2025 Iolani Science Bowl Invitational
Single Elimination 3

Tossup

1) Physics [Late SE] - *Short Answer* If the gravitational potential energy of a satellite in orbit is -100,000 joules, what is its kinetic energy in joules?

Answer: 50,000 JOULES (do not accept: -50,000 joules) [RE]

Bonus

1) Physics [Late SE] - *Multiple Choice* What name is given to the effect in which an attractive force spontaneously occurs between two very closely spaced uncharged conducting plates separated by a vacuum?

W) Hall effect
X) Leidenfrost effect [lie-den-frost]
Y) Paschen-Back effect [pass-shin back]
Z) Casimir effect [kass-i-meer]

Answer: Z) CASIMIR EFFECT [RE]

Tossup

2) Chemistry [Late SE] - *Short Answer* The Heisenberg Uncertainty Principle states that two times the product of the uncertainty in position multiplied by the uncertainty in momentum is always greater than or equal to what physical constant?

Answer: REDUCED PLANCK CONSTANT (accept: PLANCK CONSTANT OVER 2 PI) [RE]

Bonus

2) Chemistry [Late SE] - *Multiple Choice* Catalyst poisons effectively decrease the effectiveness of a catalyst by changing which of the following reaction quantities?

W) Delta S
X) Distance reactant molecules must diffuse through before undergoing reaction
Y) Turnover frequency of catalysts
Z) Single site binding affinity

Answer: X) DISTANCE REACTANT MOLECULES MUST DIFFUSE THROUGH BEFORE UNDERGOING REACTION [RE]

Tossup

3) Biology [Late DE] - *Short Answer* Identify all of the following five characteristics that are defining synapomorphies, which are uniquely shared by all chordates: I. Backbone; II. Pharyngeal slits; III. Post-anal tail; IV. Notochord; V. Bilateralism

Answer: II, III, IV

Bonus

3) Biology [Late DE] - *Multiple Choice* Brennan is growing his beloved plant when he notices a purpleing of the veins and thin stems. This is most likely due to a deficiency in which element?

W) Nitrogen
X) Potassium
Y) Phosphorus
Z) Sulfur

Answer: Y) PHOSPHOROUS

Tossup

4) Energy - *Multiple Choice* Researchers in the field of mechanistic interpretability theorize that the "memory" of a transformer lies in which of its sections, which contains the most parameters?

W) The input embedding layers
X) The output embedding layers
Y) The key, query, and value matrices of the multihead attention
Z) The weights and biases of the multilayer perceptrons

Answer: Z) THE WEIGHTS AND BIASES OF THE MULTILAYER PERCEPTRONS [MS]

Bonus

4) Energy - *Short Answer* The metropolis-hastings algorithm, meant to approximate sampling from complex probability distributions, works in the following way, starting from an initial state: First, propose a next state based on the current state. Then, accept or reject that state based on the value of the probability distribution at that state.Which of the following three choices are true of the metropolis-hastings algorithm? I. It is a markov process II. It is monte carlo III. It can be used to simulate langevin dynamics

Answer: ALL [MS]

Tossup

5) Earth and Space [Late SE] - *Short Answer* Order the following three spectral types in order of increasing B-V (b, v) color index values. I. B5; II. K2; III. F0

Answer: I, III, II [AE]

Bonus

5) Earth and Space [Late SE] - *Short Answer* A star has luminosity 100 solar luminosities. To the nearest integer, what is the absolute magnitude of this star?

Answer: 0 [AE]

Tossup

6) Math [SE] - *Short Answer* What is the total surface area of a cone with a radius of 5 and a height of 12?

Answer: 90pi [HK]

Bonus

6) Math [SE] - *Short Answer* An ant is at a vertex of a tetrahedron. If the ant moves to a nearby vertex each turn, what is the probability of the ant being back at the same vertex of the tetrahedron after 3 turns?

Answer: 2/9 [HK]

Tossup

7) Physics [Late SE] - *Short Answer* Identify all of the following three hadrons that have a net color charge of white or 0. I. Proton; II. Pion; III. Psi meson

Answer: ALL [RE]

Bonus

7) Physics [Late SE] - *Multiple Choice* A physical pendulum of uniform density is created with a circular disk of radius 10 m with a smaller disk of radius 5 m cut out of it. If it pivots about a point on its circumference, which of the following is its period?

W) 2pi sqrt(15/32)
X) 2pi sqrt(17/32)
Y) 2pi sqrt(1/16)
Z) 2 pi sqrt(5/8)

Answer: W) 2PI SQRT(15/32) [RE]

Tossup

8) Chemistry [Late SE] - *Multiple Choice* What is the major product of the reaction between ethene (C_2H_4) and bromine (Br_2) in the presence of an inert solvent?

W) Ethane
X) Dibromoethane
Y) Ethanol
Z) Bromomethane

Answer: X) DIBROMOETHANE [EC]

Bonus

8) Chemistry [Late SE] - *Multiple Choice* Which of the following reaction mechanisms is involved in the formation of an epoxide from an alkene using m-chloroperoxybenzoic acid (mCPBA)?

W) Radical substitution
X) Electrophilic addition
Y) Concerted electrophilic oxidation
Z) Nucleophilic substitution

Answer: Y) CONCERTED ELECTROPHILIC OXIDATION [EC]

Tossup

9) Biology [Late DE] - *Multiple Choice* Which of the following genetic elements would you expect to find in a bacterial cell?

W) TATA box [ta-ta box]
X) Shine-Dalgarno sequence
Y) Kozak Consensus Sequence
Z) CMV Promoter

Answer: X) SHINE-DALGARNO SEQUENCE

Bonus
9) Biology [Late DE] - *Multiple Choice* According to the Michaelis-Menten [my-callus men-ten] equation, which of the following best describes the meaning of the Michealis Constant?

W) Substrate concentration at half-maximum velocity
X) Substrate concentration at maximum velocity
Y) Half-maximum velocity
Z) Maximum velocity

Answer: W) SUBSTRATE CONCENTRATION AT HALF-MAXIMUM VELOCITY

Tossup

10) Energy - *Multiple Choice* Which of the following best describes Jensen's inequality?

W) A minimum of 75% of values in a distribution must lie within two standard deviations of the mean of the distribution
X) A minimum of 95% of values in a distribution must lie within two standard deviations of the mean of the distribution
Y) For a concave function f, the expected value of f(x) is less than or equal to f of the expected value of x
Z) For a convex function f, the expected value of f(x) is less than or equal to f of the expected value of x

Answer: Y) FOR A CONCAVE FUNCTION F, THE EXPECTED VALUE OF F(X) IS LESS THAN OR EQUAL TO F OF THE EXPECTED VALUE OF X [MS]

Bonus

10) Energy - *Multiple Choice* Which of the following does the machine learning model MAMBA [mamba] use?

W) Score-based generative modeling
X) Restricted boltzmann machines
Y) Selective State Spaces
Z) Kolmogorov-Arnold networks

Answer: Y) SELECTIVE STATE SPACES [MS]

Tossup

11) Earth and Space [Late SE] - *Short Answer* At what ratio of wave height to wavelength does a wave break at?

Answer: 1 to 7 [RE]

Bonus

11) Earth and Space [Late SE] - *Short Answer* What name is given to the dominant stratospheric circulation pattern?

Answer: BREWER-DOBSON CIRCULATION [RE]

Tossup

12) Math [SE] - *Short Answer* Given parametric equations x=t+3 and y=4t-2, find the equivalent rectangular form of the line in the form of y=mx+b

Answer: y = 4x - 14 [HK]

Bonus

12) Math [SE] - *Multiple Choice* In triangle ABC, a cevian [see-vee-an] is drawn from vertex A to D on side BC. If AB = 5, BC = 6, AC = 7, and BD = 4, what is the length of cevian D?

W) sqrt(33) [square root of 33]
X) sqrt(35)
Y) sqrt(37)
Z) sqrt(39)

Answer: W) sqrt(33) [HK]

Tossup

13) Physics [Late SE] - *Short Answer* What name is given to the highest energy level electrons occupy at absolute zero in a given atom?

Answer: FERMI LEVEL (accept: FERMI ENERGY) [RE]

Bonus

13) Physics [Late SE] - *Multiple Choice* An electric dipole made of opposite charges of 3 coulombs separated by a distance of 5 meters is placed in an electric field of strength 10 coulombs with the line between charges making a 30 degree angle with the field lines. In newtons, what is the torque exerted on this dipole?

W) 30
X) 45
Y) 60
Z) 75

Answer: Z) 75 [RE]

Tossup

14) Chemistry [Late SE] - *Short Answer* Which of the following molecules exhibit resonance? I: Phenol [fee-nol]; II: Ethylamine; III: Nitrite.

Answer: I and III only [EC]

Bonus

14) Chemistry [Late SE] - *Multiple Choice* Which of the following molecules has a structure in which the pi bonds are not delocalized over the entire molecule, thus preventing resonance stabilization?

W) Cycloheptatrienyl anion
X) Benzene
Y) Cyclobutadiene
Z) Pyridine

Answer: Y) CYCLOBUTADIENE [EC]

Tossup

15) Biology [Late DE] - *Multiple Choice* Brennan needs his favorite long-day plant with a critical period of 12 hours to flower before Valentine's Day. Which of the following procedures should he use?

W) Dark period of 16 hours
X) Dark period of 16 hours with a flash of red light at 8 hours
Y) Dark period of 16 hours with a flash of far red light at 8 hours
Z) Dark period of 16 hours with a flash of blue light at 8 hours

Answer: X) Dark period of 16 hours with a flash of red light at 8 hours

Bonus

15) Biology [Late DE] - *Multiple Choice* Ryan is suffering from hypertension and needs to decrease his blood pressure. Which of the following hormones would best suit his purposes?

W) Aldosterone
X) Vasopressin
Y) Epinephrine
Z) Atrial Natriuretic Peptide

Answer: Z) ATRIAL NATRIURETIC PEPTIDE

Tossup

16) Energy - *Short Answer* OpenAI's o1 model is able to reason step-by-step using what mechanism, involving reinforcement learning and self-prompting?

Answer: CoT (Accept: Chain-Of-Thought) [MS]

Bonus

16) Energy - *Short Answer* What technique, involving the blocking of n-length arrays into square-root-n sized chunks, allows for queries to run faster by a factor of the square root of n?

Answer: SQUARE ROOT DECOMPOSITION [MS]

Tossup

17) Earth and Space [Late SE] - *Multiple Choice* Which region of a Black Hole is it possible to extract energy from?

W) Ergosphere
X) Photon Sphere
Y) Event Horizon
Z) Singularity

Answer: W) ERGOSPHERE [AI]

Bonus

17) Earth and Space [Late SE] - *Short Answer* Which three physical parameters characterize black holes, in accordance with the No-Hair theorem?

Answer: MASS, ELECTRIC CHARGE, ANGULAR MOMENTUM (Accept: MASS, ELECTRIC CHARGE, SPIN*) [AI]

Tossup

18) Math [SE] - Short Answer Find the top right number of the inverse of the 2 by 2 matrix with top row 1, 2 and bottom row 5, 6.

Answer: ½ [HK]

Bonus

18) Math [SE] - Short Answer Brennan the pokemon lover is collecting the rare EX [EE-EX] pokemon cards. Assume there are 6 distinct EX pokemon cards. Each pokemon pack contains a single EX card and costs ten dollars. What is the expected number of dollars Brennan has to spend buying pokemon packs to obtain at least a single copy of each of the 6 EX cards?

Answer: 147 [JL]

Tossup

19) Physics [Late SE] - *Multiple Choice* In a torsional pendulum, if the momentum of inertia increases by a factor of 8 and the torsional spring constant increases by a factor of 2, by what factor does the period change?

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

Answer: Y) 2 [RE]

Bonus

19) Physics [Late SE] - *Multiple Choice* A small hole is punctured on the side of a large water tank. The velocity of the ensuing stream of water out the hole is proportional to the distance from the hole to the top of the water raised to what power?

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

Answer: Y) 1/2 [RE]

Tossup

20) Chemistry [Late SE] - *Multiple Choice* Which of the following statements correctly describes the relationship between the pKa of an acid and the strength of its conjugate base?

W) Lower pKa corresponds to a weaker conjugate base.
X) Higher pKa corresponds to a weaker conjugate base.
Y) The strength of the conjugate base is not related to the pKa of the acid.
Z) The strength of the conjugate base is directly proportional to the Ka of the acid.

Answer: W) LOWER pKa CORRESPONDS TO A WEAKER CONJUGATE BASE [EC]

Bonus

20) Chemistry [Late SE] - *Multiple Choice* Acetic acid has a pKa of 4.76. If a buffer solution contains 0.2 M acetic acid and 0.3 M sodium acetate, what is the pH of the solution?

W) 4.23
X) 4.78
Y) 5.06
Z) 5.49

Answer: Y) 5.06 [EC]

Tossup

21) Biology [Late DE] - *Short Answer* Identify all of the following three processes that significantly rely on calcium ions: I. Skeletal muscle contraction; II. Cortical reaction; III. Long-term potentiation

Answer: ALL

Bonus

21) Biology [Late DE] - *Multiple Choice* Which enzyme is the only enzyme present in both the citric acid cycle and the electron transport chain?

W) Succinate Dehydrogenase
X) Aconitase [ay-con-itase]
Y) Fumarase [few-muh-race]
Z) Citrate Synthase

Answer: W) Succinate Dehydrogenase

Tossup

22) Energy - *Multiple Choice* Which of the following best describes the function of a graph attention layer, or GAT?

W) Nodes iteratively update features through message passing
X) A convolution is run in the graph spectral domain
Y) Nodes attend to all other nodes
Z) Nodes attend to their neighbors

Answer: Z) NODES ATTEND TO THEIR NEIGHBORS [MS]

Bonus

22) Energy - *Short Answer* What structure in functional programming wraps the return values of program fragments in a wrapping type that applies additional computation to them?

Answer: MONAD [MS]

Tossup

23) Earth and Space [Late SE] - *Short Answer* Zircon crystals are particularly useful in geologic dating due to their extremely old age. What are the two primary isotopes used in radiometrically dating zircon crystals?

Answer: URANIUM-235 and LEAD-206 (order doesn't matter, numbers do) [RE]

Bonus

23) Earth and Space [Late SE] - *Short Answer* Underwater curtains are being proposed as a climate change prevention method by preventing the upwelling of warm water underneath glaciers. Warm water upwelling is particularly dangerous because it pushes what line on a glacier back, significantly decreasing its structural stability?

Answer: GROUNDING LINE [RE]

Tossup

24) Math [SE] - Short Answer What is the closest integer to (2+sqrt2)^2 [quantity 2 plus square root 2 close quantity squared]?

Answer: 12 [HK]

Bonus

24) Math [SE] - Short Answer What is the expected number of times you have to flip a coin to get 2 heads in a row?

Answer: 6 [ChatGPT]