

Round 28

1. EARTH and SPACE

Writer: Elias Milborn

Toss Up: Multiple Choice

In which of the following locations is it possible to find an esker formed during the Pleistocene [PLY-stuh-seen] epoch?

- W) Maryland
- X) West Virginia
- Y) Tennessee
- Z) Iowa

Toss Up Answer: Z

Bonus: Short Answer

Calculate the percent relative humidity for air at 70°F containing 10 millibars of water vapor if the saturation vapor pressure is 25 millibars at that temperature:

Bonus Answer: 40%

2. MATHEMATICS

Writer: Hanna Yang

Toss Up: Short Answer

What is the slope of a line parallel to $45x=9y+5$?

Bonus Answer: 5

Bonus: Multiple Choice

How many vertical asymptotes does $f(x)=(x^2+2x+1)/(x^3-x)$ have?

- W) 0
- X) 1
- Y) 2
- Z) 3

Bonus Answer: Y

3. EARTH and SPACE

Writer: Shantanu Jha

Toss Up: Short Answer

What physical quantity is the Schwarzschild radius of a Black Hole most dependent on?

Bonus Answer: Mass

Bonus: Multiple Choice

If the event horizon of a black hole is 10 km, then what is the radius of its photon sphere?

- W) 10km
- X) 15km
- Y) 20km
- Z) 25km

Bonus Answer: X

4. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

By name or number, which of these is a non-newtonian fluid?

1. Ketchup
2. Water
3. Custard
4. Toothpaste

Bonus Answer: 1,3,4

Bonus: Multiple Choice

What two parts comprise a semiconductor crystal?

- W) Lattice and Symmetry
- X) Motif and Basis
- Y) Motif and Symmetry
- Z) Basis and Lattice

Bonus Answer: Z

5. BIOLOGY

Writer: Siam Muquit

Toss Up: Short Answer

What does the Shannon Index quantify?

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

Bonus: Short Answer

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

Bonus Answer: 0

6. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A cube with 2-m sides and a bulk modulus of $4 \times 10^5 \text{ N/m}^2$ (READ 4 times 10 to the sixth newton meters squared). When it's subjected to a pressure of $2 \times 10^5 \text{ Pa}$, what is the resulting volume of the cube?

- W) 0.5 m^3
- X) 2 m^3
- Y) 3 m^3
- Z) 4 m^3

Toss Up Answer: Z

Bonus: Multiple Choice

A 4.0-m long steel beam with a cross-sectional area of $1.0 \times 10^{-2} \text{ m}^2$ and a Young's modulus of $2.0 \times 10^{11} \text{ N/m}^2$ is wedged horizontally between two vertical walls. In order to wedge the beam, it is compressed by 0.020mm. If the coefficient of static friction between the beam and the walls is 0.70, what is the maximum mass (including its own) it can bear without slipping?

- W) 700kg
- X) 710kg
- Y) 900kg
- Z) 910kg

Bonus Answer: X

7. 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: $3i, -3i, 3, -3$

8. PHYSICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

An electrical current flows across an infinite rectilinear wire. If its intensity of is doubled, then the magnetic field at a generic point:

- W) quadruples
- X) doubles
- Y) halves
- Z) remains unchanged

Toss Up Answer: X

Bonus: Short Answer

The current $I(t)$ flowing for a wire for $t \geq 0$ is given by $I(t) = 2^t(-t)$. Find the total charge that will flow through the wire.

Bonus Answer: $1/(\ln 2)$

9. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Amino acids are attached to their respective tRNA molecules by which enzyme?

Bonus Answer: aminoacyl-tRNA synthetase

Bonus: Short Answer

Which high energy molecule is responsible for forming the peptide bonds during translation elongation?

Bonus Answer: GTP (ACCEPT: guanosine triphosphate)

10. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

What is the German term for the energy released when high voltage electrons decelerate at impact with a metal and is also known as "breaking radiation"?

Bonus Answer: Bremsstrahlung

Bonus: Short Answer

Given that Planck's constant is $4 \cdot 10^{-15} \text{ eV} \cdot \text{s}$ (READ AS: 4 times 10 to the power of negative 15 electron volt second), what is the maximum kinetic energy, in electron volts, of an electron released from a metal with work function of 1 eV when a photon of frequency of 300 terahertz strikes the metal's surface?

Bonus Answer: 0.2 electron volts

11. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

If active transport is inhibited, the passive sodium and potassium ion fluxes across the axonal plasma membrane are still coupled. What makes these two passive ion fluxes dependent on each other?

- W) The membrane potential.
- X) The potassium channels.
- Y) The ratio of cholesterol to phospholipids in the membrane.
- Z) The pumping ratio of the Na⁺/K⁺ ATPase.

Toss Up Answer: W

Bonus: Multiple Choice

If a carboxylic acid has a pKa of 3.9, what percentage of the functional group will carry a negative charge at pH 4.9?

- W) 10%
- X) 90.90%
- Y) 9.09%
- Z) 50%

Bonus Answer: X

12. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What is the S.I. unit for luminous intensity?

- W) Lumen
- X) Candela
- Y) Newton
- Z) Watts

Toss Up Answer: X

Bonus: Multiple Choice

For an isotropic source how many candelas equals 3 lumens?

- W) 12π
- X) 10π
- Y) 4π
- Z) 2π

Bonus Answer: W

13. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Mutation in which of the following types of genes is least likely to result in higher chances of developing cancer?

- W) oncogene
- X) tumor suppressor gene

- Y) proto-oncogene
- Z) tumor necrosis factor gene

Toss Up Answer: Z

Bonus: Short Answer

Rearrange the following list of the structures of a nephron in the order in which filtrate flows through them:

1. proximal convoluted tubule
2. ascending limb of Loop of Henle
3. distal convoluted tubule
4. collecting duct
5. Bowman's capsule
6. descending limb of Loop of Henle

Bonus Answer: 5, 1, 6, 2, 3, 4

***A list of the structures or the correct reordering of the numbers assigned to each structure are valid answers**

14. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

Which of the 6 quarks is the lightest?

Bonus Answer: Up

Bonus: Multiple Choice

What is the "formal" SI unit of elementary particle spin?

- W) joule-second
- X) spin-h (planck constant)
- Y) joule-plancktime
- Z) spinor-second

Bonus Answer: W

15. CHEMISTRY

Writer: Jason Mohabir

Toss Up: Multiple Choice

The Standard Gibb's free energy, ΔG° , is

- W) the residual energy present in the reactants at equilibrium
- X) the residual energy present in the products at equilibrium
- Y) the energy required to convert one mole of reactants to one mole of products
- Z) the difference in the residual energy of reactants and products at equilibrium

Toss Up Answer: X

Bonus: Multiple Choice

If the enthalpy change for a reaction is zero, ΔG° is equal to

- W) $T\Delta S^\circ$
- X) $-T\Delta S^\circ$
- Y) $-\Delta H^\circ$
- Z) $\ln K_{eq}$

Bonus Answer: X

16. 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

17. EARTH and SPACE

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Which of the following is a local base level?

- W) Lake
- X) point bar
- Y) alluvial fan
- Z) floodplain

Toss Up Answer: Z

Bonus: Multiple Choice

The dry lake beds in many deserts are

- W) playas
- X) pediments
- Y) bajadas
- Z) mesas

Bonus Answer: W

18. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Acetone has a distinct smell, which many people associate with the smell of nail polish remover. What might the smell of acetone in the urine or on the breath of a patient indicate?

- W) The patient might be degrading too many amino acids from muscle proteolysis.
- X) The patient's body might be oxidizing too many fatty acids.
- Y) The patient might have enteritis and is absorbing endproducts of fermentation.
- Z) The patient might have fructose toxicity.

Toss Up Answer: X

Bonus: Multiple Choice

Which description best describes what would happen to the carbon cycle if all detritivores suddenly went on "strike" and stopped working?

- W) Carbon would increase in inorganic mass, while the atmospheric reservoir of carbon would continue to increase and plants would not be jeopardized.
- X) Carbon would accumulate in organic mass, the atmospheric reservoir of carbon would decline, and plants would eventually be starved for CO_2 .

- Y) Carbon would increase in organic mass, while the atmospheric reservoir of carbon would increase and plant-life would be starved for CO₂.
- Z) Carbon would decrease in organic mass, while the atmospheric reservoir of carbon would increase with the result that plant-life would be starved for CO₂.

Bonus Answer: X

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19. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

The principal mineral in most sand beaches is

- W) quartz
- X) orthoclase
- Y) magnetite
- Z) muscovite

Toss Up Answer: W

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Bonus: Short Answer

What geological event will allow you to see a Bishop's Ring?

Bonus Answer: a volcanic eruption

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20. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Multiple Choice

Triangle ABC is similar to triangle DEF. If triangle ABC has an area of 27, triangle DEF has an area of 3, and AC=12, then compute DF.

- W) 9
- X) 36
- Y) $2\sqrt{3}$
- Z) 4

Toss Up Answer: Z

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Bonus: Multiple Choice

What is the surface area, in terms of pi, of a cone if the slant height is 13 and the radius of the base is 5.

- W) 10 pi
- X) 20 pi
- Y) 30 pi
- Z) $10\sqrt{3}$ pi + 20

Bonus Answer: X

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21. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

If a gene is fixed in a population:

- W) the gene cannot undergo mutation
- X) one allele exhibits complete dominance over the other allele of that gene
- Y) only one allele appears for that gene in the population
- Z) the gene is incapable of recombination

Toss Up Answer: Y

Bonus: Multiple Choice

The Species-Area Relationship suggests that 10% of a given area supports:

- W) 90% of species
- X) 70% of species
- Y) 50% of species
- Z) 30% of species

Bonus Answer: Y

22. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

In which of the lists below are the atoms arranged in order of increasing size (increasing atomic radius)?

- W) Si In Ge N
- X) N In Ge Si
- Y) In Ge N Si
- Z) N Si Ge In

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the following matched pairs of name and formula has an error?

- W) H₃PO₄, phosphoric acid
- X) H₂SO₃, sulfurous acid
- Y) HNO₃, nitrous acid
- Z) HClO₄, perchloric acid

Bonus Answer: Y

23. CHEMISTRY

Writer: Nicholas Adit

Toss Up: Multiple Choice

Which of these compounds is not a saturated compound?

- W) ethane
- X) propanol
- Y) butanal
- Z) acetylene

Toss Up Answer: Z

Bonus: Short Answer

What are the two compounds formed when ethanoic acid and ethanol react?

Bonus Answer: Ethyl ethanoate and water

24. CHEMISTRY

Writer: Mohammed Jamil

Toss Up: Multiple Choice

Which of the following solutions would probably have the highest boiling point

- W) 0.1m of KOH
- X) 0.2m of CaCl_2
- Y) 0.2m of $\text{C}_6\text{H}_{12}\text{O}_6$
- Z) 0.1m CaCO_3

Toss Up Answer: X

Bonus: Short Answer

The molarity of a solution obtained when a stock solution of 50.0 ml of 6.0M HCl is diluted to a final volume of 480ml

Bonus Answer: 0.625

25. CHEMISTRY

Writer: Shanjeed Ali

Toss Up: Multiple Choice

How many elements are diatomic?

- W) 5
- X) 6
- Y) 7
- Z) 8

Toss Up Answer: Y

Bonus: Short Answer

Which elements are liquid at room temperature?

Bonus Answer: Mercury, Bromine
