



## ROUND ROBIN 5

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### TOSS-UP

1) X-Risk - *Short Answer* What type of algorithm, commonly used in machine learning, applies a function in various iterations to linear combinations of outputs from the previous iteration?

ANSWER: Neural network

### BONUS

1) X-Risk - *Multiple Choice* Interpretability is a field of machine learning focused on which of the following research objectives?

W) Applying theoretical ideas from AI alignment to modern AI systems

X) Allowing AI systems to learn human values in training

Y) Developing ways for AI systems to respond to conditions outside the training data

Z) Allowing learned models to be more easily understandable by humans

ANSWER: Z) Allowing learned models to be more easily understood by humans

## TOSS-UP

2) Math - *Short Answer* John buys a pizza with diameter 16 inches and cuts it into 8 identical slices. What is the perimeter of each slice, in inches?

ANSWER:  $2\pi + 16$

## BONUS

2) Math - *Multiple Choice* Alice sits at the bottom left of a 5 by 5 grid of dots while Bob sits at the top right. Every second, Alice randomly moves either one step right or one step up and Bob randomly moves either one step down or one step left. If either of them tries to move off the grid, they will instead not move. What is the probability that, at some point, Alice and Bob meet?

W) 1/16

X) 53/256

Y) 1/4

Z) 35/128

ANSWER: Z) 35/128

### TOSS-UP

3) Chemistry - *Multiple Choice* Which of the following is NOT an assumption of kinetic molecular theory about particles in a gas?

- W) Particles have negligible volume
- X) Particles have no net speed
- Y) Particle collisions conserve kinetic energy
- Z) Particles have no attractive forces

ANSWER: X) Particles have no net speed

### BONUS

3) Chemistry - *Short Answer* An aqueous solution of an alkali metal's hydroxide is electrolyzed. What gas is produced at the electrolytic cell's anode?

ANSWER: Oxygen

## TOSS-UP

4) Earth and Space - *Multiple Choice* The rapid quenching of pillow basalts produces what mineraloid on the surface of these rock formations?

- W) Opal
- X) Chert
- Y) Obsidian
- Z) Greywacke

ANSWER: Y) Obsidian

## BONUS

4) Earth and Space - *Short Answer* An island is surrounded by a fringing reef. When this island is eroded to form a seamount, the reef will remain behind, forming what circular feature in the ocean?

ANSWER: Atoll

## TOSS-UP

5) Biology - *Short Answer* What form of endocytosis do cells use to transport small fluids inside the cell via the budding of small vesicles from the plasma membrane?

ANSWER: Pinocytosis

## BONUS

5) Biology - *Multiple Choice* Kinases are enzymes that are responsible for transferring a phosphate group onto proteins. Cyclic AMP is necessary for the activation of which of the following kinases?

- W) Protein Kinase A
- X) Protein Kinase C
- Y) Phosphofructokinase
- Z) Hexokinase

ANSWER: W) Protein Kinase A

## TOSS-UP

6) Physics - *Short Answer* What law relates the current density in a resistive material to the electric field experienced throughout the material?

ANSWER: Ohm's law

## BONUS

6) Physics - *Multiple Choice* The peak of the Maxwell-Boltzmann velocity distribution indicates what information about the gas molecules it represents?

W) Root-mean-square speed

X) Average speed

Y) Lower-bound speed

Z) Most probable speed

ANSWER: Z) Most probable speed

## TOSS-UP

7) X-Risk - *Multiple Choice* Which of the following environmental changes most directly leads to desertification?

- W) Increase in agriculture
- X) Removal of vegetation
- Y) Increase in temperature
- Z) Decrease in rainfall

ANSWER: X) Removal of vegetation

## BONUS

7) X-Risk - *Multiple Choice* The Kardashev scale is a measure of which of the following aspects of a civilization?

- W) Intelligence
- X) Level of cooperation
- Y) Technological advancement
- Z) Resistance to extinction

ANSWER: Y) Technological advancement



### TOSS-UP

8) Math - *Multiple Choice* Which of the following is a measure of dispersion among a set of data points?

- W) Mean
- X) Median
- Y) Mode
- Z) Range

ANSWER: Z) Range

### BONUS

8) Math - *Short Answer* A circle is inscribed in a square. To the nearest tenth, what is the probability that a random point inside the square will also be inside the circle?

ANSWER: 0.8

### TOSS-UP

9) Chemistry - *Short Answer* Rank the following three chemical species by increasing atomic radius: 1)  $S^{2-}$ ; 2)  $Cl^{-}$ ; 3) Ar.

ANSWER: 3, 2, 1

### BONUS

9) Chemistry - *Short Answer* What is the bond order of the oxygen-oxygen covalent bond in the ozone molecule?

ANSWER: 1.5

## TOSS-UP

10) Earth and Space - *Multiple Choice* Which of the following statements is NOT true regarding sunspots?

- W) They are warmer than surrounding areas
- X) Their cycle has a period of approximately 11 years
- Y) They are often found in pairs with magnetic fields pointing opposite directions
- Z) Sunspots at the equator move faster than sunspots near the poles

ANSWER: W) They are warmer than surrounding areas

## BONUS

10) Earth and Space - *Short Answer* Order the following three layers of the sun from innermost to outermost: 1) Radiative zone; 2) Convective zone; 3) Photosphere.

ANSWER: 1, 2, 3

## TOSS-UP

11) Biology - *Short Answer* What ATPase is most responsible for maintaining the resting potential of a neuron?

ANSWER: Sodium-potassium pump

## BONUS

11) Biology - *Short Answer* Identify all of the following three structures that are typically considered modified stems: 1) Rhizome; 2) Stolon; 3) Tuber.

ANSWER: All

## TOSS-UP

12) Physics - *Short Answer* The beta decay of atoms is mediated by what fundamental force?

ANSWER: Weak nuclear force (ACCEPT: Weak force, weak)

## BONUS

12) Physics - *Short Answer* Beta plus decay products include an electron neutrino and what other subatomic particle?

ANSWER: Positron

## TOSS-UP

13) X-Risk - *Short Answer* What is the process in which an excess of nutrients in a lake causes growth of plant life and death of animal life from the resulting lack of oxygen?

ANSWER: Eutrophication

## BONUS

13) X-Risk - *Multiple Choice* Some fusion-based nuclear weapons were specially designed to minimize property damage by emitting most of their radiation in the form of what type of particle?

W) Photon

X) Helium nucleus

Y) Neutron

Z) Electron

ANSWER: Y) Neutron

### TOSS-UP

14) Math - *Short Answer* For what radian values of  $x$  between  $0$  and  $2\pi$  inclusive does  $\sin(x)$  equal  $\cos(x)$ ?

ANSWER:  $\frac{\pi}{4}$  and  $\frac{5\pi}{4}$

### BONUS

14) Math - *Short Answer* One fourth of all families own a cat, and of the families that own a cat, one tenth own a dog. Additionally, two fifths of all families own a dog. What is the probability that a randomly selected family that owns a dog also owns a cat?

ANSWER:  $1/16$

### TOSS-UP

15) Chemistry - *Short Answer* Transition metal complexes with four ligands around the metal center can exhibit a square planar geometry or what other geometry?

ANSWER: Tetrahedral

### BONUS

15) Chemistry - *Short Answer* Order the following three ionic compounds by increasing lattice energy: 1) MgO; 2) NaCl; 3) MgCl<sub>2</sub>.

ANSWER: 2, 3, 1



## TOSS-UP

16) Earth and Space - *Short Answer* What term describes the fractures exhibited by evenly cooling flood basalts that create a regular hexagonal pattern?

ANSWER: Columnar jointing

## BONUS

16) Earth and Space - *Multiple Choice* The rainfall and snowfall around a lake is highest on its west side. From which of the following directions does the prevailing wind likely come from?

W) North

X) South

Y) East

Z) West

ANSWER: Y) East

## TOSS-UP

17) Biology - *Multiple Choice* Galen is finding islands to claim for his kingdom, and finds two islands, which he names Island A and Island B. Island A is farther from the mainland, and has higher species diversity and richness than island B. According to the island biogeography model, which of the following can you conclude about island B?

- W) It is smaller than island A
- X) It is larger than island A
- Y) It is the same size as island A
- Z) It has more disturbance than island A

ANSWER: W) It is smaller than island A

## BONUS

17) Biology - *Multiple Choice* Which of the following best describes the function of the Casparian [cas-PAIR-ee-in] strip?

- W) Prevents water from entering the phloem
- X) Prevents sugar from entering the xylem
- Y) Forces water to move through a semipermeable membrane
- Z) Forces sugars to move through a membrane transport protein

ANSWER: Y) Forces water to move through a semipermeable membrane

## TOSS-UP

18) Physics - *Multiple Choice* Stimulated emission within a laser is done through the excitation of what subatomic particles?

W) Neutrons

X) Protons

Y) Electrons

Z) Positrons

ANSWER: Y) Electrons

## BONUS

18) Physics - *Short Answer* Identify all of the following three particles that have integer spin: 1) Proton; 2) Z-Boson; 3) Gluon.

ANSWER: 2 and 3

## TOSS-UP

19) X-Risk - *Multiple Choice* The mRNA-based vaccines used to combat COVID-19 encode which of the following parts of the virus?

- W) Spike protein
- X) Capsid
- Y) Viral envelope
- Z) Viral genome

ANSWER: W) Spike protein

## BONUS

19) X-Risk - *Multiple Choice* Dolly the sheep was the first mammal to be cloned from what type of cell?

- W) Gamete [GAM-eet]
- X) Germ cell
- Y) Stem cell
- Z) Somatic cell

ANSWER: Z) Somatic cell

### TOSS-UP

20) Math - *Multiple Choice* A regular  $n$ -gon has integer internal angle measures. Which of the following can possibly be  $n$ ?

- W) 72
- X) 75
- Y) 80
- Z) 100

ANSWER: W) 72

### BONUS

20) Math - *Short Answer* Kevin flips three fair coins. If he truthfully tells a stranger that at least two coins flipped heads, what is the probability that the unknown third coin also flipped heads?

ANSWER: 1/4

### TOSS-UP

21) Chemistry - *Multiple Choice* Which of the following elements has only one naturally occurring isotope?

- W) Carbon
- X) Oxygen
- Y) Fluorine
- Z) Phosphorus

ANSWER: Y) Fluorine

### BONUS

21) Chemistry - *Multiple Choice* Which of the following compounds has the lowest normal boiling point?

- W) H<sub>2</sub>O
- X) H<sub>2</sub>S
- Y) H<sub>2</sub>Se
- Z) H<sub>2</sub>Te

ANSWER: X) H<sub>2</sub>S

## TOSS-UP

22) Earth and Space - *Multiple Choice* The moon Triton is unique among other large moons due to which of the following properties?

- W) Retrograde orbit
- X) Lack of hydrostatic equilibrium
- Y) Tidal locking
- Z) Liquid water surface

ANSWER: W) Retrograde orbit

## BONUS

22) Earth and Space - *Short Answer* Order the following three objects in the solar system from innermost to outermost: 1) Vesta; 2) Eris; 3) Charon.

ANSWER: 1, 3, 2

### TOSS-UP

23) Biology - *Multiple Choice* From what organisms are restriction enzymes derived from?

- W) Bacteria
- X) Archaea
- Y) Bacteriophages
- Z) Lentiviruses

ANSWER: W) Bacteria

### BONUS

23) Biology - *Short Answer* Red mangrove seeds often germinate while still on the tree. This is caused by the lack of which plant hormone, which also mediates stomatal closure?

ANSWER: Absciscic [ab-SIZ-ic] acid



### TOSS-UP

24) Physics - *Multiple Choice* A ray of light at an angle of 30 degrees with respect to the normal travels from air to water, which has an index of refraction of 1.33. In degrees, which of the following is closest to the angle of the ray with respect to the normal in water?

W) 10

X) 20

Y) 30

Z) 40

ANSWER: X) 20

### BONUS

24) Physics - *Short Answer* An inductor stores 5 joules of energy. How much energy will it store, in joules, if the number of coils is doubled and the cross-sectional area of the coil is doubled?

ANSWER: 40