2025 Iolani Science Bowl Invitational
Round Robin 3

Tossup

1) Physics - *Short Answer* Brennan is using a solenoid to induce a magnetic field. Identify all of the following three changes to the solenoid that will decrease the magnitude of the field? I. Increase current; II. Decrease the number of loops per unit length; III. Decrease the radius of the loops.

Answer: II [AE]

Bonus

1) Physics - *Multiple Choice* Brennan submerges a cube with side length 10 cm underwater. If the cube's density is 0.5 grams per cm cubed, what is the net force on the cube when Brennan releases it?

W) 20 Newtons, downwards
X) 10 Newtons, upwards
Y) 10 Newtons, downwards
Z) 5 Newtons, upwards

Answer: Z) 5 NEWTONS, UPWARDS [AE]

Tossup

2) Chemistry - *Multiple Choice* Which of the following molecules has the highest electronegativity?

W) Carbon
X) Phosphorous
Y) Fluorine
Z) Chlorine

Answer: Y) FLUORINE [RE]

Bonus

2) Chemistry - *Multiple Choice* In the Born-Haber cycle, which step is associated with the formation of an ionic bond?

W) Sublimation of the metal
X) Ionization of the metal
Y) Electron affinity of the nonmetal
Z) Release of lattice energy

Answer: Z) RELEASE OF LATTICE ENERGY [EC]

Tossup

3) Biology [Mid RR] - *Short Answer* Aneuploid [uh-new-ploid] conditions like Down Syndrome and Klinefelter's Syndrome are caused by what event, which refers to the failure of chromosomes to separate properly during cell division?

Answer: NONDISJUNCTION

Bonus

3) Biology [Mid RR] - *Multiple Choice* In a certain lake lives a single species of carp. Brennan then comes and builds a wall, splitting the lake in half. After 200 years, each side of the lake has developed a new species of carp. What term best describes the event that has occurred?

W) Punctuated Equilibrium
X) Gradualism
Y) Allopatric Speciation
Z) Sympatric Speciation

Answer: Y) ALLOPATRIC SPECIATION

Tossup

4) Energy - *Multiple Choice* Which of the following best represents the loss versus training iteration graph for a properly functioning neural network using a typical training schedule and optimizer, such as adam?

W) Decreases quickly, then decreases steadily
X) Decreases quickly then increases quickly
Y) Decreases steadily forever
Z) Decreases steadily then decreases quickly

Answer: W) DECREASES QUICKLY, THEN DECREASES STEADILY [MS]

Bonus

4) Energy - *Short Answer* Supercomputers like the Department of Energy's Frontier often represent performance in a unit based on the speed of mathematical operations. What is this unit?

Answer: FLOPS (Accept floating point operations per second, exaflop, gigaflop, etc.) [MS]

Tossup

5) Earth and Space [RR] - *Short Answer* What element is fused in the core of a star on the horizontal red giant branch?

Answer: HELIUM [AE]

Bonus

5) Earth and Space [RR] - *Multiple Choice* A total solar eclipse can be observed from Earth in which which part of the Moon’s shadow?

W) Penumbra
X) Umbra
Y) Antumbra
Z) Depends on the Moon’s phase

Answer: X) UMBRA [AE]

Tossup

6) Math [RR] - *Short Answer* Runner A runs around a circular track every 20 seconds. Runner B runs around the track every 30 seconds. If runner A and runner B start at the same position but face in opposite directions, how long, in seconds, will it take for them to meet again?

Answer: 12 seconds [HK]

Bonus

6) Math [RR] - *Short Answer* If x varies directly with the square of y and inversely with the cube of z, by what percent does x increase or decrease if y is quintupled and z is halved?

Answer: 20,000 PERCENT INCREASE [RE]

Tossup

7) Physics - *Short Answer* Brennan constructs a sphere with radius 1 meter and a sphere with radius 2 meters around an electron. What is the ratio of the total electric flux through the smaller sphere to the total flux through the larger sphere?

Answer: 1 [AE]

Bonus

7) Physics - *Short Answer* What is the minimum coefficient of static friction needed to keep a block stationary on a 60 degree ramp?

Answer: SQUARE ROOT OF 3 [AE]

Tossup

8) Chemistry - *Multiple Choice* For the reaction N_2 (g) + $3H_2$ (g) ⇌ $2NH_3$ (g) [N2 gaseous plus 3 H2 gaseous yields 2 NH3 gaseous] in a rigid container with fixed volume, what happens to the equilibrium position if the pressure is increased through the addition of helium gas?

W) Shifts to the left
X) Shifts to the right
Y) No change
Z) Cannot be determined

Answer: Y) NO CHANGE [EC]

Bonus

8) Chemistry - *Short Answer* The reaction CO (g) + H_2O (g) ⇌ CO_2 (g) + H_2 (g) [CO gaseous plus H2O gaseous yields CO2 gaseous plus H2 gaseous] is endothermic. How will its equilibrium constant change when temperature is increased?

W) Increase
X) Decrease
Y) Stay the same
Z) Not enough information is provided

Answer: W) INCREASE [EC]

Tossup

9) Biology [Mid-Late RR] - *Short Answer* Beta-mercaptoethanol is a reducing agent that breaks disulfide bonds. Identify all of the following four protein structure levels that could be affected by this molecule: I. Primary; II. Secondary; III. Tertiary; IV. Quaternary

Answer: III and IV

Bonus

9) Biology [Mid-Late RR] - *Short Answer* Sickle-cell anemia is an autosomal recessive disease. In a population at Hardy-Weinberg equilibrium, 16% of people have sickle-cell anemia. What percentage of the population are carriers of sickle cell anemia?

Answer: 48%

Tossup

10) Energy - *Short Answer* In reinforcement learning, what quantity represents how "good" a given state is?

Answer: VALUE FUNCTION or VALUE [MS]

Bonus

10) Energy - *Multiple Choice* The main hurdle to breaking encryption algorithms like RSA is which of the following tasks?

W) Finding the greatest common divisor of two numbers
X) Factoring numbers
Y) Finding the roots of a polynomial
Z) Numerically solving a differential equation

Answer: X) FACTORING NUMBERS [MS]

Tossup

11) Earth and Space - *Multiple Choice* At what location would one expect to find a subduction zone?

W) Hot Spot
X) Transform Plate Boundary
Y) Divergent Plate Boundary
Z) Convergent Plate Boundary

Answer: Z) CONVERGENT PLATE BOUNDARY [AI]

Bonus

11) Earth and Space - *Multiple Choice* The Horse Latitudes, located 30 degrees north and south of the equator are associated with what type of surface atmospheric conditions?

W) High pressure, convergence
X) High pressure, divergence
Y) Low pressure, convergence
Z) Low pressure, divergence

Answer: X) HIGH PRESSURE, DIVERGENCE [AI]

Tossup

12) Math [RR] - *Short Answer* It takes 5 days for 3 workers to build 40 chairs. If there are 18 workers, how long, in days, will it take them to build 60 chairs?

Answer: 1.25 or 5/4 Days [HK]

Bonus

12) Math [RR] - *Short Answer* If a=log(2) and b=log(3), express log(30) - log(2) in terms of a and b

Answer: 1+ b - a [HK]

Tossup

13) Physics - *Multiple Choice* A damped spring-mass system is compressed then released, and comes to a stop at some point after the mass has reached the equilibrium point for the first time. What type of system is this?

W) Undamped
X) Underdamped
Y) Perfectly damped
Z) Overdamped

Answer: X) UNDERDAMPED [AE]

Bonus

13) Physics - *Short Answer* A capacitor has a capacitance of 5 microfarads and is connected to a 12-volt battery. After it is fully charged, what is the total energy stored in the capacitor, in microjoules?

Answer: 360 [ChatGPT/AE]

Tossup

14) Chemistry - *Multiple Choice* Which of the following gases has the highest rate of effusion under identical conditions, according to Graham's Law?

W) Oxygen
X) Carbon dioxide
Y) Nitrogen
Z) Helium

Answer: Z) HELIUM (He) [EC]

Bonus

14) Chemistry - *Multiple Choice* Which of the following describes the behavior of an ideal gas under isothermal conditions?

W) Intermolecular interactions are non-negligible
X) Volume decreases as pressure increases.
Y) Pressure is inversely proportional to temperature.
Z) Volume is directly proportional to pressure.

Answer: X) VOLUME DECREASES AS PRESSURE INCREASES [EC]

Tossup

15) Biology [Mid-Late RR] - *Multiple Choice* The symbiotic relationship between a barnacle and a whale, where the barnacle benefits while the whale is not harmed, is best described as which of the following?

W) Mutualism
X) Commensalism
Y) Amensalism
Z) Parasitic

Answer: X) COMMENSALISM

Bonus

15) Biology [Mid-Late RR] - *Short Answer* Carbohydrate digestion begins in which of the following organs?

W) Mouth
X) Stomach
Y) Small Intestine
Z) Large Intestine

Answer: W) MOUTH

Tossup

16) Energy - *Multiple Choice* Which of the following layers to a machine learning model is most often pretrained?

W) Embedding
X) Long Short-Term Memory
Y) Multilayer Perceptron
Z) Batch Normalization

Answer: W) EMBEDDING [MS]

Bonus

16) Energy - *Short Answer* A famous millennium prize problem is whether P equals NP. What does the P stand for?

Answer: POLYNOMIAL or POLYNOMIAL TIME [MS]

Tossup

17) Earth and Space [RR] - *Short Answer* What three elements are catalysts in the process that fuses hydrogen in the cores of higher-mass stars like Sirius?

Answer: CARBON, NITROGEN, OXYGEN (accept C, N, O) [AE]

Bonus

17) Earth and Space [RR] - *Multiple Choice* 90% of the energy of a core-collapse supernova is released via what mechanism?

W) Visible light
X) Radio waves
Y) Neutrinos
Z) Kinetic energy of expelled matter

Answer: Y) NEUTRINOS [AE]

Tossup

18) Math [RR] - *Short Answer* What is the degree of 7 when 60 factorial is prime factorized?

Answer: 9 [HK]

Bonus

18) Math [RR] - *Short Answer* What is the value of sqrt(10-4sqrt(6)) [square root of the quantity of ten minus four square root of six] in the form a + bsqrt6 [a plus b square root 6]?

Answer: -2+sqrt6 [HK]

Tossup

19) Physics - *Short Answer* Taking g to be 10 m/s^2, what is the terminal velocity of a falling 5 kg object if the drag force is equal to 10 times velocity?

Answer: 5 m/s [RE]

Bonus

19) Physics - *Short Answer* The minimum frequency of a photon required to remove an electron and successfully undergo the photoelectric effect is equal to the work function of the material divided by what physical constant?

Answer: PLANCK'S CONSTANT [RE]

Tossup

20) Chemistry - *Short Answer* Brennan wants to plate his copper medal with gold to fool his friends. He prepares a gold cyanide solution and applies a current for 20 minutes. Which of the following changes would increase the amount of gold deposited onto Brennan's medal?
I. Increasing the concentration of gold ions in the solution;
II. Increasing the applied current;
III. Increasing the amount of time for the process.

Answer: II and III [AI]

Bonus

20) Chemistry - *Short Answer* At a constant temperature and pressure, 3.0 L of SO_2 is combined with 3.0 L of O_2 according to the equation $2\ SO_2(g) + O_2(g)$ yields $2\ SO_3(g)$. What is the volume of the mixture after the reaction is completed?

Answer: 4.5 L [AI]

Tossup

21) Biology [Late RR] - *Short Answer* Identify all of the following four phyla that form the anus before the mouth during embryonic development: I. Insecta; II. Chordata; III. Echinodermata [ek-no-dermata]; IV. Nematoda.

Answer: II & III

Bonus

21) Biology [Late RR] - *Multiple Choice* Brennan suffers from type II Bare Lymphocyte Syndrome, meaning that his cells produce an abnormally low amount of MHC II. Which of the following cell types would you expect to be most affected in Brennan?

W) Red Blood Cells
X) Macrophages
Y) T Cells
Z) Neutrophils

Answer: X) Macrophages

Tossup

22) Energy - *Multiple Choice* At any given time, Brennan has a 30% chance of getting hit by one of Eli's czechballs. If czechball collision events are independent, which of the following distributions could model the number of czechballs Brennan gets hit by in a 5 minute period?

W) Bernoulli
X) Binomial
Y) Poisson [pwuh-son]
Z) Pareto [puh-ray-toe]

Answer: Y) POISSON [MS]

Bonus

22) Energy - *Multiple Choice* Which of the following data structures could best be used to store the next node to visit when performing a breadth-first search?
W) Queue
X) Stack
Y) Linked List
Z) Map

Answer: W) QUEUE [MS]

Tossup

23) Earth and Space - *Short Answer* What effect creates geostrophic [geo-strow-fick] currents by balancing the pressure gradient force, and is responsible for the rotation of oceanic gyres in the separate hemispheres?

Answer: CORIOLIS EFFECT (Accept: CORIOLIS FORCE) [RE]

Bonus

23) Earth and Space - *Short Answer* Deep-focus earthquakes occur primarily in what region of a subduction zone?

Answer: WADATI-BENIOFF ZONE [AI]

Tossup

24) Math [RR] - *Short Answer* How many diagonals does a decagon have?

Answer: 35 [HK]

Bonus

24) Math [RR] - *Short Answer* What is the acute angle formed by the minute and hour hands of a clock at 6:28 in degrees?

Answer: 26 degrees [HK]
