DOUBLE ELIMINATION 8

TOSS-UP

1) X-Risk - *Short Answer*   Microplastics may cause unwanted mesoglial cell activation because of their newly found ability to overcome what semi-permeable membrane in mice?

ANSWER: Blood-brain barrier

BONUS

1) X-Risk - *Multiple Choice*   A scientist is forecasting the time required to build a space telescope. If the scientist used reference class forecasting, which would be the primary means of information used in the forecast?

W) The sum of contractors' estimates of time required for different parts
X) The time required to build space telescopes in the past
Y) The aggregated time estimates of their colleagues
Z) The combination of multiple estimation methods weighted based on intuition

ANSWER: X) The time required to build space telescopes in the past

TOSS-UP

2) Math - *Short Answer*   Consider the arithmetic sequence with first term 1, common difference 4, and last term 33. What is the remainder when the sum of the terms in the sequence is divided by 12?

ANSWER: 9

BONUS

2) Math - *Short Answer*   Kenny creates a rectangular prism out of white unit cubes measuring 7 units by 4 units by 5 units. He paints the entire surface area blue and splits the prism into its component unit cubes. In simplest form, what is the probability that a randomly chosen unit cube will be completely unpainted?

ANSWER: 3/14

TOSS-UP

3) Chemistry - *Multiple Choice*   A solution of which of the following salts will appear light green?

W) $MnCl_2$
X) $CoCl_2$
Y) $NiCl_2$
Z) $ZnCl_2$

ANSWER: Y) $NiCl_2$

BONUS

3) Chemistry - *Multiple Choice*   Solutions A and B are formed by dissolving a small, equal mass of glucose in equal volumes of water and ethanol, respectively. Given that ethanol has a density of approximately 800 kilograms per cubic meter, which of the following will be true about solutions A and B?

W) The molarity of solution A is greater than the molarity of solution B
X) The molarity of solution B is greater than the molarity of solution A
Y) The molality of solution A is greater than the molality of solution B
Z) The molality of solution B is greater than the molality of solution A

ANSWER: Z) The molality of solution B is greater than the molality of solution A

TOSS-UP

4) Earth and Space - *Multiple Choice*   At which of the following latitudes is ocean salinity typically the highest?

W) 0 degrees
X) 30 degrees north
Y) 60 degrees north
Z) 90 degrees north

ANSWER: X) 30 degrees north

BONUS

4) Earth and Space - *Multiple Choice*   Which of the following minerals is a sorosilicate?

W) Amphibole
X) Epidote
Y) Olivine
Z) Topaz

ANSWER: X) Epidote

TOSS-UP

5) Biology - *Multiple Choice*   During which of the following phases of the cell cycle is the cyclin component of MPF degraded?

W) G2 phase
X) S phase
Y) Metaphase
Z) Anaphase

ANSWER: Z) Anaphase

BONUS

5) Biology - *Short Answer*   Identify all of the following three processes that are facilitated by the 3' UTR: 1) Binding of miRNA; 2) Binding of ribosomes; 3) Polyadenylation [paw-lee-uh-deen-ul-AY-shin].

ANSWER: 1 and 3

TOSS-UP

6) Physics - *Short Answer*   A photon of wavelength λ [lambda] has the same energy as an arbitrary, stationary, unbound particle. To what power of the particle's mass will λ [lambda] vary with?

ANSWER: -1

BONUS

6) Physics - *Multiple Choice*   A particle moving at 0.5c has its kinetic energy measured by a student. However, the student forgets to factor in relativistic effects. How many times greater would the kinetic energy have been if the student had not forgotten relativistic effects?

W) $\frac{16\sqrt{3}}{3}$
X) $\frac{32\sqrt{3}}{3}$
Y) $\frac{16\sqrt{5}}{5}$
Z) $\frac{32\sqrt{5}}{5}$

ANSWER: W) $\frac{16\sqrt{3}}{3}$

TOSS-UP

7) X-Risk - *Short Answer*   Efforts at controlling African Trypanosomiasis [tri-pa-nuh-soh-MY-uh-sis] involve controlling the population of what fly that serves as its main vector?

ANSWER: Tsetse fly

BONUS

7) X-Risk - *Short Answer*   What term is used to describe the idea that as the number of trials in a random experiment increases, the average of the results of the trials will converge to the expected value?

ANSWER: Law of large numbers

TOSS-UP

8) Math - *Short Answer*   The first 2022 natural numbers are written, and the number 1 is erased. Any number that is either 4 or 7 greater than an erased number is also erased until no more numbers can be erased. What is the largest number that is not erased?

ANSWER: 18

BONUS

8) Math - *Short Answer*   For a natural number n with 16 factors, n^3 can have at most how many factors?

ANSWER: 256

TOSS-UP

9) Chemistry - *Multiple Choice*   How many normal modes of vibration does allene, C_3H_4, have?

W) 15
X) 16
Y) 18
Z) 19

ANSWER: X) 16

BONUS

9) Chemistry - *Short Answer*   Order the following four conformations of butane from most to least energetic: 1) Eclipsed; 2) Synperiplanar; 3) Gauche; 4) Antiperiplanar.

ANSWER: 2, 1, 3, 4

TOSS-UP

10) Earth and Space - *Short Answer*   What phenomenon's effect results in an Einstein ring when a massive structure warps the incident light from behind it?

ANSWER: Gravitational lensing

BONUS

10) Earth and Space - *Multiple Choice*   Relativistic corrections provide how many times of a greater redshift than classical results for an object moving away at 0.96c?

W) 1
X) 2
Y) 3
Z) 4

ANSWER: Z) 4

TOSS-UP

11) Biology - *Short Answer*   Ganglion cells receive signals from what cells in the retina, which gather input from several rods or cones?

ANSWER: Bipolar cells

BONUS

11) Biology - *Multiple Choice*   Which of the following electron acceptors of the light reactions is the last to receive electrons?

W) Pheophytin [fee-oh-FIGHT-in]
X) Oxygen evolving complex
Y) Ferredoxin
Z) Plastocyanin [plas-toh-SY-uh-nin]

ANSWER: Y) Ferredoxin

TOSS-UP

12) Physics - *Short Answer*   An electron is traveling in the positive z-direction in a region with a uniform magnetic field pointing in the negative y-direction. In what direction does the Lorentz force point?

ANSWER: -x

BONUS

12) Physics - *Short Answer*   Two concentric electric potential rings of radius A and B have a radially outward electric field emanating from their shared center. The electric field as a function of r is given as $\frac{\alpha}{r}$. What is the potential difference when going from the ring of radius A to radius B?

ANSWER: $\alpha \ln \frac{A}{B}$ [the natural log of the quantity a over b] (ACCEPT: $-\alpha \ln \frac{B}{A}$)

TOSS-UP

13) X-Risk - *Multiple Choice*   The assumption that all members of a category, even if they do not share most traits typical of that category, have a certain trait is referred to by what name?

W) Positive bias
X) Noncentral fallacy
Y) No true Scotsman
Z) Straw man

ANSWER: X) Noncentral fallacy

BONUS

13) X-Risk - *Short Answer*   Identify all of the following three methods that can be classified under unsupervised learning: 1) K-means clustering, 2) Neural networks, 3) Principal component analysis.

ANSWER: All

TOSS-UP

14) Math - *Short Answer* If two of the roots of the cubic polynomial $x^3 + ax^2 + bx + c = 0$ are 1 and -1, then what is the value of b?

ANSWER: -1

BONUS

14) Math - *Short Answer* What is the partial derivative with respect to y of $y \ln(xyz)$?

ANSWER: $\ln(xyz) + 1$

TOSS-UP

15) Chemistry - *Short Answer*   If the rate of effusion of diatomic hydrogen gas at STP is given as some variable *x*, what would be the expected rate of effusion of neon gas, in terms of *x*?

ANSWER: $\frac{\sqrt{10}}{10}$

BONUS

15) Chemistry - *Short Answer*   In the first step of the theoretical Solvay process, carbon dioxide and ammonia are bubbled through a concentrated solution of sodium chloride. This precipitates sodium bicarbonate, leaving behind what salt in solution?

ANSWER: Ammonium chloride (ACCEPT: NH_4Cl)

TOSS-UP

16) Earth and Space - *Short Answer*   What letter in the Koppen classification system describes most land along the equator?

ANSWER: A

BONUS

16) Earth and Space - *Multiple Choice*   A fault that is nearly vertical at the surface but smoothly connects to a decollement [day-COLE-mont] plane parallel to the surface is best described as what type of fault?

W) Listric
X) Strike-slip
Y) Dip-slip
Z) Oblique

ANSWER: W) Listric

TOSS-UP

17) Biology - *Multiple Choice*   Vitamin C is required for the hydroxylation of which of the following amino acids in collagen?

W) Histidine
X) Alanine
Y) Proline
Z) Arginine

ANSWER: Y) Proline

BONUS

17) Biology - *Multiple Choice*   Jerry wants to increase gene expression in a certain area of the cell by acetylating histones. To which amino acid are the acetyl groups attached?

W) Proline
X) Histidine
Y) Valine
Z) Lysine

ANSWER: Z) Lysine

TOSS-UP

18) Physics - *Multiple Choice*   According to the equipartition theory for a monatomic molecule moving at speed v, what percent of the inverse thermodynamic beta quantity is summed per degree of freedom to find the average energy?

W) 25
X) 50
Y) 75
Z) 100

ANSWER: X) 50

BONUS

18) Physics - *Multiple Choice*   A spring-mass system undergoes simple harmonic motion with period T. The spring is removed, cut into n equal-sized, smaller springs, and all n springs are attached to the mass. The new spring-mass system is again set into simple harmonic motion. What is the new period of oscillations?

W) $T \cdot n$
X) $T \cdot \sqrt{n}$
Y) $\frac{T}{\sqrt{n}}$
Z) $\frac{T}{n}$

ANSWER: Z) $\frac{T}{n}$

TOSS-UP

19) X-Risk - *Multiple Choice*   Which of the following classes of tasks that forms part of the data mining process is designed to discover groups and structures in the data that are similar without using known structures in the data?

W) Clustering
X) Classification
Y) Regression
Z) Summarization

ANSWER: W) Clustering

BONUS

19) X-Risk - *Short Answer*   Schistosomiasis is caused by parasitic trematodes whose life cycle depends on two hosts, one being humans. To what class of organisms does the other host belong?

ANSWER: Gastropoda

TOSS-UP

20) Math - *Short Answer*   What is the largest prime factor of $3^8 - 1$?

ANSWER: 41

BONUS

20) Math - *Short Answer*   What is the remainder when 2^{2023} is divided by 17?

ANSWER: 9

TOSS-UP

21) Chemistry - *Short Answer*   What thermodynamic quantity represents the maximum work that can be performed in a system by non-expansion processes?

ANSWER: Gibbs free energy

BONUS

21) Chemistry - *Multiple Choice*   A chemistry student seeks to convert an alcohol to an ether [EE-thur]. Which of the following types of reagents should they use first on the alcohol before reacting it with an alkyl [AL-kul] halide?

W) Oxidizing agent
X) Reducing agent
Y) Acid
Z) Base

ANSWER: Z) Base

TOSS-UP

22) Earth and Space - *Short Answer*   Identify which of the following three nuclear processes one would expect to generate heat within an asymptotic red giant: 1) Triple-alpha process; 2) CNO cycle; 3) Proton-proton chain.

ANSWER: All

BONUS

22) Earth and Space - *Short Answer*   Seyfert [SAY-furt] galaxies are known for strong X-ray emission lines sourced from the galactic center as they contain what structures surrounded by dense, hot gas?

ANSWER: Active galactic nuclei (ACCEPT: AGN)

TOSS-UP

23) Biology - *Multiple Choice*   Which of the following animals contains a single ventricle and single atrium?

W) Fish
X) Bird
Y) Crocodile
Z) Platypus

ANSWER: W) Fish

BONUS

23) Biology - *Short Answer*   Kevin is trying to find amino acids that absorb light in the same range of light as DNA. Identify all of the following three amino acids that he could use: 1) Alanine; 2) Cysteine; 3) Methionine.

ANSWER: None

TOSS-UP

24) Physics - *Multiple Choice*   At the Neel temperature, antiferromagnetic materials transition into materials possessing what type of magnetism?

W) Paramagnetism
X) Diamagnetism
Y) Ferromagnetism
Z) Ferrimagnetism

ANSWER: W) Paramagnetism

BONUS

24) Physics - *Short Answer*   The kinetic energy and potential energy of an object moving at speed v_0 is given by $\mu \cdot v_0^2$ [mu times v naught squared] and $U(y) = y^2 - 3y - 9$, respectively. What is the acceleration of the object when it is located at $y = 5$?

ANSWER: $-\frac{7}{2\mu}$