

ROUND 16

TOSS-UP

1) MATH *Short Answer* Factor completely over the integers: $x^3 - 27$.

ANSWER: $(x - 3)(x^2 + 3x + 9)$

BONUS

1) MATH *Short Answer* Three fair six sided dice are rolled. Providing your answer as a fraction in lowest terms, what is the probability they will sum to 4?

ANSWER: $3/216$

TOSS-UP

2) EARTH AND SPACE *Multiple Choice* Which of the following is considered a low latitude climate?

- W) Taiga
- X) Savannah
- Y) Deciduous forest **[di-SIJ-oo-uhs]**
- Z) Chaparral

ANSWER: X) SAVANNAH

BONUS

2) EARTH AND SPACE *Short Answer* What type of galaxy is the Milky Way?

ANSWER: SPIRAL (ACCEPT: BARRED SPIRAL)

TOSS-UP

3) PHYSICAL SCIENCE *Multiple Choice* For a graph of a sinusoidal **[sy-nuh-SOID-I]** sound wave function, which of the following quantities can be on the x axis?

- W) Position
- X) Wavelength
- Y) Amplitude
- Z) Frequency

ANSWER: W) POSITION

BONUS

3) PHYSICAL SCIENCE *Multiple Choice* Which of the following is closest to the potential energy in joules of a 50 pound boulder on top of a 100 foot cliff relative to the base of the cliff and given 9.8 meters per second squared as g?

- W) 1,500
- X) 1,700
- Y) 6,800
- Z) 11,000

ANSWER: Y) 6,800

TOSS-UP

4) ENERGY *Multiple Choice* Which of the following is closest to the maximum efficiency of a DC/DC converter?

- W) 60%
- X) 70%
- Y) 80%
- Z) 90%

ANSWER: Z) 90%

BONUS

4) ENERGY *Multiple Choice* In October 2011, astrophysicists announced surprising findings from the Crab pulsar. Which of the following statements is NOT true?

- W) They used the VERITAS array to make the discovery
- X) They detected gamma-ray emissions far beyond what was expected
- Y) They can explain their results based on curvature radiation
- Z) They hope to test the Lorentz invariance in the future

ANSWER: Y) THEY CAN EXPLAIN THEIR RESULTS BASED ON CURVATURE RADIATION

TOSS-UP

5) LIFE SCIENCE *Short Answer* What is the final electron acceptor in the Krebs cycle before the electron transport chain and oxidative phosphorylation [**FOS-fohr-uh-lay-shuhn**]?

ANSWER: NAD+

BONUS

5) LIFE SCIENCE *Short Answer* Identify the specific stage at which nondisjunction most likely occurred if one meiotic cell produces four gametes, two of which do not have any copies of chromosome 3, but the other two of which have an extra copy of chromosome 3.

ANSWER: ANAPHASE I (DO NOT ACCEPT: ANAPHASE II)

TOSS-UP

6) MATH *Short Answer* Providing your answer as a fraction in lowest terms, 32 square inches is equal to how many square feet?

ANSWER: $\frac{2}{9}$

BONUS

6) MATH *Short Answer* What are the vertex, axis of symmetry, and maximum value, respectively, of $f(x) = -6x^2 + 12x - 4$?

ANSWER: VERTEX: (1, 2); AXIS OF SYMMETRY: $x = 1$; MAXIMUM VALUE: 2

TOSS-UP

7) GENERAL SCIENCE *Short Answer* Identify which of the following four choices are characteristics of a monocot: 1) single cotyledon [*kot-uhl-EED-uhn*], 2) flower parts in multiples of four or five, 3) parallel leaf veins, 4) pollen has a single pore.

ANSWER: 1, 3, 4 (ACCEPT: SINGLE COTYLEDON, PARALLEL LEAF VEINS, POLLEN HAS A SINGLE PORE)

BONUS

7) GENERAL SCIENCE *Multiple Choice* If fluorine undergoes free radical halogenation at a faster rate than bromine, how fast would chlorine be expected to undergo the reaction based on periodic trends?

- W) Faster than both fluorine and bromine
- X) Faster than fluorine but slower than bromine
- Y) Faster than bromine but slower than fluorine
- Z) Slower than both fluorine and bromine

ANSWER: Y) FASTER THAN BROMINE BUT SLOWER THAN FLUORINE

TOSS-UP

8) EARTH AND SPACE *Short Answer* During which month is the Earth farthest from the Sun?

ANSWER: JULY

BONUS

8) EARTH AND SPACE *Short Answer* Sunspots occur when the magnetic field lines at the Sun's surface become twisted up over time and reconnect. What process on the surface of the Sun causes this twisting?

ANSWER: DIFFERENTIAL ROTATION

TOSS-UP

9) PHYSICAL SCIENCE *Short Answer* What is the name of the conjugate base of sulfuric acid?

ANSWER: HYDROGEN SULFATE (ALSO ACCEPT: HYDROGEN SULFATE ION OR BISULFATE)

BONUS

9) PHYSICAL SCIENCE *Short Answer* Calculate the volume in milliliters of a solution necessary to make 2 liters of a 1 millimolar solution from a 0.1 molar solution.

ANSWER: 20

TOSS-UP

10) ENERGY *Multiple Choice* In nuclear power plants, the heat released from nuclear fissions is used in which of the following?

- W) Steam power cycle
- X) Sterling cycle
- Y) Rankine engine
- Z) Uranium enclosure

ANSWER: W) STEAM POWER CYCLE

BONUS

10) ENERGY *Multiple Choice* Which of the following is the effect of a low pass filter on the output power of a circuit?

- W) The power is doubled
- X) The power is halved
- Y) The circuit resonates and the power is maximized
- Z) The circuit resonates diminishing the power to zero

ANSWER: X) THE POWER IS HALVED

TOSS-UP

11) LIFE SCIENCE *Multiple Choice* Which of the following is NOT a characteristic of heterokonts?

- W) They are eukaryotic [*yoo-KAR-ee-oh-tik*]
- X) Most species prefer salt water
- Y) Many are algae
- Z) Many have two unequal flagella

ANSWER: X) MOST SPECIES PREFER SALT WATER

BONUS

11) LIFE SCIENCE *Short Answer* During a car accident, a passenger received an injury, severing the connection between his left and right brain hemispheres. What is the most likely brain structure that was damaged?

ANSWER: CORPUS CALLOSUM

TOSS-UP

12) MATH *Short Answer* If θ [*theta*] is an acute angle in a right triangle and $\tan\theta = \frac{3}{4}$ [*tangent of theta equals 3 over 4*], what is the $\csc\theta$ [*cosecant of theta*] as a fraction in lowest terms?

ANSWER: $\frac{5}{3}$

BONUS

12) MATH *Short Answer* Two coins are removed at random and without replacement from a box that contains 2 dimes, 3 nickels, and 1 token coin whose value is 0. Providing your answer as a fraction in lowest terms, what is the probability that the value of one of the two removed coins is five cents more than the value of the other removed coin?

ANSWER: 3/5

TOSS-UP

13) EARTH AND SPACE *Multiple Choice* Which of the following is the most common type of galaxy in the universe?

- W) Irregular
- X) Elliptical
- Y) Spiral
- Z) Barred spiral

ANSWER: X) ELLIPTICAL

BONUS

13) EARTH AND SPACE *Multiple Choice* Which of the following groups contains the most stars on a Hertzsprung-Russell diagram?

- W) White dwarfs
- X) Blue supergiants
- Y) Red dwarfs
- Z) Hypergiants

ANSWER: Y) RED DWARFS

TOSS-UP

14) LIFE SCIENCE *Multiple Choice* Which of the following vitamins is produced by bacteria in the human colon?

- W) A
- X) B
- Y) D
- Z) K

ANSWER: Z) K

BONUS

14) LIFE SCIENCE *Short Answer* During the 19th century, soldiers and prisoners in the Dutch East Indies developed a disease called beriberi that was characterized by fatigue, loss of appetite, and nervous disorders. Deficit of which dietary vitamin caused this disease?

ANSWER: B1 (ACCEPT: THIAMINE)

TOSS-UP

15) GENERAL SCIENCE *Short Answer* Twenty grams of the following gases are each added to a container: oxygen, helium, water vapor, and xenon. Which of these gases would have the largest partial pressure under conditions of standard temperature and pressure?

ANSWER: HELIUM

BONUS

15) GENERAL SCIENCE *Multiple Choice* Infrared spectroscopy is used to help identify various chemical compounds. Each functional group is identified by a peak at a particular wavelength. If a scientist synthesizes a fatty acid in the lab, which of the following peaks would indicate that impurities were present?

- W) A peak indicating an amino group
- X) A peak indicating a carboxylic acid –OH stretch
- Y) A peak indicating a carbon-carbon double bond
- Z) A peak indicating sp^2 -hybridized carbon-hydrogen bonds

ANSWER: W) A PEAK INDICATING AN AMINO GROUP

TOSS-UP

16) EARTH AND SPACE *Multiple Choice* The Coriolis effect causes southern bound currents in the southern hemisphere to do which of the following?

- W) Curve toward the east
- X) Curve toward the west
- Y) Move in a less circular pattern
- Z) Move downward

ANSWER: W) CURVE TOWARD THE EAST

BONUS

16) EARTH AND SPACE *Multiple Choice* The Clean Water Act of 1972 focused on reducing which of the following types of pollution?

- W) Thermal
- X) Acid rain
- Y) Sewage
- Z) Pesticide

ANSWER: Y) SEWAGE

TOSS-UP

17) PHYSICAL SCIENCE *Multiple Choice* Which of the following is true about sound and light waves transmitted through the air?

- W) Sound waves are longitudinal while light waves are transverse
- X) Sound waves are transverse while light waves are longitudinal
- Y) Both sound waves and light waves are compression waves
- Z) Both sound waves and light waves are shear waves

ANSWER: W) SOUND WAVES ARE LONGITUDINAL WHILE LIGHT WAVES ARE TRANSVERSE

BONUS

17) PHYSICAL SCIENCE *Multiple Choice* A ball travels a distance of 10π meters around a circle with a radius of 40 meters. Which of the following is its displacement in meters?

- W) $40\sin(\pi/4)/\sin(3\pi/8)$ [**40 sine of, open parenthesis, pi over 4, close parenthesis, over sine of, open parenthesis, 3 pi over 8, close parenthesis**]
- X) $40\sin(2/3)$ [**40 sine of two thirds**]
- Y) 10π
- Z) $40\sin(\pi/8)/\sin(7\pi/16)$ [**40 sine of, open parenthesis, pi over 8, close parenthesis, over sine of, open parenthesis, 7 pi over 16, close parenthesis**]

ANSWER: W) $40\sin(\pi/4)/\sin(3\pi/8)$

TOSS-UP

18) ENERGY *Multiple Choice* Which of the following is NOT an advantage of using high-voltage direct current electric power transmissions for the bulk transmission of electrical power?

- W) It is more reliable than AC current
- X) It has lower energy losses than AC current
- Y) It can synchronize AC produced by renewable energy sources
- Z) It can increase the power of an existing grid where additional wires are difficult to install

ANSWER: W) IT IS MORE RELIABLE THAN AC CURRENT

BONUS

18) ENERGY *Short Answer* What is the name of the metabolic pathway that results in the generation of glucose from non-carbohydrate substances such as lactate, glycerol [**GLIS-uh-rol**], and glucogenic amino acids?

ANSWER: GLUCONEOGENESIS

TOSS-UP

19) LIFE SCIENCE *Short Answer* In *Drosophila*, the wild type eye color is red. The gene responsible for white eyes causes numerous other changes to the fly's internal organs. What is the genetic term given to this phenomenon in which one gene affects multiple characteristics?

ANSWER: PLEIOTROPY

BONUS

19) LIFE SCIENCE *Multiple Choice* Given that p equals the frequency of the dominant allele and that q equals the frequency of the recessive allele, which of the following equations does NOT correctly represent a Hardy-Weinberg equilibrium?

W) $p^2 + 2pq + q^2 = 1$

X) $p^2 + 2pq + q^2 = (p + q)^2$ [***p squared plus 2 p q plus q squared equals, open parenthesis, p plus q, close parenthesis, squared***]

Y) $2p + pq + 2q = 1$

Z) $p + q = 1$

ANSWER: Y) $2p + pq + 2q = 1$

TOSS-UP

20) MATH *Short Answer* Given an ellipse with vertices (10, 0) and (-10, 0) and co-vertices (0, 9) and (0, -9), what is the standard form equation of the ellipse?

ANSWER: $\frac{x^2}{100} + \frac{y^2}{81} = 1$

BONUS

20) MATH *Short Answer* What is the equation in standard form of the plane with y-intercept 2 and XZ trace

$2x + z = 8$?

ANSWER: $2x + 4y + z = 8$

TOSS-UP

21) GENERAL SCIENCE *Multiple Choice* A statistical test is carried out measuring the correlation between the number of cigarettes that a person smokes per day and life span. It is found that the number of cigarettes a person smokes per day is moderately correlated with a shorter life span. Which of the following correlation coefficients best exemplifies the relationship between life span and number of cigarettes smoked per day?

- W) 0.5
- X) -0.1
- Y) -0.5
- Z) -0.95

ANSWER: Y) -0.5

BONUS

21) GENERAL SCIENCE *Short Answer* Name all the following five layers of Earth's atmosphere that decrease in temperature with increased altitude: 1) exosphere, 2) thermosphere, 3) troposphere, 4) stratosphere, 5) mesosphere.

ANSWER: 3, 5 (ACCEPT: TROPOSPHERE, MESOSPHERE)

TOSS-UP

22) EARTH AND SPACE *Multiple Choice* In hydrothermal vent communities, energy production in the food web is based on which of the following?

- W) Blue green algae
- X) Photosynthetic bacteria
- Y) Chemosynthetic bacteria
- Z) Brown algae

ANSWER: Y) CHEMOSYNTHETIC BACTERIA

BONUS

22) EARTH AND SPACE *Multiple Choice* Which of the following conditions could result from overgrazing of livestock?

- W) Soil formation
- X) Desertification
- Y) Aggregate buildup
- Z) Chemical precipitation

ANSWER: X) DESERTIFICATION

TOSS-UP

23) PHYSICAL SCIENCE *Short Answer* If the pH of a weak acid solution is equal to its pK_a , what is the ratio of the concentrations of the acid and its conjugate base?

ANSWER: 1 (ACCEPT: 1 TO 1)

BONUS

23) PHYSICAL SCIENCE *Multiple Choice* Metals A and B are both used in a circuit. Given that the temperatures of A and B are the same, and that metal A is a better conductor of heat than metal B, which of the following is necessarily true?

- W) The current across A is greater than the current across B
- X) The voltage across A is greater than the voltage across B
- Y) A has a higher resistivity than B
- Z) A has a lower resistivity than B

ANSWER: Z) A HAS A LOWER RESISTIVITY THAN B

TOSS-UP

24) LIFE SCIENCE *Multiple Choice* In photosynthesis, during which of the following stages is oxygen released as a byproduct?

- W) Photosystem 1
- X) Photosystem 2
- Y) Calvin reaction
- Z) ATP synthase

ANSWER: X) PHOTOSYSTEM 2

BONUS

24) LIFE SCIENCE *Multiple Choice* On an island, half of one species of birds has small beaks and the other half has large beaks. A tree with small seeds is very prevalent on the island; hundreds of years later, the small-beaked birds outnumber the large-beaked birds. According to the principles of natural selection, which of the following is the most likely explanation?

- W) Birds with small beaks were better able to fight birds with large beaks
- X) Large beaks gradually shrunk due to the smaller available food
- Y) Birds with small beaks were most likely to forage successfully, and were thus more likely to reproduce
- Z) Birds with large beaks are likely to have more offspring

ANSWER: Y) BIRDS WITH SMALL BEAKS WERE MOST LIKELY TO FORAGE SUCCESSFULLY, AND WERE THUS MORE LIKELY TO REPRODUCE

TOSS-UP

25) GENERAL SCIENCE *Short Answer* Name the soft tissue in humans that is primarily responsible for producing blood cells and platelets.

ANSWER: BONE MARROW (ACCEPT: RED BONE MARROW)

BONUS

25) GENERAL SCIENCE *Multiple Choice* The polymerase chain reaction (PCR) process is a method that makes it possible to replicate DNA segments in a very short amount of time using alternating periods of heating and cooling. The periods of heating would denature most proteins, such as DNA polymerases [*pol-uh-muh-RAYS-uhs*], and make them nonfunctional, especially at the high temperatures used during PCR. How is this obstacle overcome in modern PCR reactions?

W) DNA polymerase is added between each period of heating and cooling

X) The DNA polymerase used is from a species of bacteria that live in hot springs, so the DNA polymerase can function at high temperatures

Y) RNA polymerase is more heat resistant and is used instead, and then the DNA is reverse transcribed from the RNA

Z) DNA polymerases in most species are proteins that do not denature easily, so this process can function at high temperatures

ANSWER: X) THE DNA POLYMERASE USED IS FROM A SPECIES OF BACTERIA THAT LIVE IN HOT SPRINGS, SO THE DNA POLYMERASE CAN FUNCTION AT HIGH TEMPERATURES