

**2025 Iolani Science Bowl Invitational**  
**Single Elimination 2**

**Tossup**

- 1) Physics [Mid SE] - *Short Answer* Brennan throws 1 kg snowballs at a speed of 10 m/s at a wall once every 5 seconds after which they stop and slide down the wall. In newtons, what is the average force he exerts on the wall?

Answer: 2 [RE]

**Bonus**

- 1) Physics [Mid SE] - *Short Answer* What is the baryon [bear-ee-on] number of any quark?

Answer: 1/3 [RE]

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**Tossup**

- 2) Chemistry [Mid SE] - *Multiple Choice* Which of the following transition metals is most likely to exhibit multiple oxidation states in compounds?

- W) Iron
- X) Scandium
- Y) Zinc
- Z) Nickel

Answer: W) IRON [EC]

**Bonus**

- 2) Chemistry [Mid SE] - *Multiple Choice* Which of the following is a characteristic property of transition metals in their higher oxidation states?

- W) They tend to form colorless compounds.
- X) They have no tendency to exhibit magnetic properties.
- Y) They are highly unstable.
- Z) They often form coordination complexes with ligands.

Answer: Z) THEY OFTEN FORM COORDINATION COMPLEXES WITH LIGANDS [EC]

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**Tossup**

3) Biology [Early-Mid DE] - *Multiple Choice* Which of the following hormones is least likely to bind to a GPCR?

- W) Epinephrine
- X) Acetylcholine
- Y) Neuropeptide Y
- Z) Estrogen

Answer: Z) ESTROGEN

**Bonus**

3) Biology [Early-Mid DE] - *Multiple Choice* Brennan finds a flower that is brightly colored. The flower also has UV markings to indicate the location of the nectar. Which of the following animals is this flower most likely to be pollinated by?

- W) Bee
- X) Fly
- Y) Bat
- Z) Bird

Answer: W) BEE

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**Tossup**

4) Energy - *Short Answer* Ryan, being evil, tries to make his AI image generator only generate pictures of propaganda spreading rocks. What task is Ryan performing, involving steering AI models toward some given objective?

Answer: ALIGNMENT (Accept: AI ALIGNMENT) [MS]

**Bonus**

4) Energy - *Multiple Choice* Brennan wants to sort a list of children's names using bubble sort. What is the big omega time complexity of bubble sort?

- W) Omega(n) [omega of n]
- X) Omega(nlogn) [omega of n log n]
- Y) Omega(n^2) [omega of n squared]
- Z Omega(n^2logn) [omega of n squared log n]

Answer: W) OMEGA(n) [MS]

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**Tossup**

5) Earth and Space [Mid SE] - *Short Answer* Identify all of the following submerged locations that would have a positive gravity anomaly when measured from above by a satellite. I. A basaltic dike; II. A continental arc; III. A deep ocean trench

Answer: I and II [RE]

**Bonus**

5) Earth and Space [Mid SE] - *Multiple Choice* 15 first order streams, 30 second order streams, and 1 third order stream combine into a single stream. What is the Shreve [shreeeve] stream order of the single stream?

W) 46

X) 78

Y) 144

Z) Shreve stream order depends on the order of stream combination—there is not enough information.

Answer: X) 78 [RE]

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**Tossup**

6) Math [SE] - *Short Answer* What is the integral of  $\sec^2 x \, dx$  [secant squared x dee x] over the range of  $\pi/6$  to  $\pi/3$ ?

Answer:  $2\sqrt{3}/3$  [JL]

**Bonus**

6) Math [SE] - *Short Answer* Brennan bought a pokemon pack, containing 2 cards. In general, each pokemon pack has 2 pikachus with probability A, 2 charizards with probability B, and 1 pikachu 1 charizard with probability C, where A, B, C are positive constants with  $A+B+C=1$ . Brennan will hit the dab if he gets 2 pikachus. Brennan pulls out a card from the pack, and it's a pikachu. Given this information, what is the probability that Brennan will hit the dab? Express your answer in terms of A, B, and C.

Answer:  $2A/(2A + C)$  [JL]

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**Tossup**

7) Physics [Mid SE] - *Multiple Choice* Which of the following circuit elements functions by only allowing current to flow in one direction?

- W) Inductor
- X) Diode
- Y) Transformer
- Z) Transistor

Answer: X) DIODE [RE]

**Bonus**

7) Physics [Mid SE] - *Short Answer* Identify all of the following three changes that would increase the voltage created by the Hall effect in a conductor. I. Increasing thickness of the conductor in the direction of the applied magnetic field; II. Increasing electron drift velocity; III. Increasing charge carrier density within the conductor.

Answer: II only [RE]

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**Tossup**

8) Chemistry [Mid SE] - *Multiple Choice* Which of the following bases would be best at removing the proton connected to a terminal alkyne [al-kai-n]?

- W) Hydrogen sulfide ion
- X) Nitrite ion
- Y) Sulfide ion
- Z) Carbonate ion

Answer: Y) SULFIDE ION [RE]

**Bonus**

8) Chemistry [Mid SE] - *Short Answer* What name is given to liquids that deviate from Raoult's [ra-oolts] law?

Answer: AZEOTROPES [RE]

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**Tossup**

9) Biology [Mid DE] - *Multiple Choice* Brennan is running an experiment to determine whether protein X and protein Y interact directly within the cell. Which of the following procedures is most suitable for Brennan's experiment?

- W) FISH
- X) FACS
- Y) FRET
- Z) FRAP

Answer: Y) FRET

(*Yes, these are all actual biological procedures*)

### **Bonus**

9) Biology [Mid DE] - *Short Answer* Some contraceptives work by preventing ovulation in women. Identify all of the following three hormones which can be inhibited by these contraceptives to produce the desired effect: I. Luteinizing hormone; II. Estradiol, III. Progesterone

Answer: I & II

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### **Tossup**

10) Energy - *Short Answer* When using bootstrapping, which of the following are valid numbers of times you could take random samples? I. 1 II. 2 III. 3

Answer: II and III [MS]

### **Bonus**

10) Energy - *Multiple Choice* Which of the following describes using an octic polynomial to model data based off of 9 sample points?

- W) High variance, High bias
- X) High variance, Low bias
- Y) Low variance, High bias
- Z) Low variance, Low bias

Answer: X) HIGH VARIANCE, LOW BIAS [MS]

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### **Tossup**

11) Earth and Space [Mid SE] - *Short Answer* Which point in the Solar System is farthest away from the Sun?

- W) Heliopause
- X) Kuiper Belt [kigh-per]
- Y) Oort Cloud [or-t]
- Z) Orbit of Pluto

Answer: Y) OORT CLOUD [AI]

### **Bonus**

11) Earth and Space [Mid SE] - *Multiple Choice* Spectra taken of sunspots reveals spectral lines split into several smaller parts. This phenomenon is due to what effect, in which a magnetic field interacts with an atomic electron?

- W) Sunyaev-Zel'dovich Effect [soon-yay-ev zel-do-vich]
- X) Stark Effect
- Y) Zeeman Effect
- Z) Wolf Effect

Answer: Y) ZEEMAN EFFECT [AI]

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### **Tossup**

12) Math [SE] - *Short Answer* What is the remainder when the sum of  $1123 + 1124 + 1125 + 1126 + 1127 + 1128 + 1129 + 1130$  is divided by 5?

Answer: 2 [HK]

### **Bonus**

12) Math [SE] - *Short Answer* How many ways are there for Brennan to climb 10 stairs if he can go 1, 2, or 3 stairs up at a time?

Answer: 274 [HK]

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### **Tossup**

13) Physics [Mid SE] - *Short Answer* What is the generalized name given to the 5th derivative of position?

Answer: CRACKLE [RE]

**Bonus**

13) Physics [Mid SE] - *Short Answer* According to Noether's theorems, the translational symmetry of space is connected to the conservation of which physical quantity?

- W) Linear momentum
- X) Angular momentum
- Y) Energy
- Z) Charge

Answer: W) LINEAR MOMENTUM [RE]

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**Tossup**

14) Chemistry [Mid SE] - *Multiple Choice* Which of the following is NOT a valid combination of quantum numbers for an electron in an atom of aluminum?

- W)  $n = 1, L = 0, m_L = 1$
- X)  $n = 2, L = 1, m_L = 0$
- Y)  $n = 2, L = 1, m_L = -1$
- Z)  $n = 3, L = 2, m_L = 1$

Answer: W)  $n = 1, L = 0, m_L = 1$  [RE]

**Bonus**

14) Chemistry [Mid SE] - *Multiple Choice* The Dulong-Petit [do-long pe-tit] law states a constant value is created by multiplying the specific heat of a solid, pure, substance by what characteristic of the solid?

- W) Density
- X) Ideal gas constant
- Y) Molar mass
- Z) Lattice entropy

Answer: Y) MOLAR MASS [RE]

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**Tossup**

15) Biology [Mid DE] - *Short Answer* Rank the following three subcellular compartments in terms of increasing pH: I. Cytosol; II. Mitochondrial Matrix; III. Mitochondrial Intermembrane Space

Answer: III, I, II

**Bonus**

15) Biology [Mid DE] - *Multiple Choice* What plant hormone is responsible for the triple response to mechanical stress?

- W) Auxin
- X) Gibberellin
- Y) Ethylene
- Z) Abscisic Acid

Answer: Y) ETHYLENE

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**Tossup**

16) Energy - *Short Answer* Identify all of the following three machine learning models that use adversarial training I. GANs II. Actor-Critic models III. VAEs

Answer: I and II [MS]

**Bonus**

16) Energy - *Multiple Choice* Which of the following statements is NOT true of topological sorting?

- W) For a graph to be topologically sorted, it must be directed
- X) For a graph to be topologically sorted, it must be acyclic
- Y) The best topological sort algorithms operate in log-linear time
- Z) In a topological ordering, parents come before children

Answer: Y) THE BEST TOPOLOGICAL SORT ALGORITHMS OPERATE IN LOG-LINEAR TIME [MS]

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**Tossup**

17) Earth and Space [Mid SE] - *Short Answer* Identify all of the following 3 changes which would increase the rate of meltwater production at the base of a glacier? I. Increasing bedrock roughness; II. Decreasing the speed of the glacier; III. Decreasing the height of the glacier

Answer: I only [RE]

**Bonus**

17) Earth and Space [Mid SE] - *Multiple Choice* A certain air column has a dry adiabatic lapse rate of 10 degrees celsius per kilometer and a wet adiabatic lapse rate of 7.5 degrees per kilometer. Which of the following correctly describes the atmospheric stability of the area?

- W) Absolutely stable
- X) Absolutely unstable
- Y) Conditionally unstable
- Z) There is not enough information to say

Answer: Z) THERE IS NOT ENOUGH INFORMATION TO SAY [RE]

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**Tossup**

18) Math [SE] - *Short Answer* What is the probability that no one in a 4 person group was born on the same day of the week?

Answer: 120/343 [HK]

**Bonus**

18) Math [SE] - *Short Answer* A spherical balloon is being inflated at a rate of 6 cubic inches per second. What is the rate at which the radius is increasing at when the radius of the balloon is 3 inches?

Answer:  $1/(6\pi)$  [HK]

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**Tossup**

19) Physics [Mid SE] - *Multiple Choice* Which of the following statements is false regarding an object in projectile motion?

- W) An object will never travel faster than its terminal velocity
- X) The range of a projectile not experiencing drag is proportional to launch velocity squared
- Y) An object being thrown into a wind traveling opposite the direction of travel will go furthest when launched at an angle between 0 and 45 degrees.
- Z) In the absence of drag, the highest point a projectile reaches depends quadratically on launch velocity

Answer: W) AN OBJECT WILL NEVER TRAVEL FASTER THAN ITS TERMINAL VELOCITY [RE]

**Bonus**

19) Physics [Mid SE] - *Short Answer* A 3,500 pound car is suspended on 4 wheels, each inflated to 50 psi. Given that the weight is distributed evenly across all 4 wheels, in inches squared, what is the area of a single tire in contact with the ground?

Answer: 17.5 IN<sup>2</sup> [RE]

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**Tossup**

20) Chemistry [Mid SE] - *Multiple Choice* Which of the following is the correct units for the retention factor in a run of paper chromatography?

- W) Unitless
- X) Meter-mole [meter mole]
- Y) Meter/mole [meter per mole]
- Z) Mole/meter [mole per meter]

Answer: W) UNITLESS [RE]

**Bonus**

20) Chemistry [Mid SE] - *Multiple Choice* What type of reaction mechanism occurs when a purely nucleophilic reagent reacts with a tertiary substrate?

- W) E1
- X) E2
- Y) Sn1 [S-n-one]
- Z) Sn2 [S-n-two]

Answer: Y) SN1 [RE]

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**Tossup**

21) Biology [Mid DE] - *Multiple Choice* Venetoclax is a drug used to target blood cancers and works by activating the intrinsic apoptosis pathway. Which organelle would Venetoclax be targeting?

- W) Endoplasmic Reticulum
- X) Golgi Apparatus
- Y) Mitochondria
- Z) Nucleus

Answer: Y) MITOCHONDRIA

**Bonus**

21) Biology [Mid DE] - *Multiple Choice* Which of the following species would likely excrete nitrogenous waste in the form of uric acid?

- W) Bird
- X) Lion
- Y) Salmon
- Z) Human

Answer: W) BIRD

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**Tossup**

22) Energy - *Multiple Choice* Google's PageRank assigns weights to webpages based on the weights of their connections, updates the weights for the links between the webpages based on this, and repeats many times. PageRank can be re-expressed as which of the following?

- W) Solving a differential equation
- X) Finding the determinant of a matrix
- Y) Finding the roots of a polynomial
- Z) Finding the eigenvalues of a matrix

Answer: Z) FINDING THE EIGENVALUES OF A MATRIX [MS]

### **Bonus**

22) Energy - *Short Answer* Single-cell RNA researchers often use what nonlinear dimensionality reduction technique, involving approximating and projecting the topological manifold data lies on, to visualize their data on a 2D plot?

Answer: UMAP (Accept: UNIFORM MANIFOLD APPROXIMATION AND PROJECTION) [MS]

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### **Tossup**

23) Earth and Space [Mid SE] - *Multiple Choice* As a globular cluster gets older, what happens to the turnoff point on its HR-diagram?

- W) It separates into multiple turnoff points
- X) It moves towards lower temperature, lower luminosity
- Y) It moves towards higher temperature, lower luminosity
- Z) It moves towards higher temperature, but the same luminosity

Answer: X) IT MOVES TOWARDS LOWER TEMPERATURE, LOWER LUMINOSITY [AE]

### Bonus

23) Earth and Space [Mid SE] - *Multiple Choice* If the kinetic energy of a satellite orbiting Earth decreases to 1/3 of the original kinetic energy, by what factors do the gravitational potential energy and total energy of the satellite change?

- W) 6, 3
- X) 1, 2/3
- Y) 1/6, 1/3
- Z) 1/3, 1/3

Answer: Z) 1/3, 1/3 [AE]

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### Tossup

24) Math [SE] - *Multiple Choice* If  $X$  is a random variable with a normal distribution having mean  $\mu$  and variance  $\sigma^2$ . Which of the following has distribution standard normal having mean 0, and variance of 1?

- W)  $(X+\sigma)/\mu$  [quantity  $X$  plus sigma end quantity divided by  $\mu$ ]
- X)  $(X+\sigma+\mu)$  [ $X$  plus sigma plus  $\mu$ ]
- Y)  $(X-\mu)/\sigma^2$  [quantity  $X$  minus  $\mu$  end quantity divided by  $\sigma^2$ ]
- Z)  $(X-\mu)/\sigma$  [quantity  $X$  minus  $\mu$  end quantity divided by  $\sigma$ ]

Answer: Z)  $(X-\mu)/\sigma$  [JL]

### Bonus

24) Math [SE] - *Short Answer* Find the determinant of the 3 by 3 matrix with top row 2, 3, 5, middle row 1, 4, 3, and bottom row 2, 4 8

Answer: 14 [HK]