

Round 26

1. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

The chemical EDTA is routinely used in many experiments. For example, EDTA is used in electrophoresis buffer solutions. Which of the following statements is not true?

- W) EDTA has a strong binding affinity for divalent and some trivalent cations.
- X) EDTA is a catalyst for polymer formation and essential for protein and nucleic acid polymerization.
- Y) EDTA is a chelator.
- Z) EDTA is used to help denature proteins and weaken cell membranes.

Toss Up Answer: X

Bonus: Multiple Choice

Which of the following statements is not true?

- W) Insects, birds, and many reptiles excrete nitrogenous waste in the form of urea.
- X) Neurons have evolved to speed the communication between distant cells in multi-cellular organisms.
- Y) Synapses are specialized connections between neurons to facilitate the formation of complex neuronal networks.
- Z) The regulatory proteins tropomyosin and troponin control the contraction of contractile filaments, actin and myosin.

Bonus Answer: W

2. CHEMISTRY

Writer: George Papastefanou

Toss Up: Short Answer

What is the common name of the chemical with formula $C_9H_8O_4$

Bonus Answer: Aspirin

Bonus: Short Answer

What is the molar mass, to the nearest whole number, of three moles of aspirin?

Bonus Answer: 540 g

3. EARTH and SPACE

Writer: George Papastefanou

Toss Up: Multiple Choice

The North Pacific Gyre is mostly located within what latitudinal zone?

- W) The North Frigid Zone
- X) The Torrid Zone
- Y) The Horse Latitudes
- Z) The North Temperate Zone

Toss Up Answer: Z

Bonus: Short Answer

What ocean current keeps Western Europe relatively warm for its latitude?

Bonus Answer: North Atlantic Current (accept North Atlantic Drift, but not Gulf Stream)

4. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Multiple Choice

What mathematician proved the existence of a straight edge and compass construction of a regular 17-gon?

- W) Euler
- X) Euclid
- Y) Gauss
- Z) Galois [Gal-wah]

Toss Up Answer: Y

Bonus: Short Answer

Given $\sin X = 1/3$ [sine of x equals one third], compute $\cos^2(3X)$ [co-sine squared of three x].

Bonus Answer: -23/27

5. 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

6. CHEMISTRY

Writer: Andrew Chen (Senior)

Toss Up: Multiple Choice

Which of these ionic compounds will have the greatest melting point?

- W) NaCl
- X) NaBr
- Y) NaI
- Z) NaF

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the given compounds exhibit sp^3 hybridization?

- W) Ozone
- X) Oxygen gas
- Y) Nitrogen gas
- Z) Methane

Bonus Answer: Z

7. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

What is the thrust of a rocket ejecting fuel at 200 kg/s and with an exhaust velocity of 1500 m/s?

- W) 30000 newtons
- X) 60000 newtons
- Y) 90000 newtons
- Z) 300000 newtons

Toss Up Answer: Z

Bonus: Multiple Choice

A solid disk with a rotational inertia of $5 \text{ kg}\cdot\text{m}^2$ (READ AS: kilogram meters squared) and a radius of 0.25 m rotates on a fixed axis perpendicular to the disk and through its center. If a force of 2 N is applied tangentially to the disk, what is the work done by the force after half of a revolution to the nearest tenth?

- W) 0.4 J
- X) 0.8 J
- Y) 1.6 J
- Z) 3.1 J

Bonus Answer: Y

8. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Multiple Choice

MULTIPLE CHOICE: tossup

For an infinite sequence of numbers a_0, a_1, \dots , which of the following best describes the polynomial $P(x) = \sum_{i=0}^{\infty} a_i x^i$.

- W) Reimann-Zeta function
- X) Generating function
- Y) Newtonian series
- Z) Tchebychev polynomial

Toss Up Answer: X

Bonus: Short Answer

In the Pell equation $x^2 - 3y^2 = 1$ the smallest solution is $x=2$ and $y=1$. The next smallest solution is $x=7$ and $y=4$. Compute the third smallest solution.

Bonus Answer: $x=26, y=15$

Also accept (26,15)

9. CHEMISTRY

Writer: Janine Goh

Toss Up: Multiple Choice

Which of the following elements are Lanthanides?

- W) Lawrencium
- X) Meltnerium
- Y) Seaborgium

Z) Terbium

Toss Up Answer: Z

Bonus: Short Answer

What unit does electronegativity use?

Bonus Answer: No unit

10. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

Diffraction plays an important role in which of the following phenomena?

W) The sun appearing as a disk to the naked eye

X) Light being bent through a glass prism

Y) Shouting through a megaphone

Z) A thin soap film displaying colors when light is incident on it

Toss Up Answer: Y

Bonus: Multiple Choice

A beam of light passes through one polarizing filter and through another filter rotated at 45 degrees compared to the first one. If the original intensity of the light was 100 W, what is the new intensity of the polarized light?

W) 50

X) 75

Y) 100

Z) 150

Bonus Answer: W

11. BIOLOGY

Writer: Matthew Lee

Toss Up: Short Answer

Name the syndrome caused by a partial deletion of chromosome 5 that results in an abnormal cry in the patient.

Bonus Answer: Cri Du Chat

Bonus: Multiple Choice

If nondisjunction occurs in a cell during meiosis I, how many of the 4 daughter cells will have an abnormal chromosome number?

W) 1

X) 2

Y) 3

Z) 4

Bonus Answer: Z

12. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Short Answer

Which of the following statements concerning prime numbers are true?

1. If a and n are relatively prime then there are infinitely many primes that leave a remainder of a when divided by n .
2. All integers less than p are quadratic residues modulo p .

3. There are infinitely many prime numbers

Bonus Answer: 1 and 3

Bonus: Short Answer

If $a_1 + a_2 + a_3 + a_4 + a_5 = 17$ for positive integers a_1, a_2, a_3, a_4, a_5 , then maximize the product $a_1 a_2 a_3 a_4 a_5$?

Bonus Answer: 432

13. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

When ^{236}U fissions, the products might be which of the following?

W) Ba-146 (READ AS: barium 146), Kr-89 (READ AS: krypton 89), and a proton

X) Ba-146 (READ AS: barium 146), Kr-89 (READ AS: krypton 89), and a neutron

Y) Cs-148 (READ AS: cesium 148) and Br-85 (READ AS: barium 85)

Z) two uranium nuclei

Toss Up Answer: X

Bonus: Short Answer

In the proton-proton cycle, two hydrogen atoms initially react to form what 3 particles?

Bonus Answer: Deuterium, a positron, and an electron neutrino (ACCEPT neutrino)

14. BIOLOGY

Writer: Matthew Lee

Toss Up: Multiple Choice

Which of the following types of antibodies is typically used to fight parasitic infections?

W) IgE

X) IgM

Y) IgG

Z) IgA

Toss Up Answer: W

Bonus: Short Answer

The immune response can include complement protein cascades, which form pores in the membrane of the target cell. The cell then swells and lyses due to water and ions rushing in. The type of complex that forms the pore in the membrane is called?

Bonus Answer: membrane attack (accept: membrane attack complex)

15. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Short Answer

Which of the following transformations is a wallpaper group

1 Rotation by 90 degrees

2 Glide Reflection

3 Dilation

4 Reflection

Bonus Answer: 1,2, and 4

Bonus: Short Answer

In a circle O, diameter AB is drawn. Chord CD intersects AB at E.

If CP = 3, DP = 6, AP = x, and BP = x+4, compute the radius of the circle.

Bonus Answer: sqrt(22)

16. EARTH and SPACE

Writer: Benjamin Avrahami

Toss Up: Short Answer

From least to greatest, order these minerals in order of pressure needed to create it: Schist, Phyllite, Gneiss, Slate

Bonus Answer: 4,2,1,3

Bonus: Short Answer

During what era did oxygen begin to enter the atmosphere in abundance?

Bonus Answer: Early Proterozoic or Proterozoic

17. PHYSICS

Writer: George Papastefanou

Toss Up: Multiple Choice

What is the fundamental frequency, in Hz, for a string with a Tension of 250 N, a mass per length of .25 grams per meter, and a length of 50 cm?

W) 1200

X) 5000

Y) 1000

Z) 250

Toss Up Answer: Y

Bonus: Short Answer

Will a projectile fired at a 30 degree angle at 55 m/s clear a 25-meter fence located 50 meters away?

Bonus Answer: No (height at that point is ~23.5 m)

18. EARTH and SPACE

Writer: Elias Milborn

Toss Up: Multiple Choice

Which of the following is a term specifically given to water that replenishes an aquifer?

W) Recharge

X) Discharge

Y) Hydraulic

Z) Permeable

Toss Up Answer: W

Bonus: Multiple Choice

When a strong south wind occurs along the west coast of North America, Ekman transport causes water to move to which of the following?

W) onshore

X) offshore

Y) alongshore to the south

Z) alongshore to the north

Bonus Answer: W

=====

19. 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

=====

20. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

If the sound intensity is 10,000 times the threshold of hearing then what is the intensity in decibels?

Bonus Answer: 40dB

=====

Bonus: Short Answer

At what standard frequency would 60 decibels have a loudness of 60 phons?

Bonus Answer: 1000Hz

=====

21. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Multiple Choice

Which of the following elements has the largest number of possible oxidation states?

W) Fe

X) Cl

Y) Ca

Z) Mn

Toss Up Answer: X

=====

Bonus: Multiple Choice

What is the minimum number of electrons needed to balance the following half-reaction with whole number coefficients?

$\text{IO}_3^- \rightarrow \text{I}_2$

W) 1 e-

X) 2 e-

Y) 5 e-

Z) 10 e-

Bonus Answer: Z

22. BIOLOGY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which term describes organisms that can only tolerate a narrow range of temperatures?

- W) Eurythermal
- X) Stenothermal
- Y) Acrithermal
- Z) Anglothermal

Toss Up Answer: X

Bonus: Multiple Choice

What is the name of the ecological phenomenon, related to the Small Population hypothesis, that describes a species' path to extinction due to inbreeding and genetic drift?

- W) Inbreeding depression
- X) Outbreeding depression
- Y) Extinction cascade
- Z) Extinction vortex

Bonus Answer: Z

23. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

In planetary motion the line from the star to the planet sweeps out equal areas in equal times. This is a direct consequence of which law?

Bonus Answer: law of conservation of angular momentum (DO NOT ACCEPT: Kepler's Second Law)

Bonus: Multiple Choice

In modern theoretical physics, what effect plays an important role in the chiral bag model of the nucleon?

- W) Anderson
- X) Sabinsky
- Y) Lamoreaux
- Z) Casimir

Bonus Answer: Z

24. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Certain amino acids are considered essential in an animal's diet because they cannot be produced within the organism. Which of the following cellular processes would be most DIRECTLY affected by a dietary deficiency in essential amino acids?

- W) Translation of mRNA
- X) Cellular respiration
- Y) Cell division
- Z) Oxygen transport

Toss Up Answer: W

Bonus: Multiple Choice

Integral transmembrane proteins are proteins embedded in the cell membrane. Which of the following amino acids would you MOST expect to find in the transmembrane region of such proteins?

W) Tryptophan

X) Lysine

Y) Arginine

Z) Serine

Bonus Answer: W
