

Round 17

1. EARTH and SPACE

Writer: Benjamin Avrahami

Toss Up: Multiple Choice

At above what size, in cm, does a rock need to be in order to be a boulder?

W) 15.3

X) 25.6

Y) 40.2

Z) 22.9

Toss Up Answer: X

Bonus: Short Answer

At which two zones of Earth's atmosphere does the temperature rise as the altitude increases?

Bonus Answer: Stratosphere and Thermosphere

2. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Short Answer

In simplest terms, find the value of the limit as x approaches 0 of $(4^x - 2^x) / x$

Bonus Answer: $\ln(2)$ (do not accept $\ln(4) - \ln(2)$)

Bonus: Short Answer

How many real solutions for x does the equation $x = \ln(x) + 2$ have?

Bonus Answer: 2

3. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

What structure in the small intestine increases epithelial surface area?

Bonus Answer: Villi or microvilli

Bonus: Short Answer

What structure in the stomach increases epithelial surface area?

Bonus Answer: Rugae

4. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

A right triangle has a hypotenuse of length 12. The altitude to the hypotenuse has a length of 8. What is the area of this triangle?

W) 36

X) 48

Y) 60

Z) The triangle is impossible to construct

Toss Up Answer: Z

Bonus: Short Answer

Two REAL numbers x and y satisfy the system of equations: $x + y = 12$; $x^2 + y^2 = 64$. Find the value of the product xy .

Bonus Answer: The system has no solutions.

5. CHEMISTRY

Writer: Josh Tish

Toss Up: Multiple Choice

Dissolution of which salt in water results in a decrease in the temperature of the solution?

W) KHSO_4

X) NaOH

Y) AlCl_3

Z) NH_4NO_3

Toss Up Answer: Z

Bonus: Multiple Choice

What is observed when equal volumes of 0.1 M aqueous HCl and 0.01 M aqueous Na_2SO_3 are mixed?

W) Colorless solution and a white precipitate

X) Colored solution and a white precipitate

Y) Colorless solution and a colored precipitate

Z) Colorless solution, no precipitate, and gas evolution

Bonus Answer: Z

6. EARTH and SPACE

Writer: Jan Wojcik

Toss Up: Multiple Choice

Which of the following statements is FALSE regarding the volcano in each statement?

W) Shield volcanoes can stretch up to 3 or 4 miles in diameter

X) Cinder cone volcanoes rarely rise past 1,000 feet in elevation

Y) Stratovolcanoes are some of the smallest volcanoes in the world

Z) Volcanic domes commonly occur within the craters or on the flanks of large composite volcanoes

Toss Up Answer: Y

Bonus: Multiple Choice

Which of the following statements is true regarding stratovolcanoes?

W) Most commonly occur at subduction zones

X) They produce basaltic magma

Y) Their eruptions are infrequent

Z) They are never dormant

Bonus Answer: W

7. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Short Answer

If n is a positive integer, what is the smallest value of n such that $n! + 1$ is a perfect square?

Bonus Answer: 4

Bonus: Short Answer

If $z_1 = 3 - 4i$ and $z_2 = 7 + i$, find the absolute value of $z_1 z_2$ in simplest terms.

Bonus Answer: $25\sqrt{2}$

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8. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

An electric vehicle has two stages. If the first stage, the battery, has an efficiency of 90% and the second stage, the inverter, has an efficiency of 80%, calculate the approximate overall efficiency of the vehicle.

Bonus Answer: 72%

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Bonus: Multiple Choice

Which of the following is congruent to $(n + 1)$ modulus n ?

- W) 0
- X) 1
- Y) $n-1$
- Z) $n-2$

Bonus Answer: X

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9. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Short Answer

What is the inverse of the 2×2 matrix (row 1: 6 10), (row 2: 3 5)?

Bonus Answer: The matrix has no inverse (b.c. determinant = 0).

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Bonus: Short Answer

The legs of an isosceles triangle have a length of 10, and the altitudes to the legs have a length of 6. In simplified radical form, what is the length of the altitude to the base of the triangle?

Bonus Answer: $3 * \sqrt{10}$ (Do not accept $\sqrt{90}$)

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10. EARTH and SPACE

Writer: Zoe Orlin

Toss Up: Multiple Choice

How many miles per hour is the Earth moving?

- W) 65,000
- X) 67,000
- Y) 69,000
- Z) 70,000

Toss Up Answer: X

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Bonus: Short Answer

When magma hardens into rock, which type of rock is it?

Bonus Answer: Igneous

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11. CHEMISTRY

Writer: Andrew Chen (Senior)

Toss Up: Short Answer

Each element has its own electron configuration. What is the electron configuration of chromium (Cr).

Bonus Answer: $[\text{Ar}] 3d^5 4s^1$ (Also accept $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$)

Bonus: Multiple Choice

There are various numbers of pi and sigma bonds in certain compounds. Which of the choices below best describes the number of pi and sigma bonds ethyne (acetylene) has?

- W) 1 pi bonds and 4 sigma bonds
- X) 3 pi bonds and 2 sigma bonds
- Y) 2 pi bonds and 3 sigma bonds
- Z) 4 pi bonds

Bonus Answer: Y

12. EARTH and SPACE

Writer: Elias Milborn

Toss Up: Short Answer

Pandora is a moon of which planet?

Bonus Answer: Saturn

Bonus: Multiple Choice

Sea water is approximately what percent salt by mass?

- W) 1%
- X) 2%
- Y) 4%
- Z) 8%

Bonus Answer: Y

13. BIOLOGY

Writer: Olivia Gallager

Toss Up: Multiple Choice

Which immune cell does HIV directly target?

- W) B Cells
- X) Immunoglobulins
- Y) CD4 Cells
- Z) Killer T Cells

Toss Up Answer: Y

Bonus: Short Answer

Individuals heterozygous for the gene for which genetic disease have increased immunity to malaria?

Bonus Answer: Sickle Cell Anemia

14. CHEMISTRY

Writer: Hanna Yang

Toss Up: Short Answer

What element is mixed with gold to make rose gold / pink gold?

Bonus Answer: Copper

Bonus: Short Answer

What two elements are mixed with gold to make white gold?

Bonus Answer: Silver and Copper

15. BIOLOGY

Writer: Shanjeed Ali

Toss Up: Multiple Choice

What does it mean when an organism that can self-fertilize is true breeding?

- W) the organism will produce offspring that are genetically identical to it
- X) the organism's offspring will all be genetically identical to each other
- Y) the organism is heterozygous for the gene that controls that trait
- Z) the organism's offspring will have the same phenotype for a certain trait

Toss Up Answer: Z

Bonus: Short Answer

Gregor Mendel is known as the father of modern genetics due to his work with pea plants. Which of the following traits did he study: plant height, pod color, leaf shape, flower position?

Bonus Answer: All except leaf shape

16. CHEMISTRY

Writer: Mohammed Jamil

Toss Up: Short Answer

What is the chemical equation(s) for the reversible reaction(s) in the contact process

Bonus Answer: $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$

Bonus: Multiple Choice

Which set of conditions would promote the fastest rate for the converter reaction in the contact process?

- W) No catalyst, high pressure, low temperature. Catalyst, high pressure, high temperature. Catalyst, low pressure, low temperature. Catalyst, low pressure, high temperature.
- X) Catalyst, high pressure, high temperature.
- Y) Catalyst, low pressure, low temperature
- Z) No catalyst, high pressure, low temperature. Catalyst, high pressure, high temperature. Catalyst, low pressure, low temperature. Catalyst, low pressure, high temperature.

Bonus Answer: X

17. BIOLOGY

Writer: Matthew Lee

Toss Up: Short Answer

What fatal, degenerative disease caused by a prion is most commonly found in sheep and goats?

Bonus Answer: scrapie

Bonus: Short Answer

What fatal, degenerative disease caused by a prion is most commonly found in people?

Bonus Answer: Creutzfeldt-Jakob disease (DO NOT ACCEPT: mad cow disease)

18. PHYSICS

Writer: Aaron Gee

Toss Up: Multiple Choice

If the distance between two objects, each of mass 'M', is tripled, the force of attraction between the two objects is

- W) 1/2 original force
- X) 1/3 original force
- Y) 1/9 original force
- Z) unchanged

Toss Up Answer: Y

Bonus: Multiple Choice

In physics, a radian per second is a unit of:

- W) angular displacement
- X) angular velocity
- Y) angular acceleration
- Z) angular momentum

Bonus Answer: X

19. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Natural selection has allowed life to flourish in ever-changing environments because:

- W) causes speciation
- X) changes allele frequencies
- Y) increases the mean fitness of a population
- Z) leads to fixation or loss of particular alleles

Toss Up Answer: Y

Bonus: Short Answer

You tie a ribbon to a tree trunk. The height measured from the ribbon to the ground is five feet. The tree grows at a rate of three feet per year. After 10 years, how far up from the ground will the ribbon be?

Bonus Answer: Five feet. (EXPLANATION: The elongation of a tree trunk occurs from the apical meristem up.)

20. CHEMISTRY

Writer: Hanna Yang

Toss Up: Short Answer

Name the most reactive member of the alkaline earth metals.

Bonus Answer: Radium

Bonus: Short Answer

By name or by number, Identify the ion that has the smallest ionic radius?

1. Ca $2+$
2. Sr $2+$
3. Mg $2+$
4. Na $+$
5. F $-$

Bonus Answer: Mg $2+$ (Accept: 3)

21. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What is the relativistic mass of a particle with a rest mass of 8g traveling at a speed of $.6c$?

- W) 4g
- X) 8g
- Y) 10g

Z) 12g

Toss Up Answer: Y

Bonus: Multiple Choice

What is the length of a 1 meter rod traveling on a spaceship going at .8c, as measured by an astronaut on the ship?

W) .8m

X) .6m

Y) 1m

Z) 1.25m

Bonus Answer: Y

22. BIOLOGY

Writer: Mohammed Jamil

Toss Up: Multiple Choice

Which type of cell has a large number of glycoproteins on the cell surface membrane?

W) Ciliated cell

X) Goblet cell

Y) Lymphocyte

Z) Red blood cell

Toss Up Answer: Y

Bonus: Short Answer

Name the bond that forms between glucose molecules in polysaccharides, such as amylose.

Bonus Answer: Glycosidic bond (ACCEPT: glycosidic linkage)

23. PHYSICS

Writer: Aaron Gee

Toss Up: Multiple Choice

The process in which an atom reradiates a photon after interacting with an incident photon of the same energy is called:

W) Cooleo Theorem

X) the Cherenkov effect

Y) Bragg's Law

Z) Thomson scattering

Toss Up Answer: Z

Bonus: Multiple Choice

A protanomalous person has decreased sensitivity of the red cones

in his or her eyes. Which of the following color pairs will this person have difficulty distinguishing between:

W) black and yellow

X) blue green

Y) purple blue

Z) red and yellow

Bonus Answer: Y

24. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

The mass of the planet Yor'Ectum is 1/100 that of Earth and its radius is 1/4 that of Earth. If a person weighs 600N on Earth, what would he weigh on Yor'Rectum?

Bonus Answer: 96N

Bonus: Multiple Choice

The escape speed at the surface of Earth is approximately 8 km/s. What is the mass, in units of Earth's mass, of a planet with twice the radius of Earth for which the escape speed is twice that for Earth?

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

Bonus Answer: Y

25. 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

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
