



## ROUND ROBIN 3

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### TOSS-UP

1) X-Risk - *Multiple Choice* What type of structure is used in machine learning to allow models to draw conclusions based on past data?

W) Argument map

X) Decision tree

Y) Dendrogram

Z) Radial tree

ANSWER: X) Decision tree

### BONUS

1) X-Risk - *Short Answer* Order the following three gases by increasing global warming potential: 1) CO<sub>2</sub>; 2) N<sub>2</sub>O; 3) SF<sub>6</sub>.

ANSWER: 1, 2, 3

## TOSS-UP

2) Math - *Short Answer* What is the limit as  $x$  approaches infinity of the quantity  $\frac{x^2+2x+1}{x^2-1}$ ?

ANSWER: 1

## BONUS

2) Math - *Short Answer* A square triangular number is a triangular number which is also a perfect square. 0 and 1 are the first two square triangular numbers, respectively. What number is the third square triangular number?

ANSWER: 36

### TOSS-UP

3) Chemistry - *Short Answer* A substance is observed under certain conditions to transition from a liquid to a gas without boiling. What phase of matter is the substance most likely observed to be in?

ANSWER: Supercritical fluid

### BONUS

3) Chemistry - *Short Answer* The face-on-face overlap of two  $d_{xy}$  [d-x-y] orbitals creates what type of exotic bond?

ANSWER: Delta bond

## TOSS-UP

4) Earth and Space - *Multiple Choice* What type of rock would be expected to form when there are two distinct cooling rates for different constituents of the rock?

- W) Aphanitic [af-uh-NIT-ic]
- X) Porphyritic [por-fee-RIT-ik]
- Y) Glassy
- Z) Phaneritic [fan-uh-RIT-ik]

ANSWER: X) Porphyritic

## BONUS

4) Earth and Space - *Multiple Choice* Without corrections, carbon-14 dating in the recent past is incredibly unreliable. Which of the following contributes the most to this issue?

- W) Burning of fossil fuels decreases carbon-14 concentrations
- X) Nuclear weapons testing increases carbon-14 concentrations
- Y) Recent abnormal solar activity increases carbon-14 concentrations
- Z) Very little carbon-14 has had time to decay

ANSWER: W) Burning of fossil fuels decrease relative C-14 concentrations

## TOSS-UP

5) Biology - *Short Answer* Oligodendrocytes [uh-lig-oh-DEN-drow-sites] in the central nervous system have the same function as what cells in the peripheral nervous system?

ANSWER: Schwann cells

## BONUS

5) Biology - *Short Answer* Identify all of the following that can cause balancing selection: 1) Heterozygote advantage; 2) Positive frequency dependent selection; 3) Mullerian [moo-LEER-ee-uhn] mimicry.

ANSWER: 1 only

## TOSS-UP

6) Physics - *Multiple Choice* Justin rolls a bicycle wheel up a ramp. At the same time, Adam rolls an identical bicycle wheel down the same ramp. Both wheels roll without slipping. Which of the following best describes the relationship between the accelerations of the two bike wheels?

- W) The acceleration is greater up the ramp
- X) The acceleration is greater down the ramp
- Y) The accelerations are equal
- Z) There is not enough information to tell

ANSWER: Y) The accelerations are equal

## BONUS

6) Physics - *Short Answer* A particle's position on the  $x$ -axis is given by the equation  $x = t^3 - 27t + 4$ , where  $t$  is in seconds. At what values of  $t$  is its velocity equal to 0?

ANSWER: 3 and -3

## TOSS-UP

7) X-Risk - *Multiple Choice* What is not considered an example of greenwashing in climate change prevention?

W) Appointing an environmental oversight committee without real power

X) Focusing only on environmental measures that save money for your company

Y) Ignoring catastrophic climate change in discussion of climate change prevention

Z) Writing climate protection statements as a means of social signaling

ANSWER: Y) Ignoring catastrophic climate change in discussion of climate change prevention

## BONUS

7) X-Risk - *Multiple Choice* Which of the following infectious agents can be identified by their namesake hemagglutinin and neuraminidase proteins?

W) Ebolavirus

X) Influenza

Y) Yersinia pestis

Z) Herpes simplex

ANSWER: X) Influenza

### TOSS-UP

8) Math - *Short Answer* A fair six-sided die is rolled 12 times. What is the expected value of the sum of the rolls?

ANSWER: 42

### BONUS

8) Math - *Short Answer* A recipe for a massive ice cream cake calls for 3 dozen eggs for a cake with an area of 12 square feet. How many eggs would be needed for a square cake with an area of 9 square feet?

ANSWER: 27

### TOSS-UP

9) Chemistry - *Short Answer* Identify all of the following three states of matter that have activity equivalent to unity: 1) Solid; 2) Liquid; 3) Gas.

ANSWER: 1 and 2

### BONUS

9) Chemistry - *Short Answer* To one significant figure, calculate the change in internal energy in joules during the isothermal compression of one mole of an ideal gas from 2.7 liters to 1 liter at 400 kelvin.

ANSWER: 0

## TOSS-UP

10) Earth and Space - *Short Answer* Order the following three fusion reactions by increasing required temperature: 1) Hydrogen burning; 2) Lithium burning; 3) Oxygen burning.

ANSWER: 2, 1, 3

## BONUS

10) Earth and Space - *Short Answer* Orbits in the L4 and L5 Lagrange points are stable, even though they are peaks on a Hill diagram. What effect explains their stability?

ANSWER: Coriolis effect (ACCEPT: Coriolis force)

## TOSS-UP

11) Biology - *Multiple Choice* Jack is trying to analyze a metabolic pathway in a human cell. He notices that GTP is being produced, and water is also being utilized. Which of the following pathways is he analyzing?

- W) Pentose phosphate pathway
- X) Fatty acid synthesis
- Y) Glycolysis
- Z) Gluconeogenesis [gloo-kow-nee-oh-GEN-uh-sis]

ANSWER: W) Pentose phosphate pathway

## BONUS

11) Biology - *Multiple Choice* Which of the following hormones has nontropic effects, but not tropic effects?

- W) Follicle stimulating hormone
- X) Growth hormone
- Y) Melanocyte stimulating hormone
- Z) Thyroid stimulating hormone

ANSWER: Y) Melanocyte stimulating hormone

## TOSS-UP

12) Physics - *Short Answer* The splitting of spectral lines due to an external magnetic field is known as what effect?

ANSWER: Zeeman effect

## BONUS

12) Physics - *Short Answer* Derek is moving at  $0.8c$  in the y-direction and appears to be 2 meters tall in his frame of reference along the y-direction. To an observer, how tall does Derek appear, in meters?

ANSWER: 1.2 meters

## TOSS-UP

13) X-Risk - *Short Answer* African sleeping sickness, or trypanosomiasis, is a deadly disease in Africa that can cause high fever and death, and is difficult to deal with because the causative agent is a protozoan. What species of fly serves as the vector for African sleeping sickness?

ANSWER: Tsetse fly

## BONUS

13) X-Risk - *Short Answer* As classical computer designs approach physical limits, companies are looking towards quantum computing for further technological advances. Quantum qubits store information differently from classical bits by using what fundamental quantum principle?

ANSWER: Superposition

### TOSS-UP

14) Math - *Short Answer* The unique plane assumption in Euclidean geometry states there is exactly one plane through how many non-collinear points?

ANSWER: 3

### BONUS

14) Math - *Short Answer* A regular hexagon and heptagon are inscribed in a circle such that they share no vertices. What is the maximum number of points of intersections they could have?

ANSWER: 12

### TOSS-UP

15) Chemistry - *Short Answer* What is the coordination number of an iron atom in a body-centered cubic lattice?

ANSWER: 8

### BONUS

15) Chemistry - *Multiple Choice* Which of the following is a diradical species in its ground state?

- W) Nitrogen dioxide
- X) Diboron
- Y) Beryllium difluoride
- Z) Monatomic nitrogen

ANSWER: X) Diboron

## TOSS-UP

16) Earth and Space - *Multiple Choice* Internal waves in the ocean will most closely propagate along what boundary?

- W) Thermocline
- X) Halocline
- Y) Pycnocline [PIC-no-cline]
- Z) Carbonate compensation depth

ANSWER: Y) Pycnocline

## BONUS

16) Earth and Space - *Multiple Choice* Which of the following types of precipitation is most likely to occur if there is a shallow warm air layer 10,000 feet above the ground in an otherwise subfreezing atmosphere?

- W) Freezing rain
- X) Snow
- Y) Hail
- Z) Sleet

ANSWER: Z) Sleet

## TOSS-UP

17) Biology - *Multiple Choice* Which of the following amino acids cannot be modified by a protein kinase?

W) Methionine [muh-THY-uh-need]

X) Serine [SAIR-een]

Y) Threonine [THREE-uh-need]

Z) Tyrosine [TIE-ruh-need]

ANSWER: W) Methionine

## BONUS

17) Biology - *Short Answer* Identify all of the following three statements that are true of G-protein coupled receptors: 1) Their transmembrane domain contains many beta sheets; 2) Upon binding of a ligand, the GDP bound to the cytoplasmic side of the GPCR is phosphorylated [fas-FOUR-uh-late-id]; 3) The insulin receptor is a GPCR.

ANSWER: None

## TOSS-UP

18) Physics - *Multiple Choice* How many antiquarks are present in a pentaquark, a particle made up of five quarks?

W) 0

X) 1

Y) 3

Z) 5

ANSWER: X) 1

## BONUS

18) Physics - *Short Answer* Ryan places an infinite number of capacitors in series such that each capacitor's capacitance is twice that of the previous capacitor. He then places all of them in a circuit with a 9 volt battery. If the first capacitor has a capacitance of 1 farad, then in coulombs, what is the charge on the capacitor with capacitance of 16 farads?

ANSWER: 4.5

## TOSS-UP

19) X-Risk - *Multiple Choice* The Ring of Fire is a ring of highly explosive volcanoes around the Pacific Ocean basin. Which of the following properties of these volcanoes does NOT contribute to their high explosivity?

- W) High volatile content
- X) High viscosity
- Y) Low temperature
- Z) Low degree of mixing

ANSWER: Z) Low degree of mixing

## BONUS

19) X-Risk - *Multiple Choice* The first stage in a two-stage nuclear weapon triggers the second stage using what type of explosion?

- W) Chemical
- X) Electrical
- Y) Nuclear fission
- Z) Nuclear fusion

ANSWER: Y) Nuclear fission

### TOSS-UP

20) Math - *Short Answer* What is the directrix of the parabola with equation  $y = 2x^2$ ?

ANSWER:  $y = -1/8$  (ACCEPT:  $-1/8$ )

### BONUS

20) Math - *Short Answer* A warden is playing a game with 5 prisoners where he takes all their hats and returns them back at random. Two of the prisoners are wearing hats of the same color, while the rest of them are wearing hats with distinct colors. How many ways can the warden return the hats such that no one's hat is the same color as their starting hat?

ANSWER: 12

### TOSS-UP

21) Chemistry - *Short Answer* When chlorine gas is bubbled into a hot aqueous [AY-kwee-is] solution of sodium hydroxide, sodium chloride and sodium chlorate are formed. What type of redox reaction occurs during the formation of these products?

ANSWER: Disproportionation

### BONUS

21) Chemistry - *Short Answer* A solution of copper (II) [two] bromide is electrolyzed for 100 minutes with a 16 ampere current. Given that the molar mass of copper is approximately 64 grams, how many grams of copper are deposited on the cathode to two significant figures?

ANSWER: 32

## TOSS-UP

22) Earth and Space - *Multiple Choice* Which of the following properties of a globular cluster would be most appropriate to estimate its age?

- W) Average temperature
- X) Turnoff point
- Y) Spectral lines
- Z) Ratio of population I stars to population II stars

ANSWER: X) Turnoff point

## BONUS

22) Earth and Space - *Multiple Choice* Which of the following observatories would be expected to detect a gamma ray burst?

- W) Chandra Space Telescope
- X) ALMA Telescope
- Y) Swift Observatory
- Z) James Webb Space Telescope

ANSWER: Y) Swift Observatory

## TOSS-UP

23) Biology - *Multiple Choice* In which of the following organisms would you expect to find Malpighian [mal-PIG-ee-uhn] tubules?

- W) Grasshopper
- X) Planarian [pluh-NAIR-ee-uhn]
- Y) Rotifer [ROW-tih-fuhr]
- Z) Earthworm

ANSWER: W) Grasshopper

## BONUS

23) Biology - *Short Answer* Identify all of the following three phyla [FY-luh] which belong to the group Ecdysozoa: 1) Nematoda [NEE-mah-toh-duh]; 2) Arthropoda [arr-thruh-POD-ah]; 3) Echinodermata [ih-KAI-no-duhr-mah-tuh].

ANSWER: 1 and 2

### TOSS-UP

24) Physics - *Short Answer* The results of what theory predict that the electric field and magnetic field are different forms of the same phenomenon depending on the reference frame?

ANSWER: Special relativity

### BONUS

24) Physics - *Short Answer* Compute, in terms of  $R$ , the ideal gas constant, the molar constant volume heat capacity of a diatomic ideal gas.

ANSWER:  $5R/2$