

ROUND ROBIN – ROUND 9

TOSS-UP

1) Earth & Space – *Short Answer* What is the term for the bright head of a comet?

ANSWER: COMA

BONUS

1) Earth & Space – *Short Answer* Place the following four planets in order of increasing atmospheric pressure at the surface: 1) Mercury; 2) Venus; 3) Earth; 4) Mars.

ANSWER: 1,4,3,2

TOSS-UP

2) Energy – *Multiple Choice* Chemists at Brookhaven National Lab are studying the protein BADC [*bad CJ*], which inhibits the rate-limiting step of fatty acid synthesis in plants. BADC inhibits this process when levels of fats in the cell are already high. In glycolysis [*glye-KAWL-eh-sis*], which of the following has the role most analogous to BADC?

- W) Citrate
- X) AMP [*A.M.P.*]
- Y) Epinephrine [*eh-pih-NEH-frin*]
- Z) Phosphofructokinase-1 [*faws-fo-frook-toh-KYE-nase one*]

ANSWER: W) CITRATE

BONUS

2) Energy – *Short Answer* Scientists at Oak Ridge National Labs have developed a cerium [*SEER-ee-um*]-aluminum alloy that has promising aerospace applications partially because it is resistant to corrosion. Identify all of the following three statements that are true regarding metal corrosion: 1) Rust is formed by corrosion; 2) The galvanic [*gal-VAN-ik*] series indicates a metal's relative likelihood to corrode; 3) Dissolved sulfides accelerate metal corrosion.

ANSWER: ALL

TOSS-UP

3) Chemistry – *Short Answer* Identify all of the following four solutes in 0.05 molal [**moh-LAHL**] aqueous solutions that would be expected to display a van't Hoff factor greater than two: 1) Sodium chloride; 2) Magnesium chloride; 3) Glucose; 4) Magnesium sulfate.

ANSWER: 2

BONUS

3) Chemistry – *Short Answer* Order the following four compounds in order of increasing boiling point: 1) Iodine; 2) Water; 3) Bromine; 4) Ammonia.

ANSWER: 4, 3, 2, 1

TOSS-UP

4) Physics – *Short Answer* RLC circuits are known to have a resonant frequency that is dependent on the inductance and capacitance [**kah-PASS-ih-tense**] of the circuit. At this frequency, what aspect of the oscillating current is maximized?

ANSWER: AMPLITUDE

BONUS

4) Physics – *Short Answer* You push horizontally with a 20-newton force on a four-kilogram object initially at rest. After pushing it for a distance of 50 centimeters, in meters per second, what is its speed?

ANSWER: $\sqrt{5}$

TOSS-UP

5) Biology – *Short Answer* Saddle, hinge, and ball-and-socket are all types of what structures in the body?

ANSWER: JOINTS

BONUS

5) Biology – *Short Answer* Order the following three clades chronologically in the order that they first originated: 1) Mammals; 2) Angiosperms; 3) Insects.

ANSWER: 3, 1, 2

TOSS-UP

6) Math – *Short Answer* What is the arc length of a sector of a circle with radius 8 and central angle $\frac{7\pi}{4}$?

ANSWER: 14π

BONUS

6) Math – *Short Answer* What is the remainder when $2x^5 - 3x^4 - 4x^3 + 7x - 3$ is divided by the binomial $x + 2$?

ANSWER: -97

TOSS-UP

7) Earth & Space – *Multiple Choice* Under which of the following sets of temperature and pressure conditions would contact metamorphism occur?

- W) 800 degrees Celsius, 0.5 kilobars
- X) 500 degrees Celsius, 6 kilobars
- Y) 400 degrees Celsius, 10 kilobars
- Z) 100 degrees Celsius, 12 kilobars

ANSWER: W) 800 DEGREES CELSIUS, 0.5 KILOBARS

BONUS

7) Earth & Space – *Multiple Choice* Which of the following statements about lava is NOT correct?

- W) Rhyolitic [*rye-oh-LIT-ik*] lava has a lower melting temperature than basaltic lava
- X) Basaltic lava extrusion is typically explosive
- Y) Andesitic [*an-deh-SIH-dik*] lava has intermediate silica content
- Z) Rhyolitic lava typically flows more slowly than basaltic lava

ANSWER: X) BASALTIC LAVA EXTRUSION IS TYPICALLY EXPLOSIVE

TOSS-UP

8) Chemistry – *Short Answer* What is the term for a hydrocarbon containing one or more double or triple bonds?

ANSWER: UNSATURATED

BONUS

8) Chemistry – *Short Answer* Identify all of the following three changes that would be expected as pure water is heated from 25 degrees Celsius to 37 degrees Celsius: 1) The H-plus concentration increases; 2) The hydroxide concentration decreases; 3) The density of the water decreases.

ANSWER: 1, 3

TOSS-UP

9) Energy – *Short Answer* Researchers at Brookhaven National Lab created an abiotic-biotic **[ay-bi-AH-tic – bi-AH-tic]** hybrid catalyst inspired by the reaction center in chlorophyll. While the researchers used cadmium selenide and zinc sulfide nanoparticles, what metal atom is used by nature in the reaction center in chlorophyll?

ANSWER: MAGNESIUM (ACCEPT: Mg)

BONUS

9) Energy – *Short Answer* Brookhaven National Lab scientists are developing catalysts to accelerate the breakdown of organophosphorus nerve agents. These agents typically function by interfering with the amount of what neurotransmitter?

ANSWER: ACETYLCHOLINE

TOSS-UP

10) Physics – *Multiple Choice* A position vector terminates at (1, 1) in the *xy*-plane and experiences a momentum that is described by the vector $-\mathbf{i} + \mathbf{j}$. Toward what direction does the angular momentum vector point?

- W) Positive *y*
- X) Negative *y*
- Y) Positive *z*
- Z) Negative *z*

ANSWER: Y) POSITIVE *z*

BONUS

10) Physics – *Short Answer* A disk initially at rest undergoes an angular acceleration of three radians per second squared for a duration of six seconds. How many full rotations has the disk completed over this period?

ANSWER: 8

TOSS-UP

11) Math – *Short Answer* What is the sum of the largest prime number less than 70 and the smallest prime number greater than 70?

ANSWER: 138

BONUS

11) Math – *Short Answer* What is the area of a triangle with sides of length 17, 14, and 11?

ANSWER: $14\sqrt{30}$

TOSS-UP

12) Biology – *Short Answer* In an operon, what is the name of the site upstream of a gene to which RNA polymerase **[pah-LIM-er-ace]** binds in order to initiate transcription?

ANSWER: PROMOTER

BONUS

12) Biology – *Short Answer* Cdk's are enzymes that play an important role in cell division. They act by adding what group to other protein substrates?

ANSWER: PHOSPHATE

TOSS-UP

13) Chemistry – *Short Answer* What is the name for a saturated straight-chain alkane that contains six carbon atoms?

ANSWER: HEXANE (ACCEPT: N-HEXANE, NORMAL-HEXANE)

BONUS

13) Chemistry – *Short Answer* The following incomplete compound name is missing its oxidation state for cobalt: di-amine-ethylene-di-amine-chloro-cobalt-sulfate. What is this oxidation number?

ANSWER: 3+ (ACCEPT: +3, THREE)

TOSS-UP

14) Physics – *Short Answer* What law, which is a part of the mathematical formulation of Faraday's law of induction, describes the direction of the EMF induced by a changing magnetic field?

ANSWER: LENZ'S LAW

BONUS

14) Physics – *Short Answer* The position x of a rabbit running along a straight line as a function of time t is x of t equals t cubed + 2 t squared – 5 t + 6. What is the acceleration of the rabbit at $t = 2$?

ANSWER: 16 (ACCEPT: 16 METERS PER SECOND SQUARED)

TOSS-UP

15) Earth & Space – *Short Answer* In the proton-proton chain, hydrogen nuclei are converted to neutrons through interactions with what fundamental force?

ANSWER: WEAK (ACCEPT: WEAK NUCLEAR)

BONUS

15) Earth & Space – *Multiple Choice* What type of variable star is most prevalent in globular clusters?

- W) Cepheid [*SEF-ee-id*]
- X) T Tauri [*TOOR-ee*]
- Y) Mira [*MY-rah*]
- Z) RR Lyrae [*LYE-ree*]

ANSWER: Z) RR LYRAE

TOSS-UP

16) Energy – *Multiple Choice* DOE researchers at the Lawrence Berkeley National Lab used the Advanced Light Source to perform X-ray diffraction to determine the chemical makeup of a mineral grain that was 10 microns in diameter. This mineral grain's size is closest in size to which of the following?

- W) Single clostridium tetani [*klaw-STRIH-dee-um TET-en-eye*] organism
- X) F-naught subunit of ATP synthase
- Y) Length of the largest human motoneuron
- Z) Nucleus of a human fibroblast

ANSWER: Z) NUCLEUS OF A HUMAN FIBROBLAST

BONUS

16) Energy – *Short Answer* Scientists at SLAC [*slack*] National Accelerator Lab are using cryo-electron microscopy to study viral particles. Cryo EM [*CRY-oh-E.M.*] is a variation of what type of electron microscopy in which a beam of electrons passes through a specimen to form an image?

ANSWER: TEM (ACCEPT: TRANSMISSION ELECTRON MICROSCOPY, TRANSMISSION)

TOSS-UP

17) Biology – *Short Answer* In what cellular organelle are the receptors for lipid-soluble hormones typically located once they have bound their ligand?

ANSWER: NUCLEUS (ACCEPT: NUCLEI; DO NOT ACCEPT: NUCLEOLUS, NUCLEOLI, CYTOPLASM)

BONUS

17) Biology – *Short Answer* Identify all of the following three cellular junctions that allow direct passage of small molecules from the cytoplasm of one cell to another: 1) Gap junctions; 2) Adherens [*ad-HEER-enz*] junctions; 3) Desmosomes [*DEZ-mo-sohms*].

ANSWER: 1

TOSS-UP

18) Math – *Short Answer* What is the absolute value of the complex conjugate of $-5i$?

ANSWER: 5

BONUS

18) Math – *Short Answer* On a seven-by-seven grid of unit squares, how many squares of any size can be formed using only the line segments in the grid?

ANSWER: 140

TOSS-UP

19) Chemistry – *Short Answer* What is the oxidation number for carbon in methanol?

ANSWER: -2

BONUS

19) Chemistry – *Short Answer* Identify all of the following three statements that accurately describe the work function of a metal: 1) It is the energy difference between the HOMO and the LUMO (**L_OO-mo_j**); 2) It is the valence energy level relative to vacuum; 3) It is the energy required to eject an electron.

ANSWER: 2, 3

TOSS-UP

20) Physics – *Short Answer* John places a block on a plank of wood, and slowly tilts the plank. When the plank reaches a 60-degree incline, the block begins to slide. To the nearest tenth, what is the coefficient of static friction between the block and the wood?

ANSWER: 1.7

BONUS

20) Physics – *Short Answer* The energy that it takes to eject an electron from the n = 3 state is how many times that to excite an electron from the ground state to the n = 3 state?

ANSWER: 1/8 (ACCEPT: 0.125)

TOSS-UP

21) Earth & Space – *Short Answer* What greenhouse gas is trapped in cage-like structures in ocean sediment and may be released to the atmosphere as ocean temperature increases?

ANSWER: METHANE

BONUS

21) Earth & Space – *Multiple Choice* Two oceanic plates collide. All other factors being equal, which plate is more likely to subduct?

- W) The crust that is older
- X) The crust that is more felsic
- Y) The crust with higher average temperature
- Z) The crust with more arc volcanism

ANSWER: W) THE CRUST THAT IS OLDER

TOSS-UP

22) Biology – *Short Answer* C. elegans is a model organism notable for having a deterministic and exact development. To which phylum [**FYE-lum**] does it belong?

ANSWER: NEMATODA (ACCEPT: NEMATODES)

BONUS

22) Biology – *Short Answer* Identify all of the following three classes of molecules that are intermediates in glycolysis [**glye-KAWL-eh-sis**]: 1) 5-carbon molecules; 2) 4-carbon molecules; 3) 3-carbon molecules.

ANSWER: 3

TOSS-UP

23) Math – *Short Answer* What is the distance between the points $(0, 7)$ and $(4, 9)$?

ANSWER: $2\sqrt{5}$

BONUS

23) Math – *Short Answer* Let f of x be a function with continuous derivative, with f of $3 = 0$ and f prime of $3 = 6$. Compute the limit as x approaches zero of the fraction with numerator f of $\text{open parenthesis } 3 + 2x, \text{ close parenthesis}$, plus f of $\text{open parenthesis } 3 - 3x, \text{ close parenthesis}$, and denominator x .

ANSWER: -6