2025 Bay Area Science-Estimathon Duel

Round Robin

Question Set 2

Questions will begin on the next page.

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

TOSS-UP

1) **Earth and Space – *Multiple Choice*** What type of galaxy, characterized by its defined arm structures and active star formation, includes examples such as the Milky Way?

W) Spiral
X) Elliptical
Y) Lenticular
Z) Irregular

ANSWER: W) SPIRAL [WC]

BONUS

1) **Earth and Space – *Short Answer*** While doing some astrophotography, Max notices that if he makes the exposure time too big, almost any star he tries to photograph will move and blur the image due to Earth's rotation. What star should he try to photograph so that he will not experience this problem?

ANSWER: POLARIS (accept NORTH STAR or POLE STAR[1]) [MR]

[1] As Max's location is not specified, the south pole star, Sigma Octantis, can be accepted.

TOSS-UP

2) **Physics – *Multiple Choice*** A block with mass 10 kilograms rests on a flat table. The coefficient of static friction between the block and the table is 0.5. A constant force of magnitude 20 newtons is then applied to the block for 2 seconds. In joules and to one significant figure, what is the work done on the block by the force?

W) 0
X) 3
Y) 10
Z) 20

ANSWER: W) 0 [QG]

BONUS

2) **Physics – *Short Answer*** During a 100 meter race, a sprinter accelerates at a constant rate of 4.5 meters per second squared before hitting a top speed of 9 meters per second, running at a constant speed for the rest of the race. To the nearest tenth of a second, how long does it take the sprinter to complete the race?

ANSWER: 12.1 [QG]

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TOSS-UP

3) **Y-Risk – *Short Answer*** When amino acids bond with one another, a condensation reaction occurs. What type of bond results from this reaction?

ANSWER: PEPTIDE [AG]

BONUS

3) **Y-Risk – *Multiple Choice*** Which of the following anti-knocking agents was once added to gasoline, but has since been removed for its toxicity?

W) Dimethylmercury
X) Tetraethyl lead
Y) Lead arsenate
Z) Methyl tert-butyl ether

ANSWER: X) TETRAETHYL LEAD [AG]

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TOSS-UP

4) **Math – *Short Answer*** Quinn is playing a modded Celeste level, in which a dream jump increases speed by 40 and an ultra increases speed by 20%. If his initial speed is 160 and he performs a dream jump then an ultra, what is his final speed?

ANSWER: 240 [QG]

BONUS

4) **Math – *Short Answer*** Quinn continues his tech chain. He now has a starting speed of 240, and he continues by performing three dream jumps followed by two ultras. Recalling that a dream jump increases speed by 40 and an ultra increases speed by 20%, and to the nearest integer, what is Quinn's final speed?

ANSWER: 518 [QG]

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TOSS-UP

5) **Earth and Space – *Multiple Choice*** What region of the Solar System, located between the orbits of Mars and Jupiter, contains the majority of known asteroids?

W) Kuiper Belt
X) Asteroid Belt
Y) Heliosphere
Z) Oort Cloud

ANSWER: X) ASTEROID BELT [MR]

BONUS

5) **Earth and Space – *Multiple Choice*** Orogeny, a process that usually occurs at convergent plate boundaries, refers to the creation of which of the following?

W) Lakes
X) Rivers
Y) Mountains
Z) Tectonic plates

ANSWER: Y) MOUNTAINS [AG]

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TOSS-UP

6) **Physics – *Multiple Choice*** What is the name of the smallest angle of incidence where total internal refraction occurs in a medium?

W) Reflecting angle
X) Critical angle
Y) Refracting angle
Z) Internal angle

ANSWER: X) CRITICAL ANGLE [WC]

BONUS

6) **Physics – *Multiple Choice*** If a light ray passes through a material with an index of refraction of 5/3, which of the following is closest to the critical angle?

W) 30 degrees
X) 37 degrees
Y) 53 degrees
Z) 60 degrees

ANSWER: X) 37 DEGREES [WC]

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TOSS-UP

7) **Math – *Short Answer*** Alex is investing in SHSTV stock. He buys 50 shares at 100 dollars each. If the value of SHSTV decreases by 20% then increases by 20%, what is the value, in dollars, of his stocks?

ANSWER: 4800 [AG]

BONUS

7) **Math – *Short Answer*** Arjun purchased 12 tomatoes. Little did he know, the "tomato" item was actually in packs of 6, so he had actually purchased 72 tomatoes. If he follows the fibonacci sequence by eating one tomato on the first day, one on the second, two on the third, three on the fourth and so on, on what day will he eat his final tomato?

ANSWER: NINTH [AG]

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TOSS-UP

8) **Biology – *Short Answer*** What type of alternative photosynthetic pathway, first discovered in plants of the genus *Crassula*, involves the temporal separation of different photosynthetic stages to minimize water loss?

ANSWER: CAM (accept CRASSULACEAN ACID METABOLISM) [EP]

BONUS

8) **Biology – *Short Answer*** By name or number, order the following three types of photosynthesis in order of decreasing efficiency:

1. C4
2. CAM
3. C3

ANSWER: 2, 1, 3 (accept CAM, C4, C3) [EC]

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TOSS-UP

9) **Math – *Short Answer*** A mathematician rolls a standard six-sided die. What is the probability that he rolls a prime number?

ANSWER: 1/2 [QG]

BONUS

9) **Math – *Multiple Choice*** The mathematician now rolls a pair of standard and fair six sided dice. What is the probability that the sum of values on the dice will be a prime number?

W) 5/12
X) 1/2
Y) 7/12
Z) 2/3

ANSWER: W) 5/12 [QG]

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TOSS-UP

10) **Chemistry – *Short Answer*** Identify the hybridization of the central carbon atom in hydrogen cyanide, HCN.

ANSWER: SP HYBRIDIZED [AG]

BONUS

10) **Chemistry – *Short Answer*** What is the IUPAC systematic name for Ag2Cr2O7?

ANSWER: SILVER DICHROMATE (do not accept SILVER (I) DICHROMATE) [AG]

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TOSS-UP

11) **Physics – *Multiple Choice*** What fundamental force is most responsible for the radioactive decay of atomic nuclei?

W) Strong nuclear force
X) Weak nuclear force
Y) Electromagnetic force
Z) Gravity

ANSWER: X) WEAK NUCLEAR FORCE [QG]

BONUS

11) **Physics – *Multiple Choice*** Which of the following isotopes has a half-life greater than a year?

W) Uranium-219
X) Uranium-238
Y) Neptunium-232
Z) Neptunium-244

ANSWER: X) URANIUM-238 [QG]

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TOSS-UP

12) **Biology – *Multiple Choice*** Students at Saratoga High are investigating the effects of long-term salad deprivation. While observing a subject who has reportedly never eaten a salad, they notice significantly lower levels of many vitamins, especially vitamin K. Which of the following body functions would be most affected by this deficiency?

W) Vision at night
X) Wound repair
Y) Long bone growth
Z) Blood clotting

ANSWER: Z) BLOOD CLOTTING [EP]

BONUS

12) **Biology – *Short Answer*** In a blood clot, proteins join with platelets to stop bleeding. What protein, which polymerizes into a fibrous mesh, acts to mediate this process, as well as directly reinforce the clot?

ANSWER: FIBRIN (do not accept FIBRINOGEN or THROMBIN) [EP]

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TOSS-UP

13) **Chemistry – *Short Answer*** Max is a real gas. Unfortunately, the Ideal Gas Law does not do a very good job at approximating Max's pressure under certain conditions. What equation, which accounts for the volume of the gas particles and intermolecular forces, calculates a more accurate approximation for Max's exerted pressure?

ANSWER: VAN DER WAALS EQUATION [AG]

BONUS

13) **Chemistry – *Multiple Choice*** **(Note to moderator: read chemical names letter by letter)** When Na_3PO_4 and $Fe(NO_3)_3$ are reacted in aqueous solution, what compound precipitates out?

W) $NaNO_3$
X) H_2O
Y) Na_3FeO_3
Z) $FePO_4$

ANSWER: Z) $FePO_4$ [AG]

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TOSS-UP

14) **Earth and Space – *Short Answer*** By name or number, order the following three particle types by increasing size:

1. Silt
2. Sand
3. Clay

ANSWER: 3, 1, 2 [AG]

BONUS

14) **Earth and Space – *Short Answer*** By name or number, order the following four planets by increasing percent metal composition:

1. Mercury
2. Mars
3. Jupiter
4. Neptune

ANSWER: 3, 4, 2, 1 [MR]

TOSS-UP

15) **Y-Risk – *Multiple Choice*** Students at Saratoga High School want to tour Europe, so they start by exploring London dispersion forces. Which of the following statements is false about London dispersion forces?

W) They arise due to instantaneous dipoles
X) They are present between all molecules
Y) Their strength decreases as molecular size increases
Z) They are the primary intermolecular force between noble gases

ANSWER: Y) THEIR STRENGTH DECREASES AS MOLECULAR SIZE INCREASES [MR]

BONUS

15) **Y-Risk – *Multiple Choice*** Which of the following best describes the distinction between clean energy and green energy?

W) Clean energy is carbon-neutral, while green energy is carbon-negative
X) Clean energy involves biodegradable production methods, while green energy is strictly plant-based
Y) Clean energy produces no greenhouse gas emissions, while green energy explicitly results in no environmental harm
Z) Clean energy is always renewable, while green energy is sometimes renewable

ANSWER: Y) CLEAN ENERGY PRODUCES NO GREENHOUSE GAS EMISSIONS, WHILE GREEN ENERGY EXPLICITLY RESULTS IN NO ENVIRONMENTAL HARM [AG]

TOSS-UP

16) **Physics – *Short Answer*** What equation for fluid flow states that the amount of water flowing into a point must equal the amount of water flowing out of that point?

ANSWER: CONTINUITY EQUATION [MR]

BONUS

16) **Physics – *Short Answer*** A satellite orbits a certain planet at an altitude equal to the radius of the planet at a velocity v. If the planet's radius is doubled and so satellite's orbital altitude relative to the planet surface and planet's density remains the same, what is its new velocity, in terms of v?

ANSWER: $2v$ [WC]

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TOSS-UP

17) **Math – *Multiple Choice*** Max is doing a statistics project on how much students at Saratoga High School like certain flavors of ice cream. However, he's worried that even a slight bias in selecting students to sample could lead to a heavily skewed outcome, so he decides to sample every student to avoid this. What is the name for such a procedure?

W) Super sample
X) Poll
Y) Census
Z) Sweeping survey

ANSWER: Y) CENSUS [MR]

BONUS

17) **Math – *Short Answer*** In 2030, the US Census Bureau will conduct its 25th census, which it has conducted every 10th year since 1790. Wanting to do a little mischief, Max travels back in time and changes the Constitution before it's signed to require a census every 5 years instead. When he returns back to 2025, how many years has it been since the 25th census in that timeline?

ANSWER: 115 [MR]

TOSS-UP

18) **Biology – *Multiple Choice*** Ethan is tired of sitting on the couch, and wants to go outside to name some new species. In which of the following areas would he most likely find a species unknown to science?

W) Great Barrier Reef, Australia
X) Tropical rainforest, Papua New Guinea
Y) Mangrove islands, Florida Keys
Z) Carlsbad caverns system, New Mexico

ANSWER: X) TROPICAL RAINFOREST, PAPUA NEW GUINEA[2] [EP]

BONUS

18) **Biology – *Multiple Choice*** Based on this advice, Ethan begins searching in the rainforest. If he picks up organisms at random until he discovers an unknown species, which of the following groups will most likely contain the first unknown species he finds?

W) Vertebrates
X) Invertebrates
Y) Plants
Z) Fungi

ANSWER: X) INVERTEBRATES [EP]

[2] Deny challenges to W or Y as they are explored. Accept a challenge to Z, although it will most likely be rejected due to the scarcity of actual species in the caves.

TOSS-UP

19) **Chemistry – *Multiple Choice*** Which of the following metals is diamagnetic?

W) Zinc
X) Chromium
Y) Manganese
Z) Platinum

ANSWER: W) ZINC [AG]

BONUS

19) **Chemistry – *Short Answer*** How many electrons are gained by each manganese in the redox reaction between $KMnO_4$ and solid Cu, which produces Cu^{2+} and Mn^{2+} in acidic solution?

ANSWER: 5 [AG]

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TOSS-UP

20) **Biology – *Short Answer*** Ethan is having a heated debate with a classmate about whether or not a potato is alive. By name or number, select all of the following four traits that are shared by all living organisms:

1. Ability to respond to stimuli
2. Ability to move
3. Ability to maintain homeostasis
4. Ability to reproduce

ANSWER: 1, 3, AND 4 [EP]

BONUS

20) **Biology – *Short Answer*** Science generally agrees that potatoes are living things. Potatoes belong to the kingdom Plantae, which includes all terrestrial and aquatic plants. Organisms like the sea anemone, which were once thought of as plants, are now classified as animals even though they have evolved to share many characteristics with plants. What is the term for this type of evolution, characterized by the development of similar traits and morphologies from different ancestries?

ANSWER: CONVERGENT EVOLUTION [EP]

TOSS-UP

21) **Y-Risk – *Multiple Choice*** Ever since getting a humidity sensor, Max notices that the humidity in his room fluctuates sinusoidally from a maximum of 50% around 7AM to a minimum of 40% around 7PM, with a full cycle every 24 hours. Which function accurately describes the percent humidity in Max's room as a function of t, the amount of hours since midnight on a particular day?

W) $45 + 5\cos(\pi(t-7)/12)$ [read as: 45 plus 5 times the cosine of π times in parentheses t minus 7 close parentheses divided by 12]
X) $45 + 5\sin(\pi(t+7)/12)$ [read as: 45 plus 5 times the sine of π times in parentheses t plus 7 close parentheses divided by 12]
Y) $5 + 45\cos(\pi(t-7)/12)$ [read as: 5 plus 45 times the cosine of π times in parentheses t minus 7 close parentheses divided by 12]
Z) $5 + 45\sin(\pi(t+7)/12)$ [read as: 5 plus 45 times the sine of π times in parentheses t plus 7 close parentheses divided by 12]

ANSWER: W) $45 + 5\cos(\pi(t-7)/12)$ [MR]

BONUS

21) **Y-Risk – *Multiple Choice*** Max also keeps a glass of water in his room at all times. If the temperature in his room remains relatively constant, the humidity varies as before, peaking in the morning and dipping in the evening, and Max leaves the glass of water alone, how would one expect the water level in the glass to vary with time?

W) Sinusoidally, increasing in the morning and decreasing in the evening
X) Sinusoidally, decreasing in the morning and increasing in the evening
Y) Sinusoidally decreasing, decreasing the most in the morning and decreasing the least in the evening
Z) Sinusoidally decreasing, decreasing the least in the morning and decreasing the most in the evening

ANSWER: Z) SINUSOIDALLY DECREASING, DECREASING THE LEAST IN THE MORNING AND DECREASING THE MOST IN THE EVENING [MR]

TOSS-UP

22) **Chemistry – *Multiple Choice*** Which of the following isotopes has 7 neutrons?

W) Lithium-7
X) Carbon-14
Y) Oxygen-15
Z) Neon-20

ANSWER: Y) OXYGEN-15 [QG]

BONUS

22) **Chemistry – *Short Answer*** By name or number, order the following four ground-state atoms by increasing atomic radius:

1) Fluorine
2) Oxygen
3) Sodium
4) Neon

ANSWER: 4, 1, 2, 3 [QG]

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TOSS-UP

23) **Earth and Space – *Multiple Choice*** Students at Saratoga High are examining dirt. What soil horizon, composed mostly of organic matter, is important for its ability to support life and absorb water and nutrients?

ANSWER: O HORIZON (do not accept TOPSOIL) [EP]

BONUS

23) **Earth and Space – *Short Answer*** The O horizon is notable for its composition of decaying organic materials in addition to the standard sand, silt, and clay that typically make up soil. What is the term for this organic matter, which in a natural environment is continuously formed from the remains of plants and animals?

ANSWER: HUMUS [EP]

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TOSS-UP (30 seconds)

24) **Estimation – *Short Answer*** Alex has been overwriting isotope questions. In years, estimate the order of magnitude of the longest known half-life of a radioactive isotope.

ANSWER: 24 [AG]

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End of Questions.