

ROUND ROBIN – ROUND 3

TOSS-UP

1) Math – *Short Answer* In one draw from a deck of cards, what is the probability of getting a red even-numbered card?

ANSWER: 5/26

BONUS

1) Math – *Short Answer* Solve the following equation for x : $6x - 3$ equals the absolute value of open parenthesis $5x - 7$ close parenthesis.

ANSWER: 10/11 (DO NOT ACCEPT: -4)

TOSS-UP

2) Biology – *Short Answer* The malleus bone receives sensory information from what membrane?

ANSWER: EARDRUM (ACCEPT: TYMPANIC)

BONUS

2) Biology – *Short Answer* Levels of what gas in the blood are most responsible for regulating respiratory rate in humans?

ANSWER: CARBON DIOXIDE (ACCEPT: CO₂; DO NOT ACCEPT: BICARBONATE, CARBONIC ACID)

TOSS-UP

3) Earth & Space – *Short Answer* The CNO cycle and the triple alpha process are reactions that occur in what entities?

ANSWER: STARS (ACCEPT: MASSIVE STARS)

BONUS

3) Earth & Space – *Short Answer* A satellite is put into orbit about the Sun with a semi-major axis of 4 AU. In Earth years, what will be the period of the satellite's orbit?

ANSWER: 8

TOSS-UP

4) Physics – *Short Answer* If a particle's velocity is defined by a certain linear function of time, what physical quantity is defined as the slope of that line?

ANSWER: ACCELERATION

BONUS

4) Physics – *Short Answer* What is the power radiated, in watts, by a 50 kilo-ohm resistor that is supplied with a constant 20 milli-amp direct current?

ANSWER: 20

TOSS-UP

5) Chemistry – *Short Answer* According to Hund’s rule, how many orbitals of a set of 2p orbitals will have at least one electron in them if the set of orbitals contains four electrons?

ANSWER: THREE

BONUS

5) Chemistry – *Multiple Choice* Which of the following bonds is the LEAST polar?

- W) H-H
- X) H-C
- Y) C-N
- Z) H-N

ANSWER: W) H-H

TOSS-UP

6) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab are developing small-scale experiments to detect low-mass dark matter particles, such as those theorized to compose hot dark matter. What nearly massless leptons could constitute hot dark matter?

ANSWER: NEUTRINOS (ACCEPT: ANTINEUTRINOS)

BONUS

6) Energy – *Multiple Choice* Princeton Plasma Physics Lab researchers are exploring the use of lithium metal as a plasma-facing component in the devices they are building. Which of the following devices uses a plasma-facing component?

- W) Mass spectrometer
- X) Tokamak ***[TOH-kah-mak]***
- Y) Bubble chamber
- Z) Linear accelerator

ANSWER: X) TOKAMAK

TOSS-UP

7) Physics – *Short Answer* A basin of water is connected to two vertically-oriented pistons, one with area 30 square centimeters and the other with area 75 square centimeters. A 50-kilogram mass sits on the smaller piston. In kilograms, what mass must be placed on the larger piston in order to place the system in static equilibrium?

ANSWER: 125

BONUS

7) Physics – *Short Answer* The heat of fusion of water is 80 calories per gram. You wish to fully melt a 50-gram block of ice at zero degrees Celsius, by adding boiling liquid water. In grams, what is the minimum mass of boiling water you must add?

ANSWER: 40

TOSS-UP

8) Math – *Short Answer* A bag contains 7 uniquely-colored marbles. Two marbles are drawn simultaneously. How many different combinations are possible?

ANSWER: 21

BONUS

8) Math – *Short Answer* What is the units digit of 7 raised to the 99th power?

ANSWER: 3

TOSS-UP

9) Earth & Space – *Short Answer* In what layer of the Earth's interior will S-waves never be found?

ANSWER: OUTER CORE

BONUS

9) Earth & Space – *Multiple Choice* Which of the following statements best describes why the annual temperature range at most latitudes in the Southern Hemisphere is less than that in the Northern Hemisphere?

- W) Earth is closer to the Sun in the Southern Hemisphere summer
- X) A larger percentage of the Southern Hemisphere is mountainous
- Y) There are more cloudy days in the Southern Hemisphere
- Z) A larger percentage of the Southern Hemisphere is covered by water

ANSWER: Z) A LARGER PERCENTAGE OF THE SOUTHERN HEMISPHERE IS COVERED BY WATER

TOSS-UP

10) Energy – *Multiple Choice* Researchers at Los Alamos National Lab are building long-range radio networks for real-time sensors. Which of the following telescopes is sensitive to radio waves?

- W) Chandra [*CHAN-drah*] Observatory
- X) Hubble Space Telescope
- Y) Very Large Array
- Z) Spitzer Space Telescope

ANSWER: Y) VERY LARGE ARRAY

BONUS

10) Energy – *Short Answer* Scientists at the National Renewable Energy Laboratory are using computational methods to predict the energies of molecular orbitals. What is the term for a molecular orbital that is symmetric with respect to the inter-nuclear axis?

ANSWER: SIGMA ORBITAL (ACCEPT: SIGMA)

TOSS-UP

11) Chemistry – *Short Answer* What is the adjective for a mixture that has constant composition throughout?

ANSWER: HOMOGENEOUS [*hoe-moe-JEEN-ee-us*]

BONUS

11) Chemistry – *Short Answer* Chlorite ions can be reduced by iodide ions to form chloride, water, and solid iodine. In order for a chlorite ion to be completely reduced to chloride, how many molecules of solid iodine are generated?

ANSWER: TWO

TOSS-UP

12) Biology – *Short Answer* A surge in luteinizing [*LOO-tin-eye-zing*] hormone is the trigger for what event in the human ovarian cycle?

ANSWER: OVULATION

BONUS

12) Biology – *Short Answer* Assuming a trophic [*TROH-fik*] efficiency of 10%, and expressing your answer as a fraction, what fraction of the energy available in primary producers will be available in the tertiary [*TUR-shee-ary*] consumers?

ANSWER: 1/1000

TOSS-UP

13) Physics – *Short Answer* A parallel-plate capacitor has a capacitance C when it has a certain di-electric between its plates. If the di-electric is switched for one that has a di-electric constant four times as large, by what number will C be multiplied?

ANSWER: FOUR

BONUS

13) Physics – *Short Answer* You pull on a 400-newton sled with a rope that makes a 45-degree angle to the horizontal. If you apply a force of 300 newtons to make the sled move at two meters per second, how much power, in watts, are you applying onto the sled?

ANSWER: $300\sqrt{2}$

TOSS-UP

14) Chemistry – *Multiple Choice* Nick performs an experiment in which he dissolves a known quantity of salt in water at different temperatures and measures the amount of time the salt takes to dissolve completely. What is the independent variable in this experiment?

- W) The identity of the salt
- X) The temperature of the water
- Y) The quantity of the salt
- Z) The amount of time the salt takes to dissolve completely

ANSWER: X) THE TEMPERATURE OF THE WATER

BONUS

14) Chemistry – *Short Answer* Consider the reaction of hydrogen and iodine gases to form hydrogen iodide gas at 800 kelvins. If 0.7 moles each of hydrogen and iodine gases are introduced into a one-liter container, and there are 0.6 moles of hydrogen iodide at equilibrium, what is the $K_{\text{sub-C}}$ for this reaction?

ANSWER: 2.25 (ACCEPT: $9/4$, $2\ 1/4$)

TOSS-UP

15) Earth & Space – *Short Answer* The Mesoproterozoic [*MEH-zoh-PROH-teroh-ZO-ik*] and the Mesozoic [*MEH-zoh-ZOH-ik*] are examples of what division of geologic time?

ANSWER: ERA

BONUS

15) Earth & Space – *Short Answer* Identify all of the following three rock types that could form a pluton: 1) Granite; 2) Andesite; 3) Gabbro.

ANSWER: 1, 3

TOSS-UP

16) Biology – *Short Answer* Distinct from mitosis, what phenomenon explains why sister chromatids in meiosis [*my-OH-sis*] are not identical?

ANSWER: CROSSING OVER (ACCEPT: CHROMOSOMAL CROSSOVER, CROSSOVER EVENTS, RECOMBINATION)

BONUS

16) Biology – *Short Answer* In part of the Hershey-Chase experiment, phages were grown in the presence of a radioactive isotope of what element found in proteins but not in DNA?

ANSWER: SULFUR

TOSS-UP

17) Math – *Short Answer* A bag contains 24 socks: 6 are red, 8 are white, and 10 are blue. How many socks must you take out to be certain that you will have at least one pair of red socks?

ANSWER: 20

BONUS

17) Math – *Short Answer* What is the derivative evaluated at $x = 7$ of the fraction with numerator $x^3 + 27$ and denominator $x + 3$?

ANSWER: 11

TOSS-UP

18) Energy – *Multiple Choice* Brookhaven National Lab researchers are studying leaf properties that change with age of the leaf. Which of the following accurately describes how oak leaves change in their near-infrared absorption over time?

- W) It increases over the first half of the year, then decreases
- X) It decreases over the first half of the year, then increases
- Y) It decreases
- Z) It increases

ANSWER: W) IT INCREASES OVER THE FIRST HALF OF THE YEAR, THEN DECREASES

BONUS

18) Energy – *Short Answer* Researchers at the National Renewable Energy Lab are using microscopy to improve the recycling rate of lithium-ion batteries. What is the most common anode used in lithium-ion batteries?

ANSWER: GRAPHITE

TOSS-UP

19) Earth & Space – *Short Answer* Puck, Miranda, and Portia are moons of what planet?

ANSWER: URANUS

BONUS

19) Earth & Space – *Short Answer* Identify all of the following three statements that are true of sunlight: 1) It is polarized; 2) It is monochromatic; 3) Its peak wavelength corresponds to the color green.

ANSWER: 3

TOSS-UP

20) Chemistry – *Short Answer* Identify all of the following three compounds that interact mainly via London dispersion forces: 1) Di-chloro-methane; 2) Phosphorous trichloride; 3) Carbon tetra-chloride.

ANSWER: 3

BONUS

20) Chemistry – *Short Answer* Identify all of the following three functional groups that contain double bonds: 1) Carboxyl; 2) Amide; 3) Ester.

ANSWER: ALL

TOSS-UP

21) Math – *Short Answer* What is the discriminant of the quadratic function $y = x^2 - 6x + 15$?

ANSWER: -24

BONUS

21) Math – *Short Answer* A square has sides of length 10 centimeters. In square centimeters, what is the difference between the areas of its circumscribing circle and its inscribed circle?

ANSWER: 25π

TOSS-UP

22) Biology – *Short Answer* Most cases of genomic imprinting involve the addition of what functional group to DNA?

ANSWER: METHYL (ACCEPT: CH_3)

BONUS

22) Biology – *Short Answer* Whether cleavage is holoblastic or meroblastic in a developing fertilized egg primarily depends on the amount of what substance in the egg?

ANSWER: YOLK

TOSS-UP

23) Physics – *Short Answer* Calculating the surface integral of an electric field passing through an area results in what physical quantity?

ANSWER: ELECTRIC FLUX

BONUS

23) Physics – *Short Answer* You are keeping a 2-kilogram book pressed up against a wall by pushing with just enough force in the horizontal direction to prevent the book from slipping. If you are pushing with 50 newtons of force, then what is the coefficient of static friction between the book and the wall?

ANSWER: 0.392 (ACCEPT: 49/125)