2025 Iolani Science Bowl Invitational
Single Elimination 1

Tossup

1) Physics - *Short Answer* What name is given to the circuit component which is the magnetic analog to a capacitor, in that it stores energy in the form of a magnetic field?

Answer: INDUCTOR [RE]

Bonus

1) Physics - *Multiple Choice* Which of the following is the ratio of translational kinetic energy to rotational kinetic energy in a hollow ball while rolling down a ramp?

W) 3:2
X) 2:3
Y) 5:2
Z) 2:5

Answer: W) 3:2 [RE]

Tossup

2) Chemistry [Early SE] - *Multiple Choice* Which of the following acids is the weakest?

W) Hydrochloric acid
X) Lactic acid
Y) Acetic acid
Z) Nitric acid

Answer: Y) ACETIC ACID [EC]

Bonus

2) Chemistry [Early SE] - *Short Answer* Identify all of the following factors that would increase the acidity of an acid. I. Resonance stabilization of the conjugate base; II. The inductive effect; III. The s-character of hybridized orbitals.

Answer: I, II, and III [EC]

Tossup

3) Biology [Early DE] - *Short Answer* Order the following three plant organs in terms of increasing ploidy: I. Endosperm; II. Embryo; III. Microspore

Answer: III, II, I

Bonus

3) Biology [Early DE] - *Multiple Choice* Which of the following pairs of terms best describes Brennan, a typical human?

W) Endotherm, Poikilotherm [poi-kilo-therm]
X) Endotherm, Homeotherm
Y) Ectotherm, Poikilotherm
Z) Ectotherm, Homeotherm

Answer: X) ENDOTHERM, HOMEOTHERM

Tossup

4) Energy - *Short Answer* Data in the intermediate layers of a machine learning model is often thought to contain a unique representation of the data in some space. What is this space called?

Answer: LATENT SPACE (Accept: FEATURE SPACE, EMBEDDING SPACE) [MS]

Bonus

4) Energy - *Multiple Choice* Edwin designs an algorithm that takes as input a list of numbers of length n and outputs a list of every possible sum of those numbers, with no duplicates. What is the minimum possible time complexity of this algorithm?
W) O(n) [O of n]
X) O(n^2) [O of n squared]
Y) O(n log n) [O of n log n]
Z) O(n^2 log n) [O of n squared log n]

Answer: Z) O(n^2 log n) [MS]

Tossup

5) Earth and Space [Early SE] - *Multiple Choice* Subduction zones are associated with which metamorphic facies [fay-shees], which is characterized by the presence of minerals such as glaucophane [glau-ko-fane] and lawsonite?

W) Eclogite
X) Greenschist
Y) Hornfels
Z) Blueschist

Answer: Z) BLUESCHIST [AI]

Bonus

5) Earth and Space [Early SE] - *Short Answer* The mineral aragonite is unstable at surface temperature and pressure conditions. Because of this, aragonite very slowly transforms into what, more thermodynamically favorable mineral?

Answer: CALCITE [RE]

Tossup

6) Math [SE] - *Short Answer* Four different rocks are put on a bracelet. How many ways are there to rearrange the rocks in the bracelet, assuming rotations and reflections are considered the same?

Answer: 3 [HK]

Bonus

6) Math [SE] - *Short Answer* In how many ways can 6 friends split up into teams A, B, C, and D, assuming there can be teams without anyone?

Answer: 4096 [HK]

Tossup

7) Physics - *Short Answer* A charged particle moves in a circular path in a uniform magnetic field. If the particle's mass is doubled and its velocity is tripled, by what factor does the path's radius change?

Answer: 6 [ChatGPT/AE]

Bonus

7) Physics - *Multiple Choice* Which of the following is true about an unstable equilibrium point on a potential energy graph?

W) The first derivative of potential energy is 0, and the second derivative is positive
X) The first derivative of potential energy is 0, and the second derivative is negative
Y) The first derivative of potential energy is negative, and the second derivative is negative
Z) The first derivative of potential energy is positive, and the second derivative is positive

Answer: X) THE FIRST DERIVATIVE OF POTENTIAL ENERGY IS 0, AND THE SECOND DERIVATIVE IS NEGATIVE [AE]

Tossup

8) Chemistry [Early SE] - *Multiple Choice* What is the most common name for the compound with the formula $CH_3CH_2CH_2OH$?

W) Methanol
X) Ethanol
Y) Propanol
Z) Butanol

Answer: Y) PROPANOL [EC]

Bonus

8) Chemistry [Early SE] - *Multiple Choice* What type of isomerism is exhibited by cis- and trans-butene?

W) Geometric isomerism
X) Optical isomerism
Y) Structural isomerism
Z) Conformational isomerism

Answer: W) GEOMETRIC ISOMERISM [EC]

Tossup

9) Biology [Early DE] - *Multiple Choice* On a certain island lives a species of mice of various sizes and a species of hawk that eats the mice. Large mice are too heavy for the hawks to pick up, and small mice can hide the best from the hawks. Which of the following best predicts the type of selection acting on mouse size?

W) Directional
X) Disruptive
Y) Stabilizing
Z) Uniform

Answer: X) DISRUPTIVE

Bonus

9) Biology [Early DE] - *Multiple Choice* Brennan is experimenting with colchicine [kol-chi-seen], a drug that inhibits tubulin polymerization. He adds colchicine to cells undergoing mitosis. Which of the following cellular structures would you expect to be most affected?

W) Cleavage Furrow
X) Mitotic Spindle
Y) Kinetochore
Z) Chromosomes

Answer: X) MITOTIC SPINDLE

Tossup

10) Energy - *Multiple Choice* Which of the following is not a vector used in self attention?

W) Query
X) Hash
Y) Key
Z) Value

Answer: X) HASH [MS]

Bonus

10) Energy - *Short Answer* What simple models of computers manipulate symbols on an infinite strip of tape according to a set of rules, and can implement any algorithm?

Answer: TURING MACHINES [MS]

Tossup

11) Earth and Space [Early SE] - *Short Answer* What type of matter constitutes about 5% of the universe?

Answer: BARYONIC MATTER [AI]

Bonus

11) Earth and Space [Early SE] - *Short Answer* Order the following three events which occurred after the Big Bang from least to most recent. I. Big Bang Nucleosynthesis; II. Recombination; III. Inflation

Answer: III, I, II [AI]

Tossup

12) Math [SE] - *Short Answer* What is the area under the curve from x=1 to x=3 of the graph y=2^x?

Answer: 6/(ln2) [HK]

Bonus

12) Math [SE] - *Short Answer* What is the greatest common factor of 1397 and 2849?

Answer: 11 [HK]

Tossup

13) Physics - *Multiple Choice* The magnitude of torque applied to a wheel increases linearly with time. Which of the following best describes a graph of the wheel's angular momentum with respect to time?

W) Constant
X) Linear
Y) Quadratic
Z) Exponential

Answer: Y) QUADRATIC [AE]

Bonus

13) Physics - *Short Answer* How many antinodes are present in the second harmonic of an open pipe?

Answer: 3 [AE]

Tossup

14) Chemistry [Early SE] - *Multiple Choice* Which of the following elements is most likely to form a compound with an expanded octet?

W) Nitrogen
X) Oxygen
Y) Sulfur
Z) Carbon

Answer: Y) SULFUR [EC]

Bonus

14) Chemistry [Early SE] - *Short Answer* What is the hybridization of the central atom in xenon tetrafluoride (XeF_4)?

Answer: sp^3d^2 [EC]

Tossup

15) Biology [Early DE] - *Short Answer* Maturation Promoting Factor, or MPF, is an example of what type of enzyme, which is important for controlling the progression of the cell cycle?

Answer: CYCLIN DEPENDENT KINASE (Accept: CDK)

Bonus

15) Biology [Early DE] - *Short Answer* A PET scan is a diagnostic often used to test for cancer. In this test, a radioactive version of what molecule is used to determine regions of high metabolic activity in a patient?

Answer: GLUCOSE

Tossup

16) Energy - *Multiple Choice* Which of the following statements are NOT true of linked lists?
W) Insertion at the beginning of the list is O(1)
X) Insertion at the end of the list is O(1)
Y) Insertion at an arbitrary position in the list is O(n)
Z) Deletion at an arbitrary position in the list is O(n)

Answer: X) INSERTION AT THE END OF THE LIST IS O(1) [MS]

Bonus

16) Energy - *Short Answer* Compute the Shannon entropy, in bits, of a coin with a 0.75 probability of flipping heads, taking log base 2 of 3 to be 1.6

Answer: 0.8 [MS]

Tossup

17) Earth and Space [Early SE] - *Short Answer* Which of the following are extrusive igneous rocks? I. Andesite; II. Pumice [puh-miss]; III. Pegmatite

Answer: I and II [AI]

Bonus

17) Earth and Space [Early SE] - *Multiple Choice* Why do quartz crystals in granite tend to exhibit a subhedral [sub-hee-droll] structure?

W) Quartz is naturally subhedral
X) Quartz is an amorphous solid
Y) Quartz reacts with feldspar and fails to form
Z) Quartz is among the final minerals to crystalize out of solution

Answer: Z) QUARTZ IS AMONG THE FINAL MINERALS TO CRYSTALIZE OUT OF SOLUTION [AI]

Tossup

18) Math [SE] - *Multiple Choice* Which of the following can logically be inferred from the statement “If I ate, then I am full”?

W) Either I am full or I did not eat
X) Either I am not full, or I ate
Y) If I am full, then I ate
Z) If I did not eat, then I am not full

Answer: W) EITHER I AM FULL OR I DID NOT EAT [HK]

Bonus

18) Math [SE] - *Short Answer* What is the remainder when 11 factorial is divided by 13?

Answer: 1 [HK]

Tossup

19) Physics - *Short Answer* The potential energy of an object in joules as a function of position can be expressed as U(x) = 5x^2 - 10x + 3 [U of x equals five x squared minus ten x plus three]. In newtons, what is the force on the object at the point x = 2 meters?

Answer: -10 NEWTONS [RE]

Bonus

19) Physics - *Short Answer* A voltage difference of 20 V exists between two points separated by a distance of 10 meters. A particle of mass 1 kg and charge 1 coulomb is placed at rest, at the point of higher voltage, and allowed to move freely to the other point. In meters per second, what is the velocity of the particle when it reaches the other point?

Answer: 2sqrt(10) [RE]

Tossup

20) Chemistry [Early SE] - *Multiple Choice* Which of the following has the smallest bond angle?

W) Ammonia
X) Water
Y) Methane
Z) Boron trifluoride

Answer: X) WATER [EC]

Bonus

20) Chemistry [Early SE] - *Short Answer* What is the bond angle between the hydrogens in a methane molecule to the nearest tenth of a degree?

Answer: 109.5 DEGREES [EC]

Tossup

21) Biology [Early DE] - *Short Answer* Rank the following three blood vessels in terms of increasing blood velocity: I. Aorta; II. Venae Cavae; III. Capillaries

Answer: III, II, I

Bonus

21) Biology [Early DE] - *Short Answer* Brennan wants to be a more positive person. He believes that eating positively charged amino acids will allow him to do so. Identify all of the following four amino acids that Brennan should eat: I. Leucine; II. Lysine; III. Arginine; IV. Alanine

Answer: II & III

Tossup

22) Energy - *Multiple Choice* Google Quantum AI labs recently released the Willow Quantum chip. Which of the following statements is true about quantum computing?

W) Quantum entanglement allows for faster-than-light communication
X) Qubits must be kept at very high temperatures to function properly
Y) It is possible to construct any quantum circuit with the CNOT gate and single qubit gates
Z) Three hadamard gates in series act as an identity gate

Answer: Y) IT IS POSSIBLE TO CONSTRUCT ANY QUANTUM CIRCUIT WITH THE CNOT GATE AND SINGLE QUBIT GATES [MS]

Bonus

22) Energy - *Short Answer* What type of machine learning model generates images by continually denoising noisy versions of the image?

Answer: DIFFUSION (Accept stable diffusion) [MS]

Tossup

23) Earth and Space [Early SE] - *Multiple Choice* ‘Oumuamua [oh-mua-mua] was an interstellar object that briefly passed through our solar system. Which option best describes its orbit?

W) Circular
X) Elliptical
Y) Parabolic
Z) Hyperbolic

Answer: Z) HYPERBOLIC [AI]

Bonus

23) Earth and Space [Early SE] - *Short Answer* Planet Brennan orbits its host star in a perfectly circular orbit at a distance of 3 AU. Identical Planet Hee orbits the same star with an eccentricity of 0.3 and a semi-major axis of 3 AU. Which of the following is true about the period of planets Brennan and Hee?

W) Planet Brennan has a shorter period than Planet Hee.
X) Planet Brennan has a longer period than Planet Hee.
Y) Planet Brennan has the same period as Planet Hee.
Z) It is impossible to compare the planets without more information.

Answer: Y) PLANET BRENNAN HAS THE SAME PERIOD AS PLANET HEE [AI]

Tossup

24) Math [SE] - *Short Answer* Convert the rectangular coordinates (3, 3sqrt3, 8) into cylindrical coordinates in the form (r, theta, z) where theta is in radians.

Answer: (6, pi/3, 8) [HK]

Bonus

24) Math [SE] - *Short Answer* Two circles are externally tangent to each other. One has a radius of 6 and the common tangent line has a length of 18. What is the distance between the two centers of the circles?

Answer: 39/2 [HK]
