2025 Bay Area Science-Estimathon Duel

Round Robin

Question Set 5

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

TOSS-UP

1) **Physics – *Short Answer*** Warren drops his phone on the ground. The phone bounces off the ground with a velocity less than its initial impact velocity. What is the specific name for the ratio of the phone's speed immediately after and before it hits the ground?

ANSWER: COEFFICIENT OF RESTITUTION [MR]

BONUS

1) **Physics – *Short Answer*** If a particle with a mass to charge ratio of $4 \cdot 10^{-6}$ kilograms per coulomb is tracing out a circular path of radius 6 meters in a uniform magnetic field of 12 microteslas, what is its speed in meters per second?

ANSWER: 18 [MR]

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TOSS-UP

2) **Math – *Multiple Choice*** In a robotics tournament, teams can score points by placing rings on goal posts. Each ring on a post is worth 2 points, and the top ring on a post is worth an additional 3 points. If a team has one goal post with 4 rings, two goal posts with 5 rings, and one goal post with 6 rings, how many points does that team have in total?

W) 38
X) 49
Y) 52
Z) 56

ANSWER: Y) 52 [QG]

BONUS

2) **Math – *Short Answer*** 80 teams are attending a robotics tournament in which each match is played between two alliances of two teams each, resulting in four teams playing per match. If each team must play 8 qualification matches, and then a single elimination tournament of the same match format is played between the top 32 teams, resulting in one winning alliance of two teams, how many matches are played in total?

ANSWER: 175 [QG]

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TOSS-UP

3) **Y-Risk – *Short Answer*** Alex is hydrating blackberries, also known as washing them. If he has 25 moles of blackberries and 1000 moles of water, what is the hydrate number per mole of blackberry?

ANSWER: 40 [AG]

BONUS

3) **Y-Risk – *Multiple Choice*** While Quinn was trying to find the hydration number of his barium sulfate hydrate via heating for dehydration, he found that his experimental result was significantly greater than the expected result. Which of the following could have possibly led to this error?

W) The sample was insufficiently heated and some of the water was not burned off
X) Some of his sample spilled as he was taking it off the bunsen burner after heating
Y) He measured too much sample and the mass balance mismeasured his sample mass
Z) Carbon dioxide replaced the water molecules after heating, artificially increasing its sample mass

ANSWER: X) SOME OF HIS SAMPLE SPILLED AS HE WAS TAKING IT OFF THE BUNSEN BURNER AFTER HEATING[AG]

TOSS-UP

4) **Biology – *Short Answer*** Ethan is observing Richard during lunchtime. He notices that Richard is more likely to leave school and get tacos if there are many students in the lunch line. What behavioral model can be used to approximate Richard's dietary habits?

ANSWER: OPTIMAL FORAGING MODEL (accept OPTIMAL FORAGING THEORY or OPTIMAL FORAGING) [EP]

BONUS

4) **Biology – *Short Answer*** Every lunch, Richard can either stay in line for school food or drive to get tacos. Driving to and from the taco truck takes 10 minutes, and the tacos can give Richard 600 calories of energy to prevent him falling asleep in class. Standing in the line can take much longer, but Richard will have access to 1200 calories of greasy school pizza. Assuming Richard loses 50 calories per minute waiting for food, regardless of the option chosen, what is the maximum time, in minutes, Richard should spend in the lunch line based on expected caloric intake?

ANSWER: 22 [EP]

TOSS-UP

5) **Earth and Space – *Short Answer*** The Sun is a G-type star, meaning that it is too cool to produce strong spectroscopic signatures of what hydrogen emission series, which is more prominent in hotter stars?

ANSWER: BALMER SERIES (accept BALMER LINES) [MR]

BONUS

5) **Earth and Space – *Multiple Choice*** The Sun's full stellar classification under the commonly used Morgan-Keenan classification is G2V. In this system, what is represented by the letter V?

W) The sun is approximately five billion years old
X) The sun's temperature is between 5300 and 6000 Kelvin
Y) The sun is a yellow star
Z) The sun is a main-sequence star

ANSWER: Z) THE SUN IS A MAIN-SEQUENCE STAR [MR]

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TOSS-UP

6) **Chemistry – *Multiple Choice*** Alex is investigating the decomposition reaction of hydrogen peroxide, $2H_2O_2 \rightarrow 2H_2O + O_2$. It is known that this is a first order reaction. Which of the following graphs would be linear and decreasing?

W) Concentration of H_2O versus time
X) Concentration of H_2O_2 versus time
Y) Natural log of the concentration of H_2O versus time
Z) Natural log of the concentration of H_2O_2 versus time

ANSWER: Z) NATURAL LOG OF THE CONCENTRATION OF H_2O_2 VERSUS TIME [QG]

BONUS

6) **Chemistry – *Short Answer*** Alex wants to increase the rate constant for his H_2O_2 decomposition reaction. By name or number, identify all of the following four changes that would increase the rate constant:

1. Add a catalyst
2. Increase the concentration of H_2O_2
3. Increase the temperature
4. Remove products as they form

ANSWER: 1 AND 3 [QG]

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TOSS-UP

7) **Biology – *Short Answer*** In the species *B. krish*, early buzzing is dominant to late buzzing, and negging is dominant to not negging. If a true-breeding early buzzing, non-negging *B. krish* is crossed with another individual heterozygous for both traits, what fraction of offspring from this cross will buzz early and neg?

ANSWER: 1/2 (accept 0.5, 50%) [EP]

BONUS

7) **Biology – *Short Answer*** A population of 1500 *B. krish* is in Hardy-Weinberg equilibrium. Saratoga High School A Team conducts an experiment on the *B. krish* and finds that 240 are late-buzzing. What is the frequency of the early-buzzing allele in this population of *B. krish*?

ANSWER: 0.6 (accept 60% or THREE FIFTHS) [EP]

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TOSS-UP

8) **Math – *Short Answer*** In the TogaSara dimension, the interior angles of a triangle sum to 1434 tortles, where a tortle is a measure of a plane angle. To the nearest tortle, what is the sum of interior angles of a regular hexagon in the TogaSara dimension?

ANSWER: 5736 [AG]

BONUS

8) **Math – *Short Answer*** Max is taking the CAASPP [*read as: kasp*] exam, and is unhappy with the sheer strangeness of the questions. He tries to challenge himself by finding all distinct combinations of the letters in CAASPP, spelled out C-A-A-S-P-P, where C is immediately followed by an A. How many such combinations can be created?

ANSWER: 60 [AG]

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TOSS-UP

9) **Chemistry – *Multiple Choice*** In an electrochemical cell, which of the following occurs at the cathode?

W) Anion migration
X) Oxidation
Y) Electron flow
Z) Reduction

ANSWER: Z) REDUCTION [MR]

BONUS

9) **Chemistry – *Multiple Choice*** Arjun makes the following joke: "Absolute zero is oK [read: okay]." Warren gets fed up with his antics and decides to throw Arjun into a thermal vacuum chamber. As Warren cools the chamber towards oK [read as: zero K], which of the following gases in Arjun's lungs would condense first?

W) Neon
X) Oxygen
Y) Nitrogen
Z) Helium

ANSWER: X) OXYGEN [AG]

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TOSS-UP

10) **Physics – *Multiple Choice*** Alex, while chilling out to music from the Solar Express, ponders what would happen if a train in space was powered by the Sun. He imagines a circular track through the asteroid belt at a distance of 3 AU from the sun. Which of the following is closest to the solar irradiance, in watts per square meter, the Solar Express would receive at that distance, given that the solar constant is approximately 1360 watts per square meter?

W) 50
X) 150
Y) 450
Z) 1360

ANSWER: X) 150 [QG]

BONUS

10) **Physics – *Short Answer*** Alex now actually embarks on a solar journey, hoping to travel farther out into the Solar System. He boards a spacecraft powered by a solar sail, which relies on reflecting the Sun's solar wind to take advantage of photons' momentum in order to propel the spacecraft forward. What is the name of this physical effect, demonstrated by solar sails?

ANSWER: RADIATION PRESSURE (accept LIGHT PRESSURE) [MR]

TOSS-UP

11) **Earth and Space – *Multiple Choice*** The San Andreas Fault, which represents the transform boundary between the Pacific and North American Plates, is infamous for producing many strong earthquakes. What type of fault is San Andreas?

W) Normal
X) Reverse
Y) Strike-slip
Z) Oblique

ANSWER: Y) STRIKE-SLIP [EP]

BONUS

11) **Earth and Space – *Multiple Choice*** Which of the following rocks has the lowest metamorphic grade?

W) Slate
X) Phyllite
Y) Schist
Z) Gneiss

ANSWER: W) SLATE [AG]

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TOSS-UP

12) **Y-Risk – *Short Answer*** Saratoga High School students ended their tour of Europe, but back on their way to California, they stop in New York to explore Manhattan. What amount of fissile material did scientists working on the Manhattan Project need to make effective nuclear weapons, the mass limit at which a nuclear reaction can grow exponentially?

ANSWER: SUPERCRITICAL MASS (do not accept CRITICAL MASS) [MR]

BONUS

12) **Y-Risk – *Short Answer*** Quinn and Warren are training a neural network to estimate the time it takes them to complete their homework. However, they accidentally left the model training during their trip to Europe, and the model now performs well on training data but poorly on testing data. What is the name of this phenomenon?

ANSWER: OVERFITTING [WC]

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TOSS-UP

13) **Physics – *Multiple Choice*** Which of the following is true for a skydiver falling at terminal velocity?

W) There are no forces acting on the skydiver
X) The skydiver cannot change their speed after reaching terminal velocity
Y) Air resistance is maximized when the skydiver has the most cross-sectional area
Z) There is a net downward force acting on the skydiver

ANSWER: Y) AIR RESISTANCE IS MAXIMIZED WHEN THE SKYDIVER HAS THE MOST CROSS-SECTIONAL AREA [WC]

BONUS

13) **Physics – *Short Answer*** A skydiver weighing 60 kilograms is falling at a terminal velocity of 60 meters per second. If they open their parachute and reduce their velocity to 10 meters per second in 0.05 seconds, what is the average force, in newtons, exerted on their body in that time period?

ANSWER: 60000 [WC]

TOSS-UP

14) **Chemistry – *Multiple Choice*** Which of the following pairs of atoms has the most similar electronegativities?

W) Hydrogen and Lithium
X) Nitrogen and Phosphorus
Y) Oxygen and Chlorine
Z) Fluorine and Sulfur

ANSWER: Y) OXYGEN AND CHLORINE [AG]

BONUS

14) **Chemistry – *Short Answer*** Which of the following conformations of cyclohexane is the most stable?

W) Chair
X) Boat
Y) Half-chair
Z) Twist-boat

ANSWER: W) CHAIR [AG]

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TOSS-UP

15) **Y-Risk – *Short Answer*** While writing Science Bowl questions for the tournament, Max realizes that the completion of this question will mark the completion of half of the total number of questions required. As a celebration, by name or number, indicate all of the following four things that have a "half" version:

1. Equivalence point
2. Electron charge
3. Alpha decay
4. Cell

ANSWER: 1 AND 4 [MR]

BONUS

15) **Y-Risk – *Multiple Choice*** During the Cold War, Soviet analysts tried to infer late-night U.S. military activity by analyzing sharp increases in pizza orders in Washington DC, because it supposedly meant that officials in the Department of Defense were working overtime in response to a developing or imminent military crisis. What type of analysis technique, commonly used to detect sudden increases or anomalies in data, would be most similar to the USSR's pizza inference method?

W) Deviation analysis
X) Trend analysis
Y) Spike detection
Z) LSRL exclusion window

ANSWER: Y) SPIKE DETECTION [MR]

TOSS-UP

16) **Biology – *Short Answer*** Arjun has been watching Hunter x Hunter and he can't pick between the Yorknew City or Chimera Ant arc as his favorite parts of the story. Meruem *(mare-oo-em)*, the king of the chimera ants, has characteristics of many organisms incorporated into his being. Assuming Meruem began his life as a typical worker ant of a clonal species, by what conventional reproductive method was Meruem produced by the queen?

ANSWER: Parthenogenesis [AK]

BONUS

16) **Biology – *Short Answer*** Out of curiosity, Arjun decided to note down the apparent survivorship curve types of each of the magical creatures that inhabit the Dark Continent in Hunter x Hunter for data collecting purposes. Kiriko, one type of creature in the Dark Continent, are humanoid chimeras who are born with human-like strength and grow to be just like them, except that they are constantly at risk and placed in unfavorable positions due to the extreme dangers of the environment. What type of survivorship curve would Kiriko follow?

ANSWER: TYPE 2 [AK]

TOSS-UP

17) **Math – *Short Answer*** What is Euler's totient function of 97?

ANSWER: 96 [QG]

BONUS

17) **Math – *Short Answer*** How many factors does 728 have?

ANSWER: 16 [QG]

TOSS-UP

18) **Earth and Space – *Short Answer*** What type of binary star system involves two stars orbiting each other so closely that their outer envelopes merge?

ANSWER: CONTACT BINARY (accept CONTACT) [EP]

BONUS

18) **Earth and Space – *Short Answer*** By name or number, order the following three elements of the Earth's core by increasing mass abundance.

1. Iron
2. Sulfur
3. Nickel

ANSWER: 2, 3, 1 [AG]

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TOSS-UP

19) **Biology – *Short Answer*** Vascular plants have a large array of conducting cells and elements. By name or number, identify all of the following four cells that are NOT part of a plant's vascular tissue:

1. Tracheids
2. Vessel elements
3. Sieve-tube elements
4. Companion cells

ANSWER: NONE [EP]

BONUS

19) **Biology – *Short Answer*** At functional maturity, plant vascular tissues differ in cellular status. By name or number, identify all of the following four cells that are typically dead at functional maturity:

1. Tracheids
2. Vessel elements
3. Sieve-tube elements
4. Companion cells

ANSWER: 1 AND 2 (accept TRACHEIDS AND VESSEL ELEMENTS) [EP]

TOSS-UP

20) **Physics – *Short Answer*** Max shines a flashlight in front of him, with the beam moving at the speed of light, c, away from him. Quinn, on his quest to become the Flash, chases after the beam, running at c/2 in Max's reference frame in the same direction. In Quinn's reference frame, what is the speed of the light beam, in terms of c?

ANSWER: c (ACCEPT: 1c) [MR]

BONUS

20) **Physics – *Multiple Choice*** A gas container has an initial volume and pressure of 1 liter and 2 atmospheres, respectively. The gas first isobarically expands to twice its initial volume and then isochorically heats up to twice its initial pressure. Which of the following correctly describes the work, in atmosphere liters, done by the gas in each step, respectively?

W) -2, 0
X) 2, 0
Y) 2, -2
Z) 0, 2

ANSWER: X) 2, 0 [QG]

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TOSS-UP

21) **Chemistry – *Multiple Choice*** Which of the following best describes the role of NH_3 and BF_3, respectively, in an acid base reaction?

W) Arrhenius acid, Arrhenius base
X) Arrhenius base, Arrhenius acid
Y) Lewis acid, Lewis base
Z) Lewis base, Lewis acid

ANSWER: Z) LEWIS BASE, LEWIS ACID [AG]

BONUS

21) **Chemistry – *Short Answer*** Quinn has a beaker of $AgNO_3$ and a beaker of Na_2CO_3. In his rush to complete an experiment, he forgot to label the two. By name or number, select all of the following chemicals he can add to differentiate the beakers.

1. HNO_3
2. NaCl
3. $KC_2H_3O_2$

ANSWER: 1, 2 [AG]

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TOSS-UP

22) **Earth and Space – *Multiple Choice*** Which of the following is NOT an example of a rain shadow desert?

W) Atacama Desert
X) Gobi Desert
Y) Namib Desert
Z) Sahara Desert

ANSWER: Z) SAHARA DESERT [AG]

BONUS

22) **Earth and Space – *Multiple Choice*** Adhering to the strict definition of a desert as a region that receives less than 10 inches or 25 centimeters of precipitation annually, what is the largest desert in the world?

ANSWER: ANTARCTIC POLAR DESERT (Accept ANTARCTIC DESERT and equivalents.) [AG]

TOSS-UP

23) **Math – *Short Answer*** The Nastapoka Arc, a roughly circular arc in northern Canada, was once theorized to be extraplanetary in origin, although it is now thought to have been formed from lithospheric flexure. The arc opens to the Hudson Bay and creates a semicircular depression into the coastline. Given that the arc spans 160 degrees and has a radius of 225 kilometers, in kilometers in terms of pi, what is the length of this arc?

ANSWER: 200π [AG]

BONUS

23) **Math – *Multiple Choice*** For how many different whole number values of n is $n^2 - 3n + 2$ a prime number?

W) 0
X) 1
Y) 2
Z) Infinitely many

ANSWER: Y) 2 [QG]

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TOSS-UP (30 seconds)

24) **Estimation – *Short Answer*** An anonymous SHS student, for some reason, has a 2 Terabyte "homework" folder on his laptop, and wants to use fiber optics cables to download this folder onto another computer. Estimate the order of magnitude, in bytes per second, of the commercial average fiber optic data download speed.

ANSWER: 10 [AG]

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End of Questions.