2025 Bay Area Science-Estimathon Duel

Double Elimination

Question Set 1

Questions will begin on the next page.

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*E&S = Earth and Space, Est = Estimation.

TOSS-UP

1) **Math – *Multiple Choice*** Quinn is attempting to write a program, but as he gets more tired, he writes slower. He starts working at 3pm and finishes 1/3 from 3pm to 4pm, 1/4 from 4pm to 5pm, 1/5 from 5pm to 6pm, and so on. In which of the following blocks of time does he finish his program?

W) From 6pm to 7pm
X) From 7pm to 8pm
Y) From 8pm to 9pm
Z) From 9pm to 10pm

ANSWER: X) 7PM TO 8PM [QG]

BONUS

1) **Math – *Short Answer*** A line is defined as $f(x) = -x/3 + 7$. Another line $g(x)$ is constructed perpendicular to $f(x)$ and passes through the point $(0, 4)$. What is $g(f(3))$?

ANSWER: 22 [AG]

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TOSS-UP

2) **Chemistry – *Short Answer*** In some cases of covalent bonding, one species will donate both electrons to form a bond. What is the term for this kind of bonding?

ANSWER: COORDINATE COVALENT BOND (accept DATIVE or COORDINATE, do not accept COVALENT) [AG]

BONUS

2) **Chemistry – *Short Answer*** What is the formal anhydride of formic acid?

ANSWER: CARBON MONOXIDE (accept CO) [AG]

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TOSS-UP

3) **Physics – *Short Answer*** In a tube closed at one end, the fundamental has a wavelength of 4 meters. In meters, what would be the wavelength of the fundamental in the same tube if it were open at both ends?

ANSWER: 2 [QG]

BONUS

3) **Physics – *Short Answer*** In a tube open at both ends, the second harmonic has a wavelength of 12 meters. By name or number, list all of the following three statements that are true:

1. The third harmonic has a wavelength of 8 meters
2. The third harmonic has nodes 2 meters from each end of the tube with regards to air displacement
3. The third harmonic has an antinode at each end of the tube with regards to air displacement

ANSWER: ALL [QG]

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TOSS-UP

4) **Earth and Space – *Multiple Choice*** Quinn launches a rocket at the moon. At which of the following points in Earth's atmosphere would his rocket measure the coldest temperature reading?

W) Tropopause
X) Stratopause
Y) Mesopause
Z) Thermopause

ANSWER: Y) MESOPAUSE [AG]

BONUS

4) **Earth and Space – *Short Answer*** **(Note to moderator: read out galaxy name letter by letter)** A new galaxy, UR-MoM, has been discovered to have an active and bright galactic nucleus and very strong spectral lines. Based on this, what kind of galaxy would it be classified as?

ANSWER: SEYFERT GALAXY [MR]

TOSS-UP

5) **Y-Risk – *Multiple Choice*** Approximately how long ago did the Holocene epoch begin?

W) Ten thousand years
X) One million years
Y) One hundred million years
Z) One billion years

ANSWER: W) TEN THOUSAND YEARS [AG]

BONUS

5) **Y-Risk – *Short Answer*** By name or number, select all of the following four blotting techniques that are correctly matched with their targeted biomolecule:

1. Northern blot, RNA
2. Southern blot, RNA
3. Eastern blot, lipids
4. Western blot, proteins

ANSWER: 1 AND 4 [AG]

TOSS-UP

6) **Biology – *Short Answer*** What process, typically occurring in the mitochondrial matrix, is responsible for production of the majority of electron carriers in cellular respiration?

ANSWER: KREBS CYCLE [EP]

BONUS

6) **Biology – *Short Answer*** The term "Krebs bicycle" is sometimes used to reference the functional pairing of the Krebs cycle with which other metabolic pathways occurring in the liver, which involves the amino acids ornithine, citrulline, and arginine and functions to detoxify ammonia?

ANSWER: UREA CYCLE [EP]

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TOSS-UP

7) **Math – *Short Answer*** By name or number, identify all of the following four operations which are Euclidean transformations:

1. Dilation about the origin
2. Rotation about the origin
3. Reflection about a line not passing through the origin
4. Horizontal shear

ANSWER: 2 AND 3 [WC]

BONUS

7) **Math – *Short Answer*** Warren draws a line segment starting from the point (1,0) and ending at the point (4,4). If he translates the segment left by 5 units, rotates it 90 degrees around the point (-2,6), and then reflects it across the x axis, what is the length of the resulting segment?

ANSWER: 5 [WC]

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TOSS-UP

8) **Physics – *Multiple Choice*** A negatively charged particle is traveling 5 m/s in the positive y direction through a uniform magnetic field, resulting in a magnetic force in the positive z direction acting on it. What is the direction of the applied magnetic field?

W) Positive z
X) Negative z
Y) Positive x
Z) Negative x

ANSWER: Y) POSITIVE X [QG]

BONUS

8) **Physics – *Short Answer*** Max is playing War Thunder during his physics class. He notices that during a sharp dive in his B-34 bomber, his wings rip off. This is because the plane is going faster than its never-exceed speed, the velocity at which a plane's structural integrity fails under extreme drag forces. By name or number, identify all of the following three changes Max could theoretically make to his plane and attack strategy to help keep his plane intact:

1. Make the wings more aerodynamic
2. Make control surfaces, such as the rudder, more elastic
3. Decrease his angle of attack

ANSWER: 1 AND 3 [MR]

TOSS-UP

9) **Y-Risk – *Multiple Choice*** Which of the following best describes the type of operation that neural networks employ for the forward pass of data through layers?

W) Matrix multiplication
X) Differentiation
Y) Integration
Z) Regression

ANSWER: W) MATRIX MULTIPLICATION [QG]

BONUS

9) **Y-Risk – *Multiple Choice*** Which of the following programming languages is an interpreted language?

W) Python
X) Java
Y) C++
Z) HTML

ANSWER: W) PYTHON [WC + QG]

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TOSS-UP

10) **Chemistry – *Multiple Choice*** Which of the following is closest to the packing efficiency of a body-centered cubic unit cell?

W) 52%
X) 62%
Y) 68%
Z) 74%

ANSWER: Y) 68% [QG]

BONUS

10) **Chemistry – *Short Answer*** By name or number, select all of the three following sets of quantum numbers that would be allowed for an electron in an atom of cobalt.

1. n equals 4, l equals 2, m sub l equals 2, s equals 1/2.
2. n equals 3, l equals 3, m sub l equals 1, s equals -1/2.
3. n equals 3, l equals 1, m sub l equals -1, s equals 1.

ANSWER: 1 [AG]

TOSS-UP

11) **Biology – *Multiple Choice*** In the human vestibular system, which of the following structures is responsible for maintaining balance and detecting rotational motion, often contributing to dizziness?

W) Cochlea
X) Cupula
Y) Otoliths
Z) Eustacian tubule

ANSWER: X) CUPULA [EP]

BONUS

11) **Biology – *Short Answer*** Some aquatic vertebrates, such as fish and amphibians, do not have developed ears. Instead, components of their vestibular system are located on the exterior of the body, relying on the vibrations of water. What is the name of this system?

ANSWER: LATERAL LINE SYSTEM [EP]

TOSS-UP

12) **Earth and Space – *Multiple Choice*** Which of the following classification of eruptions would likely have the largest VEI, or volcanic explosivity index?

W) Plinian
X) Pelean
Y) Strombolian
Z) Vulcanian

ANSWER: W) PLINIAN [AG]

BONUS

12) **Earth and Space – *Short Answer*** Order the following three regions of a glacier in increasing distance from the mountain peak:

1. Zone of ablation
2. Equilibrium line
3. Zone of accumulation

ANSWER: 3, 2, 1 [AG]

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TOSS-UP

13) **Math – *Short Answer*** If a test for water quality concludes that the water does not meet quality standards when in truth it does, what type of error has been made?

ANSWER: TYPE II [WC]

BONUS

13) **Math – *Multiple Choice*** Which of the following tests would be most suitable for determining if the average amount of juice dispensed by a machine is greater than a specified amount?

W) 1-proportion Z-test
X) 2-proportion Z-test
Y) 1-sample T-test
Z) 2-sample T-test

ANSWER: Y) 1-SAMPLE T-TEST [WC]

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TOSS-UP

14) **Chemistry – *Short Answer*** By name or number, order the following three halogens by increasing oxidizing potential.

1. Fluorine
2. Chlorine
3. Bromine

ANSWER: 3, 2, 1 [AG]

BONUS

14) **Chemistry – *Short Answer*** In an isolated chamber at high temperature, magnesium carbonate, $MgCO_3$, exists in equilibrium with magnesium oxide, MgO, and carbon dioxide gas. By name or number, select all of the following three changes that would shift equilibrium to the left:

1. Adding solid MgO
2. Removing solid $MgCO_3$
3. Adding carbon dioxide gas

ANSWER: 3 ONLY [AG]

TOSS-UP

15) **Biology – *Short Answer*** Max jumps in shock every time a bee, wasp, or anything else with black and yellow stripes comes near his food. However, not every insect that intends to steal his lunch is actually a bee, even though they share the same coloration. What type of mimicry, where a palatable species imitates an unpalatable one, is exhibited by animals such as bee-mimicking hoverflies?

ANSWER: BATESIAN MIMICRY [read as: ba-tee-sian] (accept BATESIAN) [EP]

BONUS

15) **Biology – *Short Answer*** To overcome his fear of bees, Max decides to spend a day in a beehive. While in the hive, he notices a lack of worker bees. What phenomenon, which is currently threatening honeybee populations across the world, involves the sudden disappearance of male bees from a colony, while the queen, brood, and food stores are left behind?

ANSWER: COLONY COLLAPSE DISORDER [EP]

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TOSS-UP

16) **Earth and Space – *Short Answer*** What is the name of the branch on the HR diagram that consists of stars which have left the red giant phase and are currently undergoing helium fusion in their cores?

ANSWER: HORIZONTAL BRANCH [WC]

BONUS

16) **Earth and Space – *Short Answer*** Ganymede, Jupiter's biggest moon, has a very thin and modest atmosphere compared to Titan, Saturn's biggest moon, despite Ganymede being bigger and therefore having a larger gravitational field at its surface. By name or number, indicate which of the following four reasons are true regarding why Titan can retain an atmosphere while Ganymede cannot:

1. The gases that make up Titan are heavier in mass, requiring more energy to escape
2. Colder temperatures at Titan's surface prevent molecules from escaping as easily
3. Saturn's lower mass doesn't allow gas to be gravitationally siphoned from its moons' atmospheres like Jupiter can
4. Titan has mechanisms to replenish its atmosphere, while Ganymede does not

ANSWER: 1, 2, AND 4 [MR]

TOSS-UP

17) **Physics – *Multiple Choice*** The work functions for potassium and copper are 2.3 and 4.7 electron volts, respectively. A laser with a certain frequency of light is shone on a plate of potassium, and the maximum kinetic energy of the ejected electrons is 3.8 electron volts. If a second laser that emits the same frequency of light with twice the intensity is shone on a copper plate, what would be the expected maximum kinetic energy of the ejected electrons from the copper be, in electron volts?

W) 1.4
X) 3.8
Y) 6.2
Z) 7.5

ANSWER: W) 1.4 [QG]

BONUS

17) **Physics – *Short Answer*** **(Note to moderator: read the question slowly to give time for players to write down numbers).** Quinn is studying the alpha decay of Uranium-232 to Thorium-228. He measures the atomic masses of Uranium-232, Thorium-228, and Helium-4 as 232.04 amu, 228.03 amu, and 4.00 amu, respectively. According to his data, to one significant figure, what is the energy released by the alpha decay of one atom of Uranium-232 in mega electron volts?

ANSWER: 9 [QG]

TOSS-UP

18) **Y-Risk – *Short Answer*** Scramjet engines are employed in missiles, such as the Hypersonic Attack Cruise Missile, to achieve velocities many times the speed of sound. They do this by combining the gaseous oxygen from the incoming airstream with what onboard fuel?

ANSWER: HYDROGEN (accept GASEOUS HYDROGEN or H_2, do not accept LIQUID HYDROGEN)

BONUS

18) **Y-Risk – *Multiple Choice*** Which of the following is NOT an advantage of using hydrogen as fuel for scramjet engines?

W) Hydrogen's low density allows for a lot of fuel to be stored in a single missile without adding much weight
X) Hydrogen's wide flammability range allows scramjet engines to burn at a variety of temperatures and pressures
Y) Hydrogen's low ignition delay allows for the engine to function more efficiently when compared to hydrocarbons
Z) The byproduct of the hydrogen-oxygen reaction results in an environmentally-friendly byproduct

ANSWER: W) HYDROGEN'S LOW DENSITY ALLOWS FOR A LOT OF FUEL TO BE STORED IN A SINGLE MISSILE WITHOUT ADDING MUCH WEIGHT [MR]

TOSS-UP

19) **Math – *Multiple Choice*** Which of the following sets of roots is possible for a 3rd degree polynomial with real coefficients?

W) 2 real roots, 1 complex root
X) 2 real roots, 2 complex roots
Y) 3 real roots, 1 complex root
Z) 1 real root, 2 complex roots

ANSWER: Z) 1 REAL ROOT, 2 COMPLEX ROOTS [WC]

BONUS

19) **Math – *Short Answer*** The sum of the first 100 terms of an arithmetic sequence is 100, and the sum of the first 200 terms of the same sequence is 300. What is the common difference of the sequence?

ANSWER: 0.01 [QG]

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TOSS-UP

20) **Physics – *Short Answer*** By name or number, list all of the following four options that violate the first law of thermodynamics:

1. A perfect Carnot heat engine
2. A zero-entropy crystal at room temperature
3. A perpetual motion machine of the second kind
4. The transfer of heat from an object of lower temperature to one of higher temperature

ANSWER: NONE [QG]

BONUS

20) **Physics – *Short Answer*** In the standard model, which boson can have either a positive or a negative charge?

ANSWER: W BOSON [QG]

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TOSS-UP

21) **Biology – *Short Answer*** Neurons in the ventral tegmental area, or VTA, are responsible for the mechanisms of drug addiction. What neurotransmitter is responsible for positive regulation of VTA neurons?

ANSWER: DOPAMINE [EP]

BONUS

21) **Biology – *Short Answer*** In an addiction cycle, drugs either stimulate dopamine production or inhibit modulatory sites which lead to decreased dopamine production. What important inhibitory neurotransmitter in the mammalian central nervous system prevents overexcitation of neurons, and also acts to stop dopamine secretion in the VTA?

ANSWER: GABA (accept GAMMA-AMINOBUTYRIC ACID) [EP]

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TOSS-UP

22) **Chemistry – *Multiple Choice*** A reaction is spontaneous at room temperature, but becomes less spontaneous as temperature increases. What can you conclude about the ΔH and ΔS of this reaction?

W) ΔH is positive, ΔS is negative
X) ΔH is positive, ΔS is positive
Y) ΔH is negative, ΔS is negative
Z) ΔH is negative, ΔS is positive

ANSWER: Y) ΔH IS NEGATIVE, ΔS IS NEGATIVE [AG]

BONUS

22) **Chemistry – *Multiple Choice*** Which of the following sets of properties of a liquid would allow the formation of a positive meniscus in a glass beaker?

W) High adhesion, high cohesion
X) High adhesion, low cohesion
Y) Low adhesion, high cohesion
Z) Low adhesion, low cohesion

ANSWER: Y) LOW ADHESION, HIGH COHESION [AG]

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TOSS-UP

23) **Earth and Space – *Short Answer*** Farmer John notices that his bedrock consists of highly jointed granite. If a storm washes away all of his topsoil, which of the following drainage patterns would likely be uncovered?

W) Rectangular
X) Dendritic
Y) Trellis
Z) Radial

ANSWER: W) RECTANGULAR [AG]

BONUS

23) **Earth and Space – *Multiple Choice*** V-type asteroids, also known as Vestoids, are named as such because they share the spectral signature of Vesta, a large asteroid in the asteroid belt. V-type asteroids are characterized by their basaltic, volcanic surfaces and are primarily composed of silicate materials, making them most similar to what type of asteroid?

W) C-type
X) S-type
Y) M-type
Z) D-type

ANSWER: X) S-TYPE [MR]

TOSS-UP (30 seconds)

24) **Estimation – *Short Answer*** Max is being told that he has to at least make an attempt at making an estimation question for biology. Estimate the order of magnitude of the fraction of weight a single X chromosome makes up of a person's total body weight.

ANSWER: -18 [MR]

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End of Questions.