2025 Bay Area Science-Estimathon Duel

Round Robin

Question Set 4

Questions will begin on the next page.

© Saratoga High Science Bowl Team Members

Quick Navigation:

1. Biology	2. Physics	3. E&S	4. Chemistry	5. Physics	6. Biology
7. E&S	8. Y-Risk	9. Chemistry	10. Math	11. Chemistry	12. Biology
13. Y-Risk	14. Math	15. Biology	16. Physics	17. Math	18. Y-Risk
19. E&S	20. Math	21. Physics	22. Chemistry	23. E&S	24. Est

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

TOSS-UP

1) **Biology – *Short Answer*** Plants and fungi often inhabit the same areas, as they require each other to survive. What symbiotic relationship between a plant and a fungus involves the exchange of nutrients between fungal hyphae and plant roots?

ANSWER: MYCORRHIZAE [EP]

BONUS

1) **Biology – *Multiple Choice*** What class of plant hormones, named after a genus of parasitic plants, is responsible for the attraction of mycorrhizae as well as regulation of root and shoot branching?

W) Gibberellins
X) Auxins
Y) Jasmonates
Z) Strigolactones

ANSWER: Z) STRIGOLACTONES [EP]

IBASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

2) **Physics – *Multiple Choice*** A Wheatstone bridge is used to measure what electrical quantity?

W) Voltage
X) Current
Y) Resistance
Z) EMF

ANSWER: Y) RESISTANCE [QG]

BONUS

2) **Physics – *Short Answer*** Max is working with a Wheatstone bridge and balances it, such that the current between the midpoints of the legs is 0. The known leg contains 150 ohm and 210 ohm resistors, and the unknown leg contains a 400 ohm and unknown resistor. The 150 and 400 ohm resistors are connected to the positive terminal of the battery. What is the unknown resistance, in ohms?

ANSWER: 560 [QG]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

3) **Earth and Space – *Short Answer*** While out on a midnight walk, Max looks up and sees a twinkling, twinkling little star. This twinkling is due to what distortion effect, which occurs because of turbulence in Earth's atmosphere?

ANSWER: SEEING (accept ASTRONOMICAL SEEING) [MR]

BONUS

3) **Earth and Space – *Short Answer*** By name or number, indicate which of the following three statements are true of elliptical galaxies:

1. They are generally younger than spiral galaxies
2. They consist mostly of red stars
3. They have abundant dust and gas spread out within them

ANSWER: 2 ONLY [WC]

TOSS-UP

4) **Chemistry – *Multiple Choice*** Max is still a real gas. Under which of the following conditions would he act most like an ideal gas?

W) High temperature, high pressure
X) High temperature, low pressure
Y) Low temperature, high pressure
Z) Low temperature, low pressure

ANSWER: X) HIGH TEMPERATURE, LOW PRESSURE [AG]

BONUS

4) **Chemistry – *Short Answer*** Which of the following acid and conjugate base pairs could be used to construct a buffer?

W) HF and F^-
X) HCl and Cl^-
Y) H_2SO_4 and HSO_4^-
Z) $HClO_4$ and ClO_4^-

ANSWER: W) HF AND F^- [AG]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

5) **Physics – *Short Answer*** By name of number, name all of the following four units which are NOT SI base units:

1. Candela
2. Coulomb
3. Joule
4. Mole

ANSWER: 2 AND 3 [QG]

BONUS

5) **Physics – *Short Answer*** Max, tired of Quinn whipping out the waterfall analogy for electric potential every chance he gets, gently pushes Quinn off a waterfall 5 meters tall with a horizontal velocity of 24 meters per second. To two significant figures and in meters per second, what is Quinn's velocity when he hits the water?

ANSWER: 26 [WC]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

6) **Biology – *Short Answer*** Students at Saratoga High School are studying bacteria. What common, spherical gram-positive bacterial species, which sometimes acts as a pathogen, is known for its golden color and strains with notorious antibiotic resistance?

ANSWER: STAPHYLOCOCCUS AUREUS [EC]

BONUS

6) **Biology – *Short Answer*** The Gram stain is used to visualize many different species of bacteria, including *S. aureus*. This staining procedure takes advantage of the binding of crystal violet dye to what molecule, found in large quantities on the cell walls of gram-positive bacteria?

ANSWER: PEPTIDOGLYCAN [EP]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

7) **Earth and Space – *Multiple Choice*** Even with the best optical telescope, background space between stars and galaxies will seem completely dark. However, observing in what range of the electromagnetic spectrum will reveal a nearly uniform faint glow left by radiation left over from the Big Bang?

W) X-Ray
X) Ultraviolet
Y) Infrared
Z) Microwave

ANSWER: Z) MICROWAVE [MR]

BONUS

7) **Earth and Space – *Short Answer*** What feature, situated near the equator, consists of a semi-permanent low pressure region caused by the collision of trade winds, which results in clouds and frequent precipitation?

ANSWER: INTERTROPICAL CONVERGENCE ZONE (Accept: ITCZ) [AG]

IBASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

8) **Y-Risk – *Short Answer*** Saratoga High School students continue their tour of Europe by learning about the Paris Climate Agreement, which aims to limit the extent of human CO_2 emission. In addition to causing global warming, CO_2 contributes to what environmental issue that arises when it dissolves in ocean water?

ANSWER: OCEAN ACIDIFICATION [MR]

BONUS

8) **Y-Risk – *Short Answer*** Warren is observing a theoretical post-actinide element. What is its lowest principal energy level that can include a theoretical g orbital?

ANSWER: 5 (accept n = 5) [AG]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

9) **Chemistry – *Short Answer*** By name or number, rank the following four particles in order of increasing mass:

1. Electron
2. Proton
3. Neutron
4. Neutrino

ANSWER: 4, 1, 2, 3 (accept NEUTRINO, ELECTRON, PROTON, NEUTRON) [QG]

BONUS

9) **Chemistry – *Short Answer*** In the equilibrium for the dissolution of KNO_3 in water, to what power is exponent raised of the concentration of solid KNO_3?

W) -1
X) 1
Y) 2
Z) KNO_3 does not appear in the equilibrium expression.

ANSWER) Z: KNO_3 DOES NOT APPEAR IN THE EQUILIBRIUM EXPRESSION [AG]

TOSS-UP

10) **Math – *Short Answer*** What is the determinant of the 3x3 identity matrix?

ANSWER: 1 [WC]

BONUS

10) **Math – *Short Answer*** Calculate the determinant of the following three by three non-identity matrix:

First row: 1, 7, 3
Second row: 0, 4, -2
Third row: 0, 0, 5

ANSWER: 20 [QG]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

11) **Chemistry – *Short Answer*** Arjun is an employee of Ethan's wastewater treatment plant and needs to remove toxic heavy metals from the water. He knows that the hydroxides of these metals are highly insoluble, and that by Le Chatelier's principle, adding a strong electrolyte hydroxide will promote the precipitation of heavy metal hydroxide. What is the name of this effect?

ANSWER: COMMON ION EFFECT [AG]

BONUS

11) **Chemistry – *Short Answer*** A reaction is at equilibrium at 550 Kelvin. If the measured change in enthalpy is 20 kilojoules, what is the change in entropy, to the nearest joule per kelvin?

ANSWER: 36 [AG]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

12) **Biology – *Short Answer*** Every year, Ethan plans a two-week trip to the Hawaiian islands. However, his intentions to visit Big Island have been foiled by yet another eruption of Kilauea, which has covered a once-scenic area of brushland with barren, black lava. Should Ethan want to restore the ecosystem so he can visit the island again, what natural process should he try to accelerate, where gradual weathering allows vegetation to colonize previously devoid and barren land?

ANSWER: PRIMARY SUCCESSION [AG]

BONUS

12) **Biology – *Short Answer*** After half a year of promoting succession, Ethan observes small shrubs growing on the inconveniently placed lava rock. What term describes these organisms, which are the first to settle in the new environment?

ANSWER: PIONEER SPECIES [AG]

iBASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

13) **Y-Risk – *Short Answer*** Arjun is fascinated by rockets, so he decides to spectate a SpaceX Starship liftoff. If the rocket tilts slightly during liftoff and the airflow moves across its body at an angle, what aerodynamic force will act perpendicular to the airflow?

ANSWER: LIFT [MR]

BONUS

13) **Y-Risk – *Multiple Choice*** Ethan is enjoying a nice evening walk when he looks up and sees glowing SpaceX Starship debris. What is the primary source of the glow produced by spacecraft during atmospheric reentry?

W) Latent heat released due to the lack of cooling from the vacuum of space
X) Frictional heating of debris with colliding air molecules
Y) Extreme heating from adiabatic compression of air in front of the debris
Z) Combustion of debris material with abundant atmospheric oxygen

ANSWER: Y) EXTREME HEATING FROM ADIABATIC COMPRESSION OF AIR IN FRONT OF THE DEBRIS [MR + EP]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

14) **Math – *Short Answer*** Warren is looking through his drawer. He has 4 red socks, 6 blue socks, and 7 black socks. How many socks must he pull in order to guarantee he has a pair of each color?

ANSWER: 15 [QG]

BONUS

14) **Math – *Short Answer*** Now that Warren has his socks, he is ready to choose the rest of his outfit. He can customize 3 features: socks, shirt, jacket. He has red, blue, and black socks, green, blue, and black shirts, and blue and black jackets. How many unique outfits can he make, given that at least two features of his outfit must have matching colors?

ANSWER: 12 [QG]

BASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

15) **Biology – *Multiple Choice*** Students at Saratoga High School are studying the effects of the SIRT6 gene, a histone H3 and H4 deacetylase. Should SIRT6 activity be upregulated, how would the rate of gene transcription change in result?

W) Transcription would increase.
X) Transcription would decrease.
Y) Transcription would remain constant.
Z) Transcription would increase, and then decrease.

ANSWER: X) TRANSCRIPTION WOULD DECREASE [AG]

BONUS

15) **Biology – *Short Answer*** Further research has shown that SIRT6 expression is required to maintain proper telomeric structure. Decreased SIRT6 expression results in increased genomic instability due to a defect in what specific DNA repair pathway, which repairs double-strand breaks using a homologous sequence as a template?

ANSWER: HOMOLOGOUS RECOMBINATION [EP]

IBASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

16) **Physics – *Short Answer*** During 7th period, Max desperately wants to fall asleep, but can't unless the decibel level is 40 or less. If his teacher is currently lecturing 1.5 meters away and Max registers this as a 60 decibel sound, how far away, in meters, should he sit so he can peacefully fall asleep?

ANSWER: 15 [MR]

BONUS

16) **Physics – *Multiple Choice*** A 10 centimeter tall object is placed 20 centimeters in front of a concave mirror with a focal length of 15 centimeters. Which of the following describes the size, in centimeters, and orientation of the image?

W) 60, upright
X) 60, inverted
Y) 30, upright
Z) 30, inverted

ANSWER: Z) 30, INVERTED [QG]

IBASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

17) **Math – *Short Answer*** What is the value of $\int_{-\pi/2}^{\pi/2} x^3 \cos(x) dx$ [read as: the definite integral from negative π over 2 to π over 2 of x cubed times cosine of x dx]?

ANSWER: 0 [QG]

BONUS

17) **Math – *Short Answer*** At what point do the lines 4x + 2y = 4 and -3x + 5y = 23 intersect?

ANSWER: (-1, 4) (accept x = -1 AND y = 4) [QG]

TOSS-UP

18) **Y-Risk – *Short Answer*** Alex has a chair for his laundry. Because Alex is lazy, clean clothes pile up on the chair as the week progresses. Every weekend, he clears the chair starting from the top to the bottom. What data structure operates most similarly to Alex's laundry chair?

ANSWER: STACK [AG]

BONUS

18) **Y-Risk – *Short Answer*** Alex further observes his laundry chair, which has a capacity of 120 pieces of laundry. If laundry arrives at a rate of 20 pieces a day, and the chair starts with 40 pieces of laundry, how many times will Alex's laundry chair be cleared by the 2025th day?

ANSWER: 337 [AG]

BASED!
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

19) **Earth and Space – *Short Answer*** When Lord Kelvin estimated the age of the Earth, he accounted solely for radiative cooling. His estimate was incorrect due to what other major source of heat within Earth?

ANSWER: RADIOISOTOPE DECAY [AG]

BONUS

19) **Earth and Space – *Multiple Choice*** Arjun calls himself "hydrophobic," meaning that he is afraid of the liquid state. Which of the following effusive features would be safe for Arjun to visit, due to the expulsion of only gaseous matter?

W) Fumaroles
X) Cinder cones
Y) Geysers
Z) Cold seeps

ANSWER: W) FUMAROLES [AG]

IBASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

20) **Math – *Multiple Choice*** Warren is studying attendance for his AP Statistics class. If he notices that each student has a 90% chance to show up to class each day, and there are 30 people in his class, what distribution will result from tallying the total number of people that show up each day over many days?

W) Normal distribution
X) Binomial distribution
Y) Poisson distribution
Z) Chi-squared distribution

ANSWER: X) BINOMIAL DISTRIBUTION [WC]

BONUS

20) **Math – *Short Answer*** Warren continues to analyze the amount of students that show up for class. If now, the probability of someone showing up for class dropped to 75% and 32 students are enrolled in the class, what is the expected number of students that show up to class?

ANSWER: 24 [WC]

IBASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

21) **Physics – *Multiple Choice*** Which of the following particles has the same charge as an electron?

W) Positron
X) Photon
Y) Tau
Z) Down quark

ANSWER: Y) TAU [QG]

BONUS

21) **Physics – *Short Answer*** By name or number, indicate all of the following three particles that are bosons:

1. Gluon
2. Photon
3. Neutrino

ANSWER: 1 AND 2 [QG]

IBASED
An invitational like no other...
Logo by Blueseaturtle08

TOSS-UP

22) **Chemistry – *Multiple Choice*** Which of the following metals would give off a purple flame in a flame test?

W) Lithium
X) Sodium
Y) Potassium
Z) Rubidium

ANSWER: Y) POTASSIUM [AG]

BONUS

22) **Chemistry – *Short Answer*** **(NOTE TO MODERATOR: Read all chemical formulas letter by letter.)** When arsine gas, AsH_3, reacts with solid silver nitrate, $AgNO_3$, a double replacement reaction occurs and Ag_4AsNO_3, along with nitric acid, is formed. What is the oxidation number of As in Ag_4AsNO_3?

ANSWER: NEGATIVE THREE (do not accept THREE or POSITIVE THREE) [AG]

TOSS-UP

23) **Earth and Space – *Short Answer*** What is the term for when the Earth is closest to the Sun, the apsis which occurs roughly two weeks after the winter solstice?

ANSWER: PERIHELION [AG]

BONUS

23) **Earth and Space – *Short Answer*** What line, calculated by finding the depth at which seismic wave velocities dramatically shift as a result of rock density, is defined as the boundary between the crust and the mantle?

ANSWER: MOHOROVICIC DISCONTINUITY (accept MOHO DISCONTINUITY or MOHO) [AG]

TOSS-UP (30 seconds)

24) **Estimation – *Short Answer*** Arjun has some bubblegum made of teflon. If he stretches his bubblegum to be a single polymeric strand, then wraps it twice around the Earth's equator, estimate the mass of this strand to the nearest order of magnitude in grams.

ANSWER: -8 [AG]

BASED
An invitational like no other...
Logo by Blueseaturtle08

End of Questions.