

ROUND ROBIN – ROUND 10

TOSS-UP

1) Physics – *Multiple Choice* A wire is carrying current directly towards you. Which of the following describes the orientation of the magnetic field generated by this wire?

- W) In a counter-clockwise loop about the wire
- X) In a clockwise loop about the wire
- Y) Radially away from the wire
- Z) Radially toward the wire

ANSWER: W) IN A COUNTER-CLOCKWISE LOOP ABOUT THE WIRE

BONUS

1) Physics – *Short Answer* Identify all of the following three statements that are true regarding the viscosity of a fluid: 1) Viscosity arises from internal fluid friction; 2) Viscosity is inversely proportional to the shearing stress; 3) Viscous forces are conservative.

ANSWER: 1

TOSS-UP

2) Earth & Space – *Short Answer* Lapilli *[lah-PILL-eye]* are small stones produced by what events?

ANSWER: VOLCANIC ERUPTIONS (ACCEPT: METEORITE IMPACTS)

BONUS

2) Earth & Space – *Short Answer* Identify all of the following three glacial features that indicate the direction of glacial flow: 1) Drumlins; 2) Cirques; 3) Aretes *[ah-RETS]*.

ANSWER: 1, 2

TOSS-UP

3) Energy – *Multiple Choice* Scientists at Pacific Northwest National Lab are using mass spectrometry to study beta amyloid proteins. Which of the following is NOT true regarding beta-amyloid proteins?

- W) Beta-amyloid proteins are commonly seen in plaques in patients with Alzheimer's
- X) Treatments reducing beta-amyloid plaques have been successful in alleviating Alzheimer's symptoms
- Y) There are multiple forms of beta-amyloid proteins, including some that are soluble
- Z) Beta-amyloid proteins are produced from the proteolytic processing of a transmembrane protein

ANSWER: X) TREATMENTS REDUCING BETA-AMYLOID PLAQUES HAVE BEEN SUCCESSFUL IN ALLEVIATING ALZHEIMER'S SYMPTOMS

BONUS

3) Energy – *Short Answer* Researchers at Argonne National Lab are studying the isotope nickel-68, which has 28 protons and 40 neutrons. What is the LEAST massive particle that is released in the decay of this isotope?

ANSWER: ANTINEUTRINO (ACCEPT: ELECTRON ANTINEUTRINO)

TOSS-UP

4) Chemistry – *Multiple Choice* Which of the following statements cannot be true for a subshell with $n = 3$?

- W) $L = 2$
- X) $M_s = 0.5$
- Y) It has 5 orbitals
- Z) $M_L = 3$

ANSWER: Z) $M_L = 3$

BONUS

4) Chemistry – *Multiple Choice* Which of the following molecules is not iso-electronic with carbon monoxide?

- W) NO^+
- X) O_2
- Y) CN^-
- Z) N_2

ANSWER: X) O_2

TOSS-UP

5) Math – *Multiple Choice* Which of the following best describes the graph of $y = -x^7$ at $x = -4$?

- W) Increasing and concave up
- X) Increasing and concave down
- Y) Decreasing and concave up
- Z) Decreasing and concave down

ANSWER: Y) DECREASING AND CONCAVE UP

BONUS

5) Math – *Short Answer* A pizza has a radius of 6. After eating the right half of the pizza, you fold the other half into a cone. What is the volume enclosed by this cone?

ANSWER: $9\pi\sqrt{3}$ [any order of factors]

TOSS-UP

6) Biology – *Short Answer* A logistic model of population growth more closely matches observational data compared to an exponential model because there exists a threshold K above which population size will not increase. What is the term for this threshold?

ANSWER: CARRYING CAPACITY

BONUS

6) Biology – *Short Answer* Identify all of the following three characteristics that are found during the embryological development of all chordates [**KOR-dates**]: 1) Vertebrae; 2) Notochord [**NO-toh-cord**]; 3) Pharyngeal [**fair-in-JEE-ul**] slits.

ANSWER: 2, 3

TOSS-UP

7) Earth & Space – *Short Answer* The Trojan and Greek camps of asteroids originally refer to those that share the orbit of what planet?

ANSWER: JUPITER

BONUS

7) Earth & Space – *Multiple Choice* Which of the following stars would have the highest gravitational redshift?

- W) A one solar-mass star that has half the radius of our Sun
- X) A nine solar-mass star that has the same radius as our Sun
- Y) A five solar-mass star that has half the radius of our Sun
- Z) A five solar-mass star that has twice the radius of our Sun

ANSWER: Y) A FIVE SOLAR-MASS STAR THAT HAS HALF THE RADIUS OF OUR SUN

TOSS-UP

8) Energy – *Short Answer* Scientists working on the DOE's Energy Exascale Earth System Model are simulating ice movement in the Antarctic ice sheets. What term is used to describe this movement, which is thought of as a solid deforming beyond the limits under which Hooke's law applies?

ANSWER: PLASTIC FLOW (ACCEPT: PLASTIC DEFORMATION)

BONUS

8) Energy – *Multiple Choice* Scientists at Oak Ridge National Lab are studying the behavior of certain nightshades. Which of the following plants is an example of a nightshade?

- W) Apple
- X) Tea
- Y) Bell pepper
- Z) Spinach

ANSWER: Y) BELL PEPPER

TOSS-UP

9) Physics – *Multiple Choice* A region contains a time-varying magnetic field. Which of Maxwell's equations would be most directly useful for computing the EMF induced in objects within the field?

- W) Gauss's law
- X) Gauss's law for magnetism
- Y) Faraday's law
- Z) Ampere's law

ANSWER: Y) FARADAY'S LAW

BONUS

9) Physics – *Multiple Choice* Which of the following is closest to the amount of energy, in electron-volts, that a photon of visible light carries?

- W) 1,000,000
- X) 10,000
- Y) 100
- Z) 1

ANSWER: Z) 1

TOSS-UP

10) Math – *Short Answer* Solve the following equation for x : the absolute value of open parenthesis $x - 2$ close parenthesis is equal to 9.

ANSWER: 11 AND -7

BONUS

10) Math – *Short Answer* What is the slope-intercept form of the equation of the slant asymptote of the function f of x equals the fraction with numerator $4x^2 - 7x$ and denominator $x - 3$?

ANSWER: $y = 4x + 5$

TOSS-UP

11) Chemistry – *Short Answer* What is the term used to describe the movement of a gas as it escapes through a small opening?

ANSWER: EFFUSION (DO NOT ACCEPT: DIFFUSION)

BONUS

11) Chemistry – *Short Answer* What is the ratio of the root-mean-square-speed of a sample of helium gas to that of oxygen gas at the same temperature?

ANSWER: $2\sqrt{2}$ (ACCEPT: $2\sqrt{2}$ TO 1)

TOSS-UP

12) Biology – *Multiple Choice* As read from 5 prime to 3 prime, which of the following codons could a release factor bind to?

- W) UGG
- X) UAA
- Y) AUG
- Z) GAG

ANSWER: X) UAA

BONUS

12) Biology – *Short Answer* In peas, purple flowers are dominant to white flowers. Assuming Hardy-Weinberg equilibrium and absence of other alleles, if 64% of a population has purple flowers, then what fraction of the alleles in this population are for white flowers?

ANSWER: 0.6 (ACCEPT: 60%, 3/5)

TOSS-UP

13) Physics – *Multiple Choice* If you take the line integral of an electric field with respect to path length between two points, which of the following quantities have you calculated?

- W) The work it takes per unit charge to move the charge from one point to the other
- X) The change in electric field strength between the two points
- Y) The electric flux between the two points
- Z) The magnetic flux between the two points

ANSWER: W) THE WORK IT TAKES PER UNIT CHARGE TO MOVE THE CHARGE FROM ONE POINT TO THE OTHER

BONUS

13) Physics – *Short Answer* Consider an object at rest with a moment of inertia *[in-UR-shah]* of five kilogram meters squared, which undergoes an angular acceleration of five radians per second squared for two seconds. In joules, what is its rotational kinetic energy afterwards?

ANSWER: 250

TOSS-UP

14) Chemistry – *Short Answer* How many of sulfur's valence electrons are in *p* orbitals in the ground state?

ANSWER: FOUR

BONUS

14) Chemistry – *Short Answer* How many pi bonds are there in 2-cyan-o-hexa-3-ene?

ANSWER: 3

TOSS-UP

15) Energy – *Short Answer* Scientists at Idaho National Lab’s Advanced Test Reactor can see a blue glow emanating from the core of the nuclear reactor when it is powered up. This glow arises from what phenomenon?

ANSWER: CHERENKOV RADIATION

BONUS

15) Energy – *Short Answer* Scientists at the National Renewable Energy Laboratory collaborated with counterparts at Lawrence Berkeley National Lab to map electronic relationships between ternary metal nitrides [*NYE-trides*], such as the compound Zn₂ Sb N₃. What is the oxidation state on the antimony [*AN-tih-moh-nee*] atom in this compound?

ANSWER: 5 (ACCEPT: +5)

TOSS-UP

16) Math – *Short Answer* Given f of $x = 3x - 7$ and g of $x = 4x$, what is g off of x ?

ANSWER: $12x - 28$

BONUS

16) Math – *Short Answer* What is the average value of the function f of x equals $\underline{x^2 - 6x}$ over the interval from one to four?

ANSWER: -8

TOSS-UP

17) Earth & Space – *Multiple Choice* Which of the following best describes the typical path of a P-wave through the mantle following an earthquake?

- W) Straight line
- X) Curved toward the surface
- Y) Curved toward the core
- Z) Irregular zig-zag

ANSWER: X) CURVED TOWARD THE SURFACE

BONUS

17) Earth & Space – *Short Answer* The chemical formula for the mineral gypsum contains calcium, sulfate, and what third component?

ANSWER: WATER (ACCEPT: H₂O)

TOSS-UP

18) Biology – *Multiple Choice* HIV evades the human immune system by hiding primarily in which of the following groups of cells?

- W) Egg and sperm cells
- X) Muscle cells
- Y) Red blood cells
- Z) White blood cells

ANSWER: Z) WHITE BLOOD CELLS

BONUS

18) Biology – *Short Answer* Mollusk shells are primarily composed of protein and a mineral with what chemical formula?

ANSWER: CaCO₃

TOSS-UP

19) Math – *Short Answer* If an exterior angle adjacent to a base angle of an isosceles triangle measures 126 degrees, what is the degree measure of the vertex angle?

ANSWER: 72

BONUS

19) Math – *Short Answer* If $100!$ factorial base 10 is written as an integer in base 7, how many consecutive zeros will it have at its right end?

ANSWER: 16

TOSS-UP

20) Earth & Space – *Short Answer* In a telescope, the ratio of the focal length of the objective lens to that of the eyepiece quantifies what property of the telescope?

ANSWER: MAGNIFICATION

BONUS

20) Earth & Space – *Short Answer* The lifetime of a planet's surface evolution is proportional to the total amount of energy available divided by the rate of energy loss. This means that the lifetime is directly proportional to what power of the planet's radius?

ANSWER: ONE

TOSS-UP

21) Chemistry – *Multiple Choice* Which of the following gasses demonstrates the highest root-mean-square velocity at standard temperature and pressure?

- W) Nitrogen
- X) Neon
- Y) Oxygen
- Z) Chlorine

ANSWER: X) NEON

BONUS

21) Chemistry – *Short Answer* How many degenerate states are there for an electron in a hydrogen atom with principal quantum number $n = 3$?

ANSWER: 18

TOSS-UP

22) Physics – *Short Answer* Consider two parallel wires that are carrying current in the same direction. If the current in one wire were doubled and the current in the other wire were reversed, then, in terms of the original force F between the wires, what is the new force between the wires?

ANSWER: $-2F$

BONUS

22) Physics – *Short Answer* A cat stands in front of a convex mirror. Identify all of the following three statements that are true regarding the image formed by the mirror: 1) It is virtual; 2) It is larger than the cat; 3) It is inverted.

ANSWER: 1

TOSS-UP

23) Biology – *Short Answer* The three germ layers of the vertebrate embryo are formed during what stage of development?

ANSWER: GASTRULATION

BONUS

23) Biology – *Short Answer* When the pulmonary valve is open in a mammalian heart, what other cardiac valve should also be open?

ANSWER: AORTIC (ACCEPT: AORTIC SEMILUNAR VALVE, LEFT SEMILUNAR VALVE)