

ROUND ROBIN – ROUND 17

TOSS-UP

1) Physics – *Short Answer* Andrew measures the strength of a magnetic field, B , caused by a current-carrying wire at a distance R from the wire. If he measures it again from $3R$, B would be multiplied by what number?

ANSWER: 1/3

BONUS

1) Physics – *Short Answer* Identify all of the following three substances that are known to be paramagnetic: 1) Water; 2) Oxygen; 3) Magnetite.

ANSWER: 2

TOSS-UP

2) Earth & Space – *Short Answer* Astronomers use the hydrogen 21-centimeter line to map regions of the galaxy and beyond. In what part of the electromagnetic spectrum is this radiation found?

ANSWER: RADIO (ACCEPT: RADIO WAVE)

BONUS

2) Earth & Space – *Short Answer* Identify all of the following three gases that make up a larger volume percentage of the atmosphere of Jupiter than of Saturn: 1) Hydrogen; 2) Helium; 3) Methane.

ANSWER: 2

TOSS-UP

3) Math – *Short Answer* A right triangular region has a leg of length 6 lying along the x -axis, and its other leg is of length 5. If the region is rotated about the x -axis, what is the volume of the resulting shape?

ANSWER: 50π

BONUS

3) Math – *Short Answer* What is the area of an equilateral triangle whose circumcircle has a radius of 8?

ANSWER: $48\sqrt{3}$

TOSS-UP

4) Chemistry – *Short Answer* Using standard nomenclature rules, what is the name of the compound HClO_2 ?

ANSWER: CHLOROUS ACID

BONUS

4) Chemistry – *Short Answer* In the Bohr model of the hydrogen atom, what is the ratio of the energy of the $n = 3$ energy level to that of the $n = 1$ energy level?

ANSWER: $1/9$ (ACCEPT: ONE TO NINE)

TOSS-UP

5) Energy – *Multiple Choice* Researchers are using the DOE’s Environmental Molecular Sciences Laboratory to study the distribution of metabolites produced during nitrogen-fixation via MALDI-TOF [*mawl-dee-tawf*]. MALDI-TOF is a variation of what family of techniques?

- W) Liquid chromatography
- X) Mass spectrometry
- Y) Nuclear magnetic resonance
- Z) Infrared spectroscopy

ANSWER: X) MASS SPECTROMETRY

BONUS

5) Energy – *Short Answer* Scientists at Jefferson Lab use machine learning techniques to analyze their data. One technique they use to reduce the dimensionality of their data sets is to transform the data into a set of values of linearly uncorrelated components such that the first few components captures most of the variance of the data set. What is the term for this technique?

ANSWER: PRINCIPAL COMPONENT ANALYSIS (ACCEPT: PCA, EIGENVECTOR ANALYSIS)

TOSS-UP

6) Biology – *Short Answer* What single-celled organisms construct double shells from silica and are known for synthesizing the carbohydrate chrysolaminarin [*kris-oh-lamin-AIR-in*]?

ANSWER: DIATOMS

BONUS

6) Biology – *Short Answer* Identify all of the following three characteristics that would be more commonly seen in eudicots [*YOO-dih-cots*] than in monocots: 1) Flowers with six petals; 2) Taproot; 3) Parallel leaf veins.

ANSWER: 2

TOSS-UP

7) Chemistry – *Multiple Choice* As a multiple of the gas constant, which of the following represents the change in entropy for the reversible isothermal expansion of a mole of ideal gas doubling in volume?

- W) Natural log of 2
- X) 2
- Y) Natural log of one-half
- Z) 1/2

ANSWER: W) NATURAL LOG OF 2

BONUS

7) Chemistry – *Short Answer* Identify all of the following three statements that **MUST** be true about two substances that have the same molecular formula: 1) They are isomers; 2) They are the same compound; 3) They have the same empirical formula.

ANSWER: 3 (DO NOT ACCEPT: 1, 3)

TOSS-UP

8) Math – *Short Answer* If the graph of y equals open parenthesis $x - 4$ close parenthesis squared $- 3$ is translated 2 units to the left and 4 units down, what are the coordinates of the vertex of the image?

ANSWER: (2, -7) (ACCEPT: $x = 2$ AND $y = -7$)

BONUS

8) Math – *Short Answer* A restaurant has a special that allows you to order any 3 of 12 possible items, and allows duplicates of the same item. How many different orders are possible?

ANSWER: 364

TOSS-UP

9) Biology – *Short Answer* What part of the telencephalon [*tel-en-SEF-ah-lon*] serves as the primary connection between the two hemispheres of the human brain?

ANSWER: CORPUS CALLOSUM (ALSO ACCEPT: CALLOSAL COMMISSURE)

BONUS

9) Biology – *Short Answer* Identify all of the following three statements that are true of meiosis [*my-OH-sis*]: 1) The synaptonemal [*sin-apta-NEE-mul*] complex is present during prophase II; 2) During meiosis I, homologues are held together at chiasmata [*KYE-az-MAH-tah*]; 3) Microtubules are used to pull homologous [*ha-MAWL-uh-gus*] chromosomes apart in meiosis I.

ANSWER: 2, 3

TOSS-UP

10) Energy – *Short Answer* In order to monitor disease outbreaks, Sandia National Lab researchers are modeling a group of lymphocytes that includes some labeled as helper and cytotoxic. What type of lymphocytes are they modeling?

ANSWER: T CELL (ACCEPT: T LYMPHOCYTE)

BONUS

10) Energy – *Multiple Choice* Oak Ridge National Lab researchers are using neutron imaging to study different materials. Assuming every sample has the same dimensions, which of the following materials would give the highest contrast with the background in a thermal neutron imaging experiment?

- W) Nickel
- X) Silver
- Y) Zirconium [*zur-KOH-nee-um*]
- Z) Boron

ANSWER: Z) BORON

TOSS-UP

11) Earth & Space – *Multiple choice* Which of the following rocks has undergone low-grade metamorphism?

- W) Peat
- X) Lignite
- Y) Anthracite
- Z) Bituminous coal

ANSWER: Y) ANTHRACITE

BONUS

11) Earth & Space – *Short Answer* Place the following three periods in chronological order:
1) Silurian [*sil-UR-ee-an*]; 2) Paleogene; 3) Triassic [*tri-ASS-ik*].

ANSWER: 1, 3, 2

TOSS-UP

12) Physics – *Short Answer* The electric field along the x -axis scales with x to the fourth power. The voltage along the same axis will scale with x raised to what power?

ANSWER: 5

BONUS

12) Physics – *Multiple Choice* Which of the following statements is TRUE of simple harmonic oscillation?

- W) Acceleration is proportional to velocity, but in the opposite direction
- X) Acceleration is proportional to displacement, but in the opposite direction
- Y) Velocity is proportional to displacement, but in the opposite direction
- Z) Velocity is proportional to displacement and shares the same direction

ANSWER: X) ACCELERATION IS PROPORTIONAL TO DISPLACEMENT, BUT IN THE OPPOSITE DIRECTION

TOSS-UP

13) Biology – *Short Answer* What is the term for the attachment point of a muscle to the bone, which moves when the muscle contracts?

ANSWER: INSERTION

BONUS

13) Biology – *Short Answer* Rank the following three ecosystems in increasing order of net primary productivity per unit area: 1) Savanna; 2) Open ocean; 3) Tropical rain forest.

ANSWER: 2, 1, 3

TOSS-UP

14) Earth & Space – *Short Answer* Particles from the solar wind experience a deflection when they enter the Earth's magnetosphere [*mag-NEE-toh-sfeer*], with a force that is perpendicular to both the particle's velocity and the magnetic field, and whose magnitude is directly proportional to both. What is the term for this force?

ANSWER: LORENTZ

BONUS

14) Earth & Space – *Short Answer* Roche [*rawsh*] lobes are most apparent in what type of stellar binary system with a merged gas envelope?

ANSWER: CONTACT BINARY

TOSS-UP

15) Energy – *Short Answer* Ames Lab scientists are working with the resources of the National Energy Research Scientific Computing Center to implement randomized methods for catalysis [*kut-AL-eh-sis*] modeling. What is the general term for computational methods that use randomness to estimate solutions to integrals and generate samples from distributions?

ANSWER: MONTE CARLO

BONUS

15) Energy – *Short Answer* Scientists at the Joint Genome Institute are studying giant viruses, like Mimivirus [*mee-mee-virus*]. Identify all of the following three biochemical functions for which the Mimivirus genome can produce proteins: 1) Ribosomal [*rye-boh-SOH-mul*] translation; 2) Amino acid synthesis; 3) Nucleotide synthesis.

ANSWER: 2, 3

TOSS-UP

16) Chemistry – *Multiple Choice* Which of the following is the term for a non-ideal mixture that deviates from Raoult's [*rah-OOLZ*] and Dalton's laws?

- W) Azeotrope [*ay-zee-oh-trohp*]
- X) Fractional
- Y) Peritectic [*perry-TEK-tic*]
- Z) Eutectic

ANSWER: W) AZEOTROPE

BONUS

16) Chemistry – *Short Answer* Identify all of the following three numbers of p-electrons in a fully-conjugated planar cyclic system that would make that system anti-aromatic: 1) 4; 2) 10; 3) 16.

ANSWER: 1, 3

TOSS-UP

17) Math – *Short Answer* What is the $3/5$ power of -243 ?

ANSWER: -27

BONUS

17) Math – *Short Answer* Teams A and B meet in a best-of-three series. If Team A wins any given game with probability $3/4$, what is the probability that Team A wins the series?

ANSWER: $27/32$ (ACCEPT: 0.84375)

TOSS-UP

18) Physics – *Multiple Choice* A planet has an atmosphere composed of an ideal gas at a uniform temperature. According to Maxwell-Boltzmann statistics, how does the density of the atmosphere decline with height?

- W) Linearly
- X) Quadratically [*kwad-DRAT-ik-lee*]
- Y) Exponentially
- Z) Logistically

ANSWER: Y) EXPONENTIALLY

BONUS

18) Physics – *Short Answer* The equivalent capacitance of five capacitors in series is three microfarads. If these capacitors were instead all connected in parallel, then in microfarads, what is the minimum equivalent capacitance possible?

ANSWER: 75

TOSS-UP

19) Biology – *Short Answer* Ants, termites, and naked mole rats all demonstrate what type of social structure?

ANSWER: EUSOCIAL (ACCEPT: EUSOCIALITY)

BONUS

19) Biology – *Short Answer* Identify all of the following three adaptations demonstrated by *r*-selected populations: 1) High juvenile mortality rate; 2) Short maturation time; 3) Few offspring per reproductive episode.

ANSWER: 1, 2

TOSS-UP

20) Earth & Space – *Multiple choice* A magma chamber cools and half of its volume crystallizes. Which of the following describes the remaining melt relative to the starting melt?

- W) Higher silica content
- X) Higher mafic [*MAF-ik*] content
- Y) Higher melting temperature
- Z) Higher olivine [*AW-liv-een*] content

ANSWER: W) HIGHER SILICA CONTENT

BONUS

20) Earth & Space – *Short Answer* Rank the following three tectonic plates in order of increasing area: 1) Scotia; 2) African; 3) Pacific.

ANSWER: 1, 2, 3

TOSS-UP

21) Chemistry – *Short Answer* How many angular and radial nodes, respectively, are there in a hydrogen 3s orbital?

ANSWER: 0 ANGULAR, 2 RADIAL (ACCEPT: 0 AND 2)

BONUS

21) Chemistry – *Short Answer* Rank the following three ionization energies in order of increasing magnitude: 1) Oxygen's second ionization energy; 2) Beryllium's third ionization energy; 3) Oxygen's third ionization energy.

ANSWER: 1, 3, 2

TOSS-UP

22) Physics – *Multiple Choice* Which of the following is closest to the mean free path of a nitrogen molecule at room temperature air at sea level?

- W) 100 picometers
- X) 100 nanometers
- Y) 100 micrometers
- Z) 100 millimeters

ANSWER: X) 100 NANOMETERS

BONUS

22) Physics – *Short Answer* Identify all of the following three statements that are considered axiomatic principles of the special theory of relativity: 1) The four-dimensionality of spacetime; 2) The flatness of spacetime; 3) The constancy of the speed of light.

ANSWER: 3

TOSS-UP

23) Math – *Short Answer* What is 59 times 24?

ANSWER: 1416

BONUS

23) Math – *Short Answer* What is the integral from 2 to 4 of x times e to the $0.5x$ power dx ?

ANSWER: $4e^2$