ROUND ROBIN – ROUND 16

TOSS-UP

1) Energy – *Short Answer* Researchers at Brookhaven National Lab are modeling the amount of photosynthesis in the Arctic. One of the parameters in their model is the maximum carboxylation ***[car-box-ill-AY-shun]*** rate of what enzyme involved in photosynthesis?

ANSWER: RUBISCO (ACCEPT: RIBULOSE BISPHOSPHATE CARBOXYLASE OXYGENASE)

BONUS

1) Energy – *Short Answer* Scientists at the Joint Genome Institute recently reported on a toluene ***[TALL-you-een]***-synthesizing enzyme that decarboxylates ***[dee-car-BOX-ihl-ates]*** what ester of phenol and acetyl ***[ah-see-til]*** chloride?

ANSWER: PHENYL ACETATE (ACCEPT: PHENYL ETHANOATE)

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TOSS-UP

2) Earth & Space – *Multiple Choice* Which of the following best explains why oceanic volcanos eventually sink and form atolls?

W) Volcanos are moved away from a buoyant mantle plume by tectonic plate movement
X) Volcanos are eroded by the ocean's saline waters
Y) Volcanos collapse after exhausting their supply of magma
Z) Volcanos become structurally unstable and disintegrate into atolls

ANSWER: W) VOLCANOS ARE MOVED AWAY FROM A BUOYANT MANTLE PLUME BY TECTONIC PLATE MOVEMENT

BONUS

2) Earth & Space – *Short Answer* What event occurs during a thunderstorm and is characterized by a strong cold downdraft with a maximum size less than four kilometers?

ANSWER: MICROBURST

TOSS-UP

3) Biology – *Short Answer* What is the term for the type of cancer that arises from mesenchymal ***[meh-zen-KYE-mul]*** or connective tissue cells?

ANSWER: SARCOMA

BONUS

3) Biology – *Short Answer* Identify all of the following three features that are typical of hominids ***[HAW-min-ids]*** but not of other apes: 1) Wide, bowl-shaped pelvis; 2) Arms shorter than legs; 3) Posteriorly attached skull.

ANSWER: 1, 2

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TOSS-UP

4) Chemistry – *Short Answer* What is the term for the short-lived state that forms as bonds are breaking or forming in a chemical reaction?

ANSWER: TRANSITION STATE (ACCEPT: ACTIVATED COMPLEX)

BONUS

4) Chemistry – *Short Answer* Rank the following three ionic compounds in order of increasing boiling point: 1) Sodium chloride; 2) Cesium chloride; 3) Magnesium oxide.

ANSWER: 2, 1, 3

TOSS-UP

5) Physics – *Multiple Choice* A positively-charged infinite sheet lies on the *x*-*y* plane. A parallel, negatively-charged infinite sheet with the same magnitude of charge density lies on the plane $z = 10$. Which of the following positions on the *z*-axis will experience the smallest magnitude of electric field?

W) –1
X) 1
Y) 5
Z) 9

ANSWER: W) –1

BONUS

5) Physics – *Short Answer* The flow of water in a pipe accelerates from five meters per second in section A to seven meters per second in section B, without any change in the mean elevation of the pipe. In pascals, how much does the static pressure drop from section A to B?

ANSWER: 12,000

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TOSS-UP

6) Math – *Short Answer* What is the slope of the positively-sloped asymptote of the hyperbola with equation $9x^2 - 4y^2 - 72x - 24y + 72 = 0$?

ANSWER: 3/2 (ACCEPT: 1½, 1.5)

BONUS

6) Math – *Short Answer* What is the approximation for e^2 that results from using the first four nonzero terms of the Taylor series for e to the x centered at 0?

ANSWER: 6 1/3 (ACCEPT: 19/3)

TOSS-UP

7) Biology – *Short Answer* Chlorosis in plant leaves can be caused by a deficiency in what metal ion, which is chelated by the organic portion of chlorophyll?

ANSWER: MAGNESIUM (ACCEPT: MAGNESIUM 2+, Mg^{2+})

BONUS

7) Biology – *Short Answer* Identify all of the following four compounds that, when introduced to the human body, would result in a net increase in production of thyroid hormones:
1) TRH; 2) TSH; 3) T3; 4) T4.

ANSWER: 1, 2

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TOSS-UP

8) Chemistry – *Multiple Choice* What is the systematic IUPAC name of the primary alcohol that has formula $C_4H_{10}O$?

W) Butan-1-ol
X) n-Butanol
Y) Butyric alcohol
Z) Butyl alcohol

ANSWER: W) BUTAN-1-OL

BONUS

8) Chemistry – *Short Answer* Identify all of the following three statements that are true regarding spontaneity of a reaction: 1) A more spontaneous reaction produces a larger proportion of product than a less spontaneous one; 2) A more spontaneous reaction occurs more quickly than a less spontaneous one; 3) A more spontaneous reaction always has a greater magnitude Gibbs free energy change than a less spontaneous one.

ANSWER: 1

TOSS-UP

9) Physics – *Short Answer* Consider a circuit that is experiencing a magnetic flux *phi* that can be described by the equation $\underline{phi = 3t^2}$, where *t* represents time. In SI base units, what is the magnitude of the EMF induced in the circuit by the magnetic field at $t = 3$?

ANSWER: 18 (ACCEPT: 18 VOLTS)

BONUS

9) Physics – *Multiple Choice* Which of the following are the correct units for Young's modulus?

W) Dimensionless
X) Kilogram per meter second
Y) Kilogram per meter second squared
Z) Kilogram per second squared

ANSWER: Y) KILOGRAM PER METER SECOND SQUARED

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TOSS-UP

10) Earth & Space – *Short Answer* A type One-A supernova is caused by the destruction of what stellar remnant?

ANSWER: WHITE DWARF

BONUS

10) Earth & Space – *Short Answer* Identify all of the following three points in the night sky for which the projection onto background stars appears to change location for a stationary observer over the course of a precession cycle: 1) Zenith; 2) Nadir ***[NAY-der]***; 3) North Celestial Pole.

ANSWER: ALL

TOSS-UP

11) Math – *Short Answer* What is the integral with respect to x from 8 to 216 of the derivative of the cube root of x?

ANSWER: 4

BONUS

11) Math – *Short Answer* For the increasing arithmetic sequence with first two terms 8 and 11, what is the sum of the first 70 terms?

ANSWER: 7805

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TOSS-UP

12) Energy – *Short Answer* In order to study the binding properties of lectins and synthetic glycoproteins, Lawrence Berkeley National Lab researchers functionalized the lectins with a green-absorbing, red-emitting fluorophore ***[FLOOR-oh-for]*** and the glycoproteins with a blue-absorbing, green-emitting fluorophore. When the lectin bound the glycoprotein, the researchers were able to shine blue light on the conjugate and see the emission of red light. What is the name for this effect?

ANSWER: FRET (ACCEPT: FLUORESCENCE RESONANT ENERGY TRANSFER, FORSTER RESONANT ENERGY TRANSFER)

BONUS

12) Energy – *Short Answer* Researchers sponsored by the Department of Energy are studying resonant excited states in nuclei that resemble clusters of alpha particles. Identify all of the following three nuclei that are expected to possess these resonant states: 1) Carbon-12; 2) Nitrogen-14; 3) Oxygen-16.

ANSWER: 1, 3

TOSS-UP

13) Chemistry – *Multiple Choice* Which of the following statements are true of a fuel cell but not a secondary battery?

W) Chemical energy is converted to electrical energy
X) There are voltage losses due to kinetics
Y) Devices must be able to recharge as well as discharge
Z) Additional chemical fuel can be supplied during operation

ANSWER: Z) ADDITIONAL CHEMICAL FUEL CAN BE SUPPLIED DURING OPERATION

BONUS

13) Chemistry – *Short Answer* What is the name of the organic compound that is formed by the reaction of sodium hydroxide with 2-iodo-2-methylbutane ***[two-eye-oh-doe-two-methil-BYOO-tane]*** at 80 degrees Celsius in DMSO?

ANSWER: 2-METHYL-2-BUTENE (ACCEPT: 2-METHYLBUT-2-ENE)

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TOSS-UP

14) Math – *Short Answer* A cyclic quadrilateral has two angles of measures 40 and 80 degrees. What are the degree measures of its other two angles?

ANSWER: 100 AND 140 *[either order]*

BONUS

14) Math – *Short Answer* Given that cosine of one equals 0.5403, and expressing your answer to two decimal places, what is the integral from 0 to 1 of x^2 sine of open parenthesis x^3 close parenthesis dx?

ANSWER: 0.15

TOSS-UP

15) Energy – *Short Answer* Researchers at Fermi National Accelerator Facility are working on the Dark Energy Spectroscopic Instrument. What term in the Einstein field equations describes dark energy?

ANSWER: COSMOLOGICAL CONSTANT (ACCEPT: LAMBDA)

BONUS

15) Energy – *Short Answer* Scientists at Pacific Northwest National Lab are synthesizing diamondoids ***[DYE-mun-doyds]***, which are small carbon cage molecules that have the same structure as the diamond crystal lattice. How many carbon atoms are in the smallest diamondoid?

ANSWER: 10

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TOSS-UP

16) Physics – *Multiple Choice* One of Maxwell's equations states that the divergence of any magnetic field is zero. Which of the following statements is a direct corollary to this expression?

W) When traveling at relativistic speeds, some part of a magnetic field will appear as an electric field
X) Any moving electric charge induces a magnetic field
Y) Any changing magnetic field induces an electric field
Z) No magnetic field lines have endpoints

ANSWER: Z) NO MAGNETIC FIELD LINES HAVE ENDPOINTS

BONUS

16) Physics – *Short Answer* Three nine-volt batteries are connected in series to a 10-micro-farad capacitor. In milli-coulombs, what is the magnitude of the equilibrium charge on the capacitor?

ANSWER: 0.27 (ACCEPT: 27/100)

TOSS-UP

17) Earth & Space – *Short Answer* What type of winds result from the balance between the horizontal pressure gradient force and the Coriolis ***[CORE-ee-OH-lis]*** effect?

ANSWER: GEOSTROPHIC

BONUS

17) Earth & Space – *Short Answer* Identify all of the following three minerals that are mafic:
1) Plagioclase ***[PLAY-jee-oh-klaze]*** feldspar; 2) Quartz; 3) Amphibole ***[AM-fih-bowl]***.

ANSWER: 3

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TOSS-UP

18) Biology – *Short Answer* Arthropods breathe through small tubes that connect to the air via openings called what?

ANSWER: SPIRACLES

BONUS

18) Biology – *Multiple Choice* Which of the following best describes a major role of the p53 protein in the cell?

W) Transitioning a cell into the G-naught phase after differentiation
X) Detecting DNA damage and halting cell division in the G-one phase
Y) Triggering division in a cell with damaged DNA
Z) Acting as a nuclease in the process of repairing DNA

ANSWER: X) DETECTING DNA DAMAGE AND HALTING CELL DIVISION IN THE G-ONE PHASE

TOSS-UP

19) Math – *Short Answer* A pair of 12-sided dice, each with the numbers one through 12 printed on the faces, is rolled. What is the most probable sum of the two numbers rolled?

ANSWER: 13

BONUS

19) Math – *Short Answer* What is the largest possible difference between two 3-digit palindromes each divisible by 12?

ANSWER: 636

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TOSS-UP

20) Biology – *Short Answer* Akin to hibernation, some animals slow their metabolism during the summer. What is the term for this state?

ANSWER: ESTIVATION (ACCEPT: SUMMER TORPOR; DO NOT ACCEPT: TORPOR)

BONUS

20) Biology – *Short Answer* Much of equine evolution is thought to have occurred on what continent, despite horses becoming extinct on that continent approximately 10,000 years ago?

ANSWER: NORTH AMERICA

TOSS-UP

21) Physics – *Multiple Choice* In a simple harmonic oscillator system, which of the following is equal to the spring constant?

W) First derivative of potential energy with respect to displacement
X) First derivative of potential energy with respect to time
Y) Second derivative of potential energy with respect to displacement
Z) Second derivative of potential energy with respect to time

ANSWER: Y) SECOND DERIVATIVE OF POTENTIAL ENERGY WITH RESPECT TO DISPLACEMENT

BONUS

21) Physics – *Short Answer* An alien civilization uses a system of units constructed identically as the SI system, except that the alien unit of time is equal to two SI seconds. Based on this difference alone, identify all of the following three SI units whose numerical values are different than their corresponding unit in the alien system: 1) Kilogram; 2) Mole; 3) Meter.

ANSWER: 1, 3

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TOSS-UP

22) Chemistry – *Short Answer* What type of cubic lattice has atoms at each vertex of the cube as well as an atom in the center?

ANSWER: BODY-CENTERED CUBIC (ACCEPT: BCC)

BONUS

22) Chemistry – *Short Answer* Rank the following three elements in order of increasing atomic radius: 1) Gallium ***[GAL-ee-um]***; 2) Barium; 3) Oxygen.

ANSWER: 3, 1, 2

TOSS-UP

23) Earth & Space – *Short Answer* A zone of disrupted and fractured terrain on Mercury is located at the antipode of what large impact basin?

ANSWER: CALORIS (ALSO ACCEPT: CALORIS PLANITIA)

BONUS

23) Earth & Space – *Multiple Choice* Which of the following best explains why composite volcanos are not common on Venus?

W) Venus does not have subduction zones
X) Magmas on Venus are primarily felsic
Y) Venus cooled quickly and has not been volcanically active for billions of years
Z) Hotspot volcanism is common on Venus

ANSWER: W) VENUS DOES NOT HAVE SUBDUCTION ZONES