Round 13

TOSSUP

1) BIOLOGY *Short Answer* PEP Carboxylase adds what compound to phosphoenolpyruvate, or PEP, to form a 4 carbon substance in the C4 pathway?

ANSWER: CO_2 OR CARBON DIOXIDE

BONUS

1) BIOLOGY *Multiple Choice* Phosphoenolpyruvate (PEP) carboxylase catalyzes the formation of what molecule from the addition of a bicarbonate ion to PEP?

W) Malate
X) Succinate
Y) Oxaloacetate
Z) Argininosuccinate

ANSWER: Y) OXALOACETATE

TOSSUP

2) MATH *Short Answer* If sinx - cosx = 1, what is the value of $sin^3x\text{-}cos^3x$?

ANSWER: 1

BONUS

2) MATH *Short Answer* What is the smallest positive integer that leaves a remainder of 6 when divided by 10 and a remainder of 4 when divided by 7?

ANSWER: 46

TOSSUP

3) EARTH AND SPACE *Multiple Choice* Which of the following entities can have a glitch?

W) Quasar
X) Pulsar
Y) Nebula
Z) Galaxy

ANSWER: X) PULSAR

BONUS

3) EARTH AND SPACE *Short Answer* A pulsar is a very rapidly rotating type of a neutron star. What other type of neutron star has an extremely strong magnetic field which manifests itself by emitting very high energy X-rays and gamma rays?

ANSWER: MAGNETAR

TOSSUP

4) ENERGY *Short Answer* Scientists at Oak Ridge National laboratory studied the molecular structure of Bismuth Ferrite to determine why its piezoelectric response was so high. Given that the composition of bismuth ferrite is $BiFeO_3$, determine the atomic mass of the compound given that the bismuth weighs 209 amu, iron weighs 56 amu, and oxygen weighs 16 amu.

ANSWER: 313 AMU

BONUS

4) ENERGY *Short Answer* Cosmic rays are high-energy radiation that come from space. They are primarily composed of protons. What particle is the second most abundant in cosmic rays?

ANSWER: ALPHA (PARTICLE)

TOSSUP

5) PHYSICS *Short Answer* Given that the third harmonic of an object is 120 Hz, what is the fifth harmonic in Hertz?

ANSWER: 200 (Hz)

BONUS

5) PHYSICS *Short Answer* A baseball is at the base of an inclined plane that is 30° with the horizontal. The ball is launched up the plane with an initial velocity of 14 m/s and at an angle of 60° with the horizontal. At what distance away from the initial position will the ball land on the plane? Assume the acceleration due to gravity is -10 m/s^2.

ANSWER: 49/6 METERS

TOSSUP

6) EARTH AND SPACE *Multiple Choice* A type of solar cell is named after this mineral because the absorber in the solar cell has the same structureas this mineral. What is this mineral with the formula $CaTiO_3$?

W) Ilmenite
X) Sphene
Y) Perovskite
Z)Titanite

ANSWER: Y) PEROVSKITE

BONUS

6) EARTH AND SPACE *Multiple Choice* According to Bowen's Reaction Series, minerals at the bottom of the series have a relatively ____ (blank) crystallization temperature meaning that they will be one of the____(blank) minerals to crystallize.

W) high, first
X) high, last
Y) low, first
Z) low, last

ANSWER: Z) LOW, LAST

TOSSUP

7) PHYSICS *Short Answer* Both the z-pinch and stellarator were devices used to attempt this, however both failed but are still being developed. The most promising device for this process is a Russian, torus shaped device called a tokamak. All of these devices attempt to efficiently contain plasma to maintain the high temperatures generally necessary for this process. In stars, silicon undergoes this process to become iron, the last element that can be made by this process. Name this process that combines lighter atomic nuclei into heavier nuclei that is contrasted with nuclear fission.

ANSWER: (NUCLEAR) FUSION

BONUS

7) PHYSICS *Multiple Choice* A form of cold fusion does in fact exist. However, it must be catalyzed by a certain elementary particle. Name this particle.

W) Muon
X) Electron
Y) Z boson
Z) Kaon (Kay-on)

ANSWER: W) MUON

TOSSUP

8) CHEMISTRY *Multiple Choice* Which of the following metals is not dissolved by aqua regia?

W) Gold
X) Silver
Y) Palladium
Z) Platinum

ANSWER: X) SILVER

BONUS

8) CHEMISTRY *Short Answer* Order the following substances from most acidic to least acidic by name or number. (1) Hydrochloric Acid (2) sulfuric acid (3) citric acid (4) chromic acid

ANSWER: HYDROCHLORIC ACID, SULFURIC ACID, CHROMIC ACID, CITRIC ACID (1, 2, 4, 3)

TOSSUP

9) MATH *Short Answer* What is the maximum number of points of intersection that can be made by 6 lines?

ANSWER: 15 (POINTS OF INTERSECTION)

BONUS

9) MATH *Short Answer* Given $sin^2\theta = \frac{x^2+y^2+1}{2x}$, find the value of x, y, and θ that satisfy this equation.

ANSWER: x=1, y=0, θ= 90 degrees or π/2 radians

TOSSUP

10) CHEMISTRY *Short Answer* Of sulfur's more than 30 allotropes, which form of sulfur is most commonly found in nature?

ANSWER: S_8

BONUS

10) CHEMISTRY *Multiple Choice* Sulfur is a very reactive element and forms sulfides with metals except with two. Name these two metals that sulfur doesn't react with.

W) Gold and Silver
X) Platinum and Gold
Y) Silver and Mercury
Z) Gold and Mercury

ANSWER: X) PLATINUM AND GOLD

TOSSUP

11) BIOLOGY *Multiple Choice* Selection for traits that maximize reproductive success in uncrowded environments is called
W) Semelparity
X) K Selection
Y) Iteroparity
Z) R Selection

ANSWER: Z) R SELECTION

BONUS

11) BIOLOGY *Short Answer* You are a park ranger who want to measure the population of endangered rabbits in a national park. You initially capture and mark 57 rabbits. You then release them back into the park and capture 55 rabbits at random. 5 of those rabbits are marked. Approximately how many rabbits are in the park?

ANSWER: 627 (RABBITS)

TOSSUP

12) PHYSICS *Short Answer* BCS Theory is the current phenomenological theory for this property. BCS Theory explains this property via Cooper pairs. What is this property?

ANSWER: SUPERCONDUCTIVITY (ACCEPT WORD FORMS)

BONUS

12) PHYSICS *Short Answer* Using numbers, identify which of the following statements is true about a superconductor. 1. A Josephson current can be observed by using 2 of them and an insulating material in the middle. 2. It has a critical temperature above which it returns to a normal non-superconductive state. 3. The Meissner effect can be observed in it. 4. Its magnetic susceptibility is 1.

ANSWER: 1,2,3

TOSSUP

13) MATH *Short Answer* This fractal can be made using a finite subdivision rule. Name this famous fractal made up of repeating equilateral triangles.

ANSWER: SIERPINSKI TRIANGLE/GASKET/SIEVE

BONUS

13) MATH *Short Answer* What is the area of the circle circumscribed about a regular octagon with side length 2?

ANSWER: $(4 + 2\sqrt{2})\pi$

TOSSUP

14) CHEMISTRY *Multiple Choice* Which of the following is the chemical equation for fermentation?

W) $C_6H_{12}O_6$ —> $2C_2H_5OH + 2O_2$
X) $C_6H_{12}O_6$ —> $2C_2H_5OH + 2CO_2$
Y) $C_6H_{12}O_6$ —> $2C_2H_6 + 2O_2$
Z) $C_6H_{12}O_6$ —> $2C_2H_5OH + 2H_2O$

ANSWER: X) $C_6H_{12}O_6$ —> $2C_2H_5OH + 2CO_2$

BONUS

14) CHEMISTRY *Multiple Choice* Which of the following can be used to catalyze an esterification reaction?

W) Sulfuric Acid
X) Hydrogen Gas
Y) Sodium Hydroxide
Z) Benzene

ANSWER: W) SULFURIC ACID

TOSSUP

15) ENERGY *Short Answer* What model in particle physics explains the confinement of quarks using an elastic membrane that allows quarks to move freely within it but does not let quarks be pulled out of it?

ANSWER: BAG (MODEL)

BONUS

15) ENERGY *Short Answer* In 2016, scientists at the University of Portsmouth found a strain of bacteria in a wasteland that breaks down Polyethylene Terephthalate (ter-ef-THAL-ate), a common plastic. They tried to tweak its enzymes to understand how it evolved. In the process, they discovered that the structure looked similar to a waxy, water-repellent coating found in plants. What is this coating called?

ANSWER: CUTIN

TOSSUP

16) EARTH AND SPACE *Multiple Choice* Which of the following animals would be most likely found in savannah biomes?

W) Fat sand rat
X) Lynx
Y) Spotted Hyena
Z) Jaguar

ANSWER: Y) SPOTTED HYENA

BONUS

16) EARTH AND SPACE *Short Answer* Given that GPP is 2 kilojoules and the energy available at the secondary consumer level is 15 joules, what is the amount consumed by the producers for cellular respiration? Express your answer in Joules

ANSWER: 500 (JOULES)

TOSSUP

17) BIOLOGY *Multiple Choice* Which of the following adaptations give desert ants their characteristic heat tolerance?

W) Evaporative Cooling
X) Nocturnal behavior
Y) Heat resistant exoskeleton
Z) Long Legs

ANSWER: Z) LONG LEGS

BONUS

17) BIOLOGY *Multiple Choice* Generally speaking, which of the following combination of terms most accurately describes deep-sea fish in the context of thermoregulation?

W) Homeothermic Endotherms
X) Poikilothermic Ectotherms
Y) Homeothermic Ectotherms
Z) Poikilothermic Endotherms

ANSWER: Y) HOMEOTHERMIC ECTOTHERMS

TOSSUP

18) MATH *Short Answer* What is the angle, in degrees, between the minute hand and the hour hand of a clock when the time is 7:20 AM.

ANSWER: 100

BONUS

18) MATH *Short Answer* In nondegenerate triangle ABC, an angle bisector is drawn from angle B that intersects side AC at point D. Given that AD = 3, DC = 8 and all sides are integer lengths, what is the least possible perimeter of the triangle ABC?

ANSWER: 33

TOSSUP

19) CHEMISTRY *Multiple Choice* The Born-Haber Cycle is often used to determine this quantity, represented by the amount of energy released when the gaseous ions of an ionic compound are combined.

W) Standard Enthalpy
X) Enthalpy of Sublimation
Y) Lattice Energy
Z) Bonding Energy

ANSWER: Y) LATTICE ENERGY

BONUS

19) CHEMISTRY *Short Answer* Identify by name or number all of the following four acids that are diprotic:

I. Sulfuric Acid

II. Hydrochloric Acid

III. Phosphorous Acid

IV. Citric Acid

ANSWER: I and III OR SULFURIC ACID AND PHOSPHOROUS ACID

TOSSUP

20) BIOLOGY *Multiple Choice* Which of these mutations in a gene will most likely result in a shortened protein with a long sequence of substituted amino acids?

W) Missense substitution
X) Insertion of two nucleotides
Y) Deletion of three nucleotides
Z) Silent Substitution of four nucleotides

ANSWER: X) INSERTION OF TWO NUCLEOTIDES

BONUS

20) BIOLOGY *Multiple Choice* Which analytical technique allows for detection of specific proteins in an extract?

W) Northern Blot
X) Eastern Blot
Y) Southern Blot
Z) Western Blot

ANSWER: Z) WESTERN BLOT

TOSSUP

21) EARTH AND SPACE *Short Answer* Type Ia (One A) supernovae are produced from a binary system of a star of any size and what type of stellar remnant from mid-sized stars?

ANSWER: WHITE DWARF

BONUS

21) EARTH AND SPACE *Multiple Choice* What process occurs in very high mass stars (130-250 solar masses) that causes a pair-instability supernova?

W) Cooper Pairing
X) Pair Production
Y) Quantum Pairing
Z) Electron coupling

ANSWER: X) PAIR PRODUCTION

TOSSUP

22) PHYSICS *Multiple Choice* Which of the following particles has a lifetime of 2.20 microseconds and is produced in the upper atmosphere by the decay of pions?

W) Muon
X) Tau
Y) Muon neutrino
Z) Tau neutrino

ANSWER: W) MUON

BONUS

22) PHYSICS *Short Answer* If the potential energy of an object is 400 Joules and its mass is 2 kg, find the time this object will take to reach the ground if it free falls. Assume that g is 10 meters per second squared.

ANSWER: 2 (SECONDS)

TOSSUP

23) MATH *Multiple Choice* How many factors does the number 126 have?

W) 10
X) 12
Y) 14
Z) 16

ANSWER: X) 12

BONUS

23) MATH *Short Answer* What is the smallest number with at least 20 factors?

ANSWER: 240