

ROUND ROBIN 6

TOSS-UP

1) Longtermism - *Multiple Choice* In 2012, Nick Bostrom [BOSS-truhm] first argued for the position that an artificial intelligence can have practically any combination of intelligence level and final goals. What is this position called?

- W) Goal induction hypothesis
- X) Goal independence hypothesis
- Y) Principle of independent action
- Z) Orthogonality thesis

ANSWER: Z) Orthogonality thesis

BONUS

1) Longtermism - *Multiple Choice* In this same paper, Bostrom argued that a wide range of sufficiently intelligent AIs would pursue similar intermediate goals, regardless of final goal. What is this hypothesis called?

- W) Final-intermediate divergence
- X) Terminal convergence
- Y) Instrumental convergence
- Z) Mediated orthogonality

ANSWER: Y) Instrumental convergence

TOSS-UP

2) Math - *Multiple Choice* What is the numerical coefficient of the third term in the binomial expansion of $(2x + 3y)^5$ [open parentheses two x plus three y, close parentheses, to the fifth power]?

- W) 240
- X) 480
- Y) 720
- Z) 960

ANSWER: Y) 720

BONUS

2) Math - *Multiple Choice* 2^{50} is closest to which of the following powers of 10?

- W) 10
- X) 15
- Y) 20
- Z) 25

ANSWER: X) 15

TOSS-UP

3) Chemistry - *Short Answer* How many distinct signals are present in the H1 NMR spectrum of neopentane?

ANSWER: 1

BONUS

3) Chemistry - *Short Answer* In thin layer chromatography, what value is defined as the ratio between the distance traveled of the component to that of the solvent?

ANSWER: Retention factor (ACCEPT: R_f)

TOSS-UP

- 4) Earth and Space - *Short Answer* A proposed explanation for rapid prehistoric global warming is based on a feedback loop involving the melting of what ice-like deposits on the ocean floor, which form a crystalline structure that traps methane?

ANSWER: Clathrates

BONUS

- 4) Earth and Space - *Multiple Choice* The difference between a laccolith [LACK-uh-lith] and a sill is most directly caused by which of the following properties of a magma?

- W) Viscosity
- X) Temperature
- Y) Gas content
- Z) Depth

ANSWER: W) Viscosity

TOSS-UP

5) Biology - *Multiple Choice* Which of the following neurotransmitters is considered a biogenic amine [A-meen]?

- W) Acetylcholine [uh-SEE-dul-KO-leen]
- X) Dopamine
- Y) Substance P
- Z) Glutamate

ANSWER: X) Dopamine

BONUS

5) Biology - *Short Answer* Order the following three ions in order of increasing contribution to resting membrane potential in a typical neuron at rest: 1) Na^+ ; 2) K^+ ; 3) Ca^{2+} .

ANSWER: 3, 1, 2

TOSS-UP

- 6) Physics - *Short Answer* Identify all of the following conditions that are required for the speed of light to be c : 1) An inertial frame of reference; 2) A vacuum; 3) A stationary source of light.

ANSWER: 2

BONUS

- 6) Physics - *Short Answer* What principle states that systems described with quantum theory agree with classical theory at large quantum numbers?

ANSWER: Correspondence principle

TOSS-UP

7) Longtermism - *Multiple Choice* Which of the following diseases is not currently a target for eradication?

- W) Polio
- X) Dracunculiasis [druh-KUN-gyuh-LIE-uh-sis]
- Y) Yaws
- Z) Rinderpest

ANSWER: Z) Rinderpest

BONUS

7) Longtermism - *Multiple Choice* Which of the following traits in a disease would make eradication unfeasible?

- W) It does not have a vaccine to prevent it
- X) It is highly contagious
- Y) It is spread through an animal vector
- Z) It is spread by infected water

ANSWER: Y) It is spread through an animal vector

TOSS-UP

8) Math - *Short Answer* How many sides does a regular congruent polygon have if each of its exterior angles measures 2.4 degrees?

ANSWER: 150

BONUS

8) Math - *Multiple Choice* The Cartesian coordinates $(1, 1, \sqrt{2})$ can be rewritten as what triplet of numbers in spherical coordinates?

- W) 2, 30 degrees, 60 degrees
- X) 2, 45 degrees, 45 degrees
- Y) 4, 30 degrees, 60 degrees
- Z) 4, 45 degrees, 45 degrees

ANSWER: X) 2, 45 degrees, 45 degrees

TOSS-UP

9) Chemistry - *Short Answer* What principle states that in the ground state of an atom or ion, electrons fill subshells of the lowest energy level before filling subshells of higher energy?

ANSWER: Aufbau [OFF-bough] Principle

BONUS

9) Chemistry - *Short Answer* When the natural logarithm of a reaction's equilibrium constant is plotted against one over temperature, what is the slope of the line, in terms of the reaction enthalpy H, reaction entropy S, and ideal gas constant R?

ANSWER: $-\frac{H}{R}$

TOSS-UP

10) Earth and Space - *Multiple Choice* Which of the following best explains why black dwarf stars have never been observed by astronomers?

- W) They emit very little light
- X) Their gravity is extremely weak
- Y) Most decomposed soon after the Big Bang
- Z) The universe is too young for them to form

ANSWER: Z) The universe is too young for them to form

BONUS

10) Earth and Space - *Short Answer* Identify all of the following three Milankovitch [mih-LAHN-ko-vich] cycles that could change the date of perihelion: 1) Eccentricity; 2) Obliquity [uh-BLIK-wih-dee]; 3) Apsidal [APP-sih-dull] precession.

ANSWER: 3 only

TOSS-UP

11) Biology - *Short Answer* Trypanosoma brucei [truh-PA-nuh-ZO-muh BROO-say], the organism which causes sleeping sickness, belongs to what group of flagellated [FLA-juh-lay-did] protists, which are named due to the presence of an organelle containing a large mass of DNA?

ANSWER: Kinetoplastida [kih-NEE-duh-PLAS-tih-duh]

BONUS

11) Biology - *Short Answer* Order the following four animals from oldest to most recent to evolve: 1) Mammals; 2) Birds; 3) Fish; 4) Reptiles.

ANSWER: 3, 4, 1, 2

TOSS-UP

12) Physics - *Short Answer* A pendulum's amplitude, length, and mass are all tripled, while the gravity acting upon the system is halved. By what factor is the period of the pendulum multiplied?

ANSWER: $\sqrt{6}$

BONUS

12) Physics - *Multiple Choice* In an alternate universe, if the permeability constant of free space were to change while the permativity constant remains the same, which of the following would change?

- W) Speed of light
- X) Electric field outside a spherical conductor
- Y) Electric field inside a spherical conductor
- Z) Magnetic field outside an ideal solenoid [SOL-eh-noyd]

ANSWER: W) Speed of light

TOSS-UP

13) Longtermism - *Multiple Choice* Which of the following best describes the rate of global economic growth per year over the course of human history?

- W) Quadratic
- X) Subexponential
- Y) Exponential
- Z) Superexponential

ANSWER: Z) Superexponential

BONUS

13) Longtermism - *Short Answer* Negative utilitarianism [yew-TIL-uh-TARE-yuh-nism] is a moral philosophy distinct from traditional utilitarianism by focusing on minimizing the aggregate amount of what?

ANSWER: Suffering (ACCEPT: Disutility, pain)

TOSS-UP

14) Math - *Multiple Choice* Joseph builds 5.2 houses and Sydney builds 2.4 houses each hour. If Joseph is paid \$20 per hour and Sydney is paid \$10 per hour, which of the following is closest to the least possible cost for a total of 104 new houses?

- W) \$371
- X) \$400
- Y) \$416
- Z) \$433

ANSWER: X) \$400

BONUS

14) Math - *Multiple Choice* Noah picks a random positive integer n and makes n evenly spaced horizontal cuts and n evenly spaced vertical cuts into an unit square. He then takes one of the resulting figures and calculates its area. The sum of all possible areas Noah can end up with is closest to which of the following numbers?

- W) 0.4
- X) 0.5
- Y) 0.6
- Z) 0.7

ANSWER: Y) 0.6

TOSS-UP

15) Chemistry - *Short Answer* What is the formal charge of the central atom in the iodine tetrachloride anion?

- W) -1
- X) 0
- Y) 1
- Z) 2

ANSWER: W) -1

BONUS

15) Chemistry - *Multiple Choice* Order the following three bonds in order of increasing average bond dissociation enthalpy: 1) Carbon-hydrogen; 2) Carbon-carbon; 3) Carbon-fluorine.

ANSWER: 2, 1, 3

TOSS-UP

16) Earth and Space - *Short Answer* Hornfels [HORN-fellz] and quartzite typically form from what type of metamorphism?

ANSWER: Contact

BONUS

16) Earth and Space - *Multiple Choice* In 2021, currents in the Gulf Stream were measured to be moving at their slowest rate in over 1,600 years. Which of the following factors is most directly contributing to the gradual decline of these Atlantic currents?

- W) Heat-driven increase in atmospheric convection
- X) Melting of glaciers in Greenland
- Y) Decreased surface albedo
- Z) Rising sea levels

ANSWER: X) Melting of glaciers in Greenland

TOSS-UP

17) Biology - *Multiple Choice* Angiotensin-(1-7) [AN-jee-uh-TEN-sin ONE SEVEN] has opposing effects to angiotensin II. Which of the following would you expect the primary effect of angiotensin-(1-7) release to be?

- W) Increased heart rate
- X) Decreased heart rate
- Y) Increased blood pressure
- Z) Decreased blood pressure

ANSWER: Z) Decreased blood pressure

BONUS

17) Biology - *Multiple Choice* Which of the following describes the arrangement of microtubules doublets in a motile cilium [SIH-lee-um]?

- W) 9+0
- X) 9+1
- Y) 9+2
- Z) 9+3

ANSWER: Y) 9+2

TOSS-UP

18) Physics - *Short Answer* A positively charged object is attracted by a rod 1 meter away. If the charges of both objects are doubled, what new distance from the rod, in meters, would create a force with half the strength as before?

ANSWER: 8

BONUS

18) Physics - *Multiple Choice* A planet orbiting the sun travels in an elliptical path with semi major axis A and semi minor B. If, after applying a thrust, its new semi major axis is 3A and semi minor is 2B, by what factor is its angular momentum multiplied?

- W) $\frac{2\sqrt{3}}{3}$
- X) $\frac{2}{3}$
- Y) $\frac{\sqrt{3}}{3}$
- Z) $\frac{3}{2}$

ANSWER: W) $\frac{2\sqrt{3}}{3}$

TOSS-UP

19) Longtermism - *Short Answer* Which type of machine learning involves taking in pairs of inputs and outputs to model an input-output function?

ANSWER: Supervised learning

BONUS

19) Longtermism - *Short Answer* Which type of statistical analysis, used in supervised learning, systematically estimates the relationship between a dependent variable and a set of independent variables?

ANSWER: Regression analysis

TOSS-UP

20) Math - *Short Answer* Three concentric circles have radii [RAY-dee-eye] of lengths 5, 7, and 10. A region in this shape is shaded if it is contained within an odd number of circles. What is the area of the shaded regions of this shape?

ANSWER: 76π

BONUS

20) Math - *Multiple Choice* What is $\lim_{(x,y) \rightarrow (0,\pi)} \frac{\cos xy + \sin xy}{2y}$ [the limit as x, y approaches 0, pi of the expression with numerator cosine of xy plus sine of xy and denominator 2y]?

- W) 0
- X) $\frac{1}{\pi}$
- Y) $\frac{1}{2\pi}$
- Z) $\frac{1}{3\pi}$

ANSWER: Y) $\frac{1}{2\pi}$

TOSS-UP

21) Chemistry - *Multiple Choice* Which of the following materials is a molecular solid?

- W) Silica
- X) Water-ice
- Y) Silicon carbide
- Z) Nichrome [NYE-krome]

ANSWER: X) Water-ice

BONUS

21) Chemistry - *Short Answer* What is the bond order of the oxygen-oxygen bond in the superoxide anion?

ANSWER: 1.5

TOSS-UP

22) Earth and Space - *Short Answer* The intensity of sunspot magnetic fields can be determined by the strength of spectral line splitting that occurs due to what effect?

ANSWER: Zeeman effect

BONUS

22) Earth and Space - *Short Answer* At its formation, the CMBR is estimated to have had a temperature of 3000 K. To one significant figure, what is the value of its redshift due to the expansion of the universe?

ANSWER: 1000

TOSS-UP

23) Biology - *Short Answer* Mediated by AMPA and NMDA receptors, what term is given to repeated stimulation of a neuronal synapse leading to a long-lasting increase in synaptic strength?

ANSWER: Long-term potentiation (ACCEPT: LTP)

BONUS

23) Biology - *Short Answer* Amyloid [A-mih-loyd] beta has been shown to have antimicrobial properties, and recent studies have shown that it can translocate from the gut to the brain. Through what cranial nerve, which is responsible for parasympathetic innervation of the gut, does amyloid beta travel?

ANSWER: Cranial nerve X (ACCEPT: Vagus nerve)

TOSS-UP

24) Physics - *Multiple Choice* Which of the following changes would decrease the period of small angled pendulum oscillations?

- W) Relocating the pendulum to the moon
- X) Increasing the amplitude of oscillations
- Y) Replacing the pendulum with one half the length but twice the mass
- Z) Tripling the mass of the pendulum

ANSWER: Y) Replacing the pendulum with one half the length but twice the mass

BONUS

24) Physics - *Short Answer* A square loop of wire with side length 9 m is angled at 30 degrees from a uniform magnetic field of 3 teslas. If the current through the loop is 1 ampere, what is the magnitude of the torque exerted on the loop by the magnetic field?

ANSWER: $\frac{243}{2}$