Shanjeed Ali

Toss Up: Short Answer

What will happen solubility of oxygen gas as temperature increases?

Bonus Answer: Decrease

Bonus: Short Answer

Which elements are found in the form of diatomic gases at room temperature?

Bonus Answer: Hydrogen, oxygen, fluorine, chlorine, nitrogen

2. EARTH and SPACE

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

A stream can lengthen its channel by:

- W) hydraulic action
- X) headward erosion
- Y) downcutting
- Z) vertical accretion

Toss Up Answer: X

Bonus: Multiple Choice

In uniform flat rocks, drainage patterns are typically

- W) Radial
- X) dendritic
- Y) trellis
- Z) braided

Bonus Answer: X

3. CHEMISTRY

Writer: Josh Tish

Toss Up: Multiple Choice

A 20.0 g sample of mercury(II) oxide is heated strongly, causing it to decompose to metallic Hg and O₂ gas. What volume of O₂ gas is produced (measured at STP)?

- W) 1.03 L
- X) 2.07 L
- Y) 4.14 L
- Z) 14.0 L

Toss Up Answer: W

Bonus: Multiple Choice

When 30.0 mL of 0.10 M AgNO₃ is added to 30.0 mL of 0.10 M NaCl, aqueous NaNO₃ and solid AgCl are formed. How much solid AgCl is produced?

- W) 0.0030 mol
- X) 0.0060 mol
- Y) 0.030 mol

Z) 0.060 mol

Bonus Answer: W

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4. MATHEMATICS

Writer: Justin Lam

Toss Up: Multiple Choice

Which of the following are prime factors of the number 5304?

W) 19

X) 7

Y) 5

Z) 13

Toss Up Answer: Z

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Bonus: Short Answer

What integer satisfies the equation $y = x^3 - 1$ [Read as: x to the third power subtracted by 1] when $y = 0$?

Bonus Answer: $x = 1$

(Explanation: The factors of the equation is $y = (x - 1)(x^2 + x + 1)$. We want to find an integer solution, so we take the factor $x - 1$ and set it to zero. By adding one to both sides, we see that $x = 1$.)

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5. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What is the most abundant element in the human body by mass?

Bonus Answer: Oxygen

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Bonus: Short Answer

What naturally occurring radioactive element is so common in homes that testing for its presence is often advisable?

Bonus Answer: Radon (accept: Rn)

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6. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

To determine if a rigid body is in equilibrium the vector sum of the gravitational forces acting on the particles of the body can always be replaced by a single force acting at which point, regardless of the uniformity of the gravitational field which acts upon it?

W) the center of mass

X) the geometrical center

Y) the center of gravity

Z) a point on the boundary

Toss Up Answer: Y

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Bonus: Short Answer

A uniform 120-N plank is supported by two forces acting at one end and at a point halfway between the plank center and the other end. What are the magnitudes of these two forces?

Bonus Answer: 40, 80

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7. CHEMISTRY

Writer: Shanjeed Ali

Toss Up: Short Answer

What is the net ionic reaction for the reaction between silver nitrate and potassium chloride?

Bonus Answer: $\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$

Bonus: Short Answer

Which of the following compounds are insoluble in water: potassium nitrate, barium chromate, nickel(II) hydroxide, and magnesium chloride?

Bonus Answer: Barium chromate and nickel(II) hydroxide

8. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

The focal length of a concave mirror is 2 meters. An object is positioned 6 meters in front of the mirror. Where is the image of this object formed?

Bonus Answer: 3 meters in front of the mirror

Bonus: Multiple Choice

A standing wave is formed on a tightly stretched string. The distance between a node and an antinode is how many wavelengths?

- W) $1/2$
- X) $1/4$
- Y) $1/8$
- Z) 1

Bonus Answer: X

9. MATHEMATICS

Writer: Ivan Zhang

Toss Up: Multiple Choice

A function with real coefficients with the zero $1 + 23i$ must have a multiplicity of at least?

- W) 1
- X) 23
- Y) 4
- Z) 2

Toss Up Answer: Z

Bonus: Short Answer

Find the zeros of the function: $0 = x^4 - 81$

Bonus Answer: $3i, -3i, 3, -3$

10. BIOLOGY

Writer: Shanjeed Ali

Toss Up: Short Answer

What term describes the number of times a normal human cell population can divide?

Bonus Answer: Hayflick limit

Bonus: Multiple Choice

What controls the Hayflick limit?

- W) apoptosis
- X) length of telomeres
- Y) genomic instability
- Z) genetic drift

Bonus Answer: X

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11. PHYSICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

Which of the following is the most correct statement of the equivalence principle?

- W) General relativity is equivalent to Newtonian gravity under certain conditions
- X) All kinds of energy are equivalent
- Y) The effects of accelerating a frame are indistinguishable from gravitational forces
- Z) The acceleration due to gravity is equivalent to GM/r under Newtonian conditions

Toss Up Answer: Y

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Bonus: Short Answer

When a particle collides with its corresponding antiparticle, they annihilate, producing photons with energy equal to their rest mass energy. Imagine that you had 1 g of hydrogen and 1 g of anti-hydrogen. If the energy released when they collide is in the form $[a \times 10^k \text{ Joules}]$, what's the value of k?

Bonus Answer: 14

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12. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

What is the penultimate spectral type of a star?

- W) F
- X) G
- Y) K
- Z) M

Toss Up Answer: Y

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Bonus: Short Answer

What spectral type is the Sun?

Bonus Answer: G

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13. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What is the electron configuration of $Mg(2+)$?

Bonus Answer: 1s2 2s2 2p6

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Bonus: Short Answer

What is the electron configuration of $Cu(2+)$?

Bonus Answer: 1s2 2s2 2p6 3s2 3p6 3d9

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14. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

What is the area of the circle $x^2+y^2=6/\pi^2$ in terms of π

Bonus Answer: $6/\pi$

Bonus: Short Answer

What is the area of the circle $x^2-4x+y^2-6y-2=0$ in terms of π

Bonus Answer: 15π

15. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

What law most directly states that the total of the electric flux out of a closed surface is equal to the charge enclosed divided by the permittivity?

Bonus Answer: Gauss's Law

Bonus: Short Answer

When a magnet is moved into a coil of wire, changing the magnetic field and magnetic flux through the coil, a voltage will be generated in the coil according to which law?

Bonus Answer: Faraday's Law

16. EARTH and SPACE

Writer: Benjamin Avrahami

Toss Up: Multiple Choice

Fog forms when the difference between temperature and dew point is:

- W) More than 7.5 degrees Celsius
- X) Between 5 and 7.5 degrees Celsius
- Y) Between 2.5 and 5 degrees Celsius
- Z) Less than 2.5 degrees Celsius

Toss Up Answer: Z

Bonus: Multiple Choice

Name how the environmental lapse rate changes going from the troposphere into the stratosphere:

- W) In the troposphere, it is positive; in the tropopause, it is negative; in the stratosphere, it is positive
- X) In the troposphere, it is negative; in the tropopause, it is positive; in the stratosphere, it is negative
- Y) In the troposphere, it is positive; in the tropopause, it is zero; in the stratosphere, it is negative
- Z) In the troposphere, it is negative; in the tropopause, it is zero; in the stratosphere, it is positive

Bonus Answer: Y

17. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Exocytotic vesicles are most frequently exported via the

- W) endoplasmic reticulum
- X) the nuclear envelope
- Y) the cis Golgi
- Z) the trans Golgi

Toss Up Answer: Z

Bonus: Multiple Choice

Endosomes formed as a result of receptor-mediated endocytosis are most frequently coated with which type of proteins?

- W) G proteins
- X) clathrins
- Y) pseudopodium
- Z) microtubules

Bonus Answer: X

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18. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

A heat engine does positive work W as it absorbs energy Q_h (READ AS: $Q_{\text{sub } h}$) from a heat reservoir and transfers energy Q_c (READ AS: $Q_{\text{sub } c}$) to a cold reservoir. What is the efficiency of the heat engine in terms of Q_h , Q_c , and W ?

Bonus Answer: W/Q_h

Bonus: Multiple Choice

For Christmas, Bobby Tables got a heater with a coefficient of performance of 10. If the heater supplies 50 kilojoules of heat into the room in 2 seconds, what is the power of the heater in kilowatts?

- W) 1
- X) 2.4
- Y) 2.1
- Z) 2.5

Bonus Answer: Z

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19. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

The majority of photosynthesis occurs in which part of the leaf?

- W) the veins
- X) the lower palisade layer
- Y) the upper palisade layer
- Z) the stomata

Toss Up Answer: Y

Bonus: Short Answer

What is the final electron receptor in photosynthetic light reactions?

Bonus Answer: NADP+ (DO NOT Accept: NADPH)

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20. PHYSICS

Writer: Jan Wojcik

Toss Up: Short Answer

An electron is being held in an electric field. The direction of the electric field lines of the electric field are East. In what direction will the electron move when it is released.

Bonus Answer: West (accept: Left)

Bonus: Multiple Choice

A proton is traveling to the right with a velocity of 1m/s and there is a magnetic field of 3 Teslas coming towards you.

What is the direction and magnitude of the force, in scientific notation to the nearest tenth, felt by the proton?

W) 4.8×10^{-19} N down

X) 4.8×10^{-19} N up

Y) 3.6×10^{-19} N down

Z) 3.6×10^{-19} N up

Bonus Answer: W

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21. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which of the following is not an electron carrier involved cellular respiration?

W) NADH

X) FADH₂

Y) NADPH

Z) NAD⁺

Toss Up Answer: Y

Bonus: Multiple Choice

For each turn of the Krebs cycle, how many electron carriers are produced?

W) 3 FADH₂ and 1 NADH

X) 6 NADH and 2 FADH₂

Y) 3 NAD⁺ and 1 FAD

Z) 3 NADH and 1 FADH₂

Bonus Answer: Z

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22. EARTH and SPACE

Writer: Shantanu Jha

Toss Up: Short Answer

What is the average temperature of the universe today to the nearest Kelvin?

Bonus Answer: 3K

Bonus: Short Answer

What is the most common star in the Milky Way Galaxy?

Bonus Answer: Red Dwarf

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23. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Which class of MHC molecules do helper TH2 cells interact with?

Bonus Answer: II (ACCEPT: class II)

Bonus: Short Answer

Name all of the following that correctly distinguish between B cell antibodies and T cell receptors.

- 1) Antibodies can bind to free antigens while T cell receptors can only bind to antigens displayed on MHC molecules.
- 2) T cell receptors contain two antigen binding sites while antibodies contain only one.
- 3) T cell receptors generally only bind to fragments of antigens while antibodies bind to whole antigen molecules.

4) Both antibodies and T cell receptors have discrete alpha and beta components.

Bonus Answer: 1, 3

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24. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

In which state is the oldest North American lake located?

W) California

X) Minnesota

Y) Ohio

Z) Utah

Toss Up Answer: W

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Bonus: Short Answer

What is the densest naturally occurring element?

Bonus Answer: Osmium

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25. EARTH and SPACE

Writer: Jan Wojcik

Toss Up: Multiple Choice

Which of the following pairs of minerals share the same cleavage?

W) Fluorite and Calcite

X) Mica and Galena

Y) Cryolite and Fluorite

Z) Halite and Sylvite

Toss Up Answer: Z

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Bonus: Short Answer

In how many directions does muscovite break (cleave)?

Bonus Answer: 1 (one)

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