BASH



Double Elimination 2

TOSS-UP

1. Energy *Short Answer* Students at Montgomery Blair are investigating how sperm cells mature. What cells, analogous to astrocytes in the brain, form the blood-testis barrier in order to protect developing spermatids as they enter the seminiferous tubules?

ANSWER: SERTOLI CELLS

BONUS

1. Energy *Multiple Choice* Students at Amador Valley are studying penalties due to their enjoyment of incorrectly interrupting. Which of the following loss functions combines L1 and L2 losses by applying a quadratic penalty to small errors and a linear penalty to large residuals?

W) Mean squared error
X) Hinge loss
Y) Cross-entropy
Z) Huber loss

ANSWER: Z) HUBER LOSS

TOSS-UP

2. Earth and Space *Multiple Choice* Which of the following properties of a stream increases further downstream?

W) Capacity
X) Competence
Y) Dissolved oxygen levels
Z) Channel roughness

ANSWER: W) CAPACITY

BONUS

2. Earth and Space *Multiple Choice* Rohan is baking yellowcake for Ritwik's birthday, not realizing that yellowcake is a byproduct of uranium processing. Given this, which of the following ores does his yellowcake recipe most likely call for?

W) Wolframite
X) Cassiterite
Y) Pitchblende
Z) Sphalerite

ANSWER: Y) PITCHBLENDE

TOSS-UP

3. Chemistry *Multiple Choice* Which of the following cyclohexane conformations is the least stable?

W) Boat

X) Twist-boat

Y) Half-chair

Z) Chair

ANSWER: Y) HALF-CHAIR

BONUS

3. Chemistry *Short Answer* Rohan finds an element whose electron energy levels are all 9 times that of hydrogen. What element did he most likely find?

ANSWER: LITHIUM

TOSS-UP

4. Physics *Multiple Choice* Two nuclei are called mirrors if the number of protons in one nucleus equals the number of neutrons in the other, and vice versa. Which of the following nuclei equals its own mirror?

W) Boron-9

X) Carbon-12

Y) Nitrogen-15

Z) Oxygen-18

ANSWER: X) CARBON-12

BONUS

4. Physics *Short Answer* Chris is running at a speed of 0.8 times the speed of light while watching a YouTube short. If the short lasts 30 seconds in Chris's reference frame, then in seconds, how long would someone in the lab frame observe the YouTube short to be?

ANSWER: 50

TOSS-UP

5. Math *Short Answer* Two random positive integers in the range 1 to 3 inclusive are selected, without replacement. What is the expected value of the maximum of the two positive integers?

ANSWER: 8/3

BONUS

5. Math *Short Answer* In a circle of radius 5, two parallel chords are 6 units and 8 units long. What is the maximum distance between those two chords?

ANSWER: 7

TOSS-UP

6. Biology *Multiple Choice* Under which of the following conditions would reinforcement be favored between two closely related species living in the same habitat?

W) High character displacement, high hybrid fitness

X) High character displacement, low hybrid fitness

Y) Low character displacement, high hybrid fitness

Z) Low character displacement, low hybrid fitness

ANSWER: X) HIGH CHARACTER DISPLACEMENT, LOW HYBRID FITNESS

BONUS

6. Biology *Multiple Choice* Evan adds a fluorescent tag to the inside face of a vesicle that recently budded off from the trans face of the Golgi body. After waiting for the vesicle to reach and fuse with its destination, where would he most likely find the tag?

W) Inside face of the ER membrane

X) Outside face of the ER membrane

Y) Inside face of the cell membrane

Z) Outside face of the cell membrane

ANSWER: Z) OUTSIDE FACE OF THE CELL MEMBRANE

TOSS-UP

7. Earth and Space *Short Answer* Saturn's interior is heated through the gravitational settling of liquid droplets of what element?

ANSWER: HELIUM

BONUS

7. Earth and Space *Short Answer* The Sun has an absolute magnitude of 4.8. Kian discovers a star in a neighboring galaxy with a flux 1000 times that of the sun. To two significant figures, what is the absolute magnitude of Kian's star?

ANSWER: -2.7

TOSS-UP

8. Chemistry *Multiple Choice* Yunyi has two lasers. The first emits light of wavelength 100 nm and intensity I, and the second emits light of wavelength 200 nm and intensity 2I. What is the ratio of the energy of a photon in the first laser to that of a photon in the second laser?

W) 1/4

X) 1/2

Y) 1

Z) 2

ANSWER: Z) 2

BONUS

8. Chemistry *Multiple Choice* Yunyi is electrolyzing a solution of silver (I) fluoride. Which of the following are produced at the cathode and anode, respectively?

W) Metallic silver, fluorine gas

X) Metallic silver, oxygen gas

Y) Hydrogen gas, fluorine gas

Z) Hydrogen gas, oxygen gas

ANSWER: X) METALLIC SILVER, OXYGEN GAS

TOSS-UP

9. Physics *Short Answer* Pions and kaons are both examples of what type of subatomic particle, which consists of a quark bound to an antiquark?

ANSWER: MESON

BONUS

9. Physics *Short Answer* The electric field of an electromagnetic wave is 600 volts per meter. To one significant figure and in scientific notation, what is the magnetic field of the wave in teslas?

Answer: $2 * 10^{-6}$

TOSS-UP

10. Math *Short Answer* A planar graph has 7 vertices and the sum of the degrees of the vertices is 18. How many faces does the graph contain?

ANSWER: 4

BONUS

10. Math *Short Answer* How many 4-digit integers that use the digits 1, 3, 5, and 7 exactly once are divisible by 11?

ANSWER: 8

TOSS-UP

11. Biology *Short Answer* Intrinsic factor, secreted by parietal cells in the stomach, increases the absorption of what vitamin in the ileum?

ANSWER: VITAMIN B12 (ACCEPT: COBALAMIN)

BONUS

11. Biology *Short Answer* Identify all of the following three structures in birds that are analogous structures with their human counterparts:

1) Four-chambered heart

2) Amniotic egg

3) Pelvis bone

ANSWER: 1 ONLY

TOSS-UP

12. Energy *Multiple Choice* Students at Amador Valley are touching grass and studying local valley and mountain soils. Which of the following statements is NOT true regarding soil?

W) Valley soils have better-developed horizons than mountain soils
X) Mountain soils contain more alluvium than valley soils
Y) Mountain soils are more easily eroded than valley soils
Z) Valley soils are more susceptible to overfertilization

ANSWER: X) MOUNTAIN SOILS CONTAIN MORE ALLUVIUM THAN VALLEY SOILS ESS

BONUS

12. Synergy *Short Answer* Order the following three amino acids in terms of increasing UV absorption:

1) Tyrosine
2) Tryptophan
3) Phenylalanine

ANSWER: 3, 1, 2

TOSS-UP

13. Earth and Space *Short Answer* Earth's magnetosphere traps solar wind particles in what 2 bands that envelope the planet?

ANSWER: VAN ALLEN BELTS

BONUS

13. Earth and Space *Short Answer* Identify all of the following 3 minerals that could accumulate below the carbonate compensation depth:

1) Aragonite
2) Gypsum
3) Dolomite

ANSWER: 2 ONLY

TOSS-UP

14. Chemistry *Short Answer* Yunyi is performing his daily chemical synthesis, and has synthesized a ylide in which a positively-charged nitrogen atom is adjacent to a negatively-charged carbon atom. This is an example of what broad class of neutral compounds that contain both a negative and positive charge?

ANSWER: ZWITTERIONS

BONUS

14. Chemistry *Multiple Choice* Which of the following reactions likely has the greatest positive difference between change in enthalpy and change in internal energy?

W) Decomposition of sodium nitrate
X) Precipitation of lead (II) iodide
Y) Dissolution of sodium chloride
Z) Neutralization of acetic acid and sodium hydroxide

ANSWER: W) DECOMPOSITION OF SODIUM NITRATE

TOSS-UP

15. Physics *Multiple Choice* A ball is launched horizontally off a ramp sloped at 30 degrees to the horizontal. If every collision with the ramp is perfectly elastic, which of the following best describes how the distance between successive bounces and the time between successive bounces change over time, respectively?

W) Increases, increases
X) Increases, stays the same
Y) Decreases, increases
Z) Decreases, stays the same

ANSWER: X) INCREASES, STAYS THE SAME

BONUS

15. Physics *Short Answer* Bill is biking at 5 meters per second when he passes Chris, who is at rest. If Chris starts accelerating at 5 meters per second squared after Bill the instant Bill passes him, then in meters, how far will Chris travel before he catches Bill?

ANSWER: 10

TOSS-UP

16. Math *Short Answer* Kian decides to simulate the 100 men versus 1 gorilla challenge. The men stand in a line and each man, one by one, attacks the gorilla and has a 1/3 chance of killing it and a 2/3 chance of dying. To the nearest tenth, what is the expected number of people dead until either the gorilla dies or all 100 men are dead?

ANSWER: 2.0

BONUS

16. Math *Short Answer* In a 3 by 3 grid of points, 3 points are chosen at random. What is the probability they form a non-degenerate triangle?

ANSWER: 19/21

TOSS-UP

17. Biology *Short Answer* Identify all of the following three enzymes for which oxygen is either a reactant or product:

1) RuBisCO
2) Alcohol dehydrogenase
3) Catalase

ANSWER: 1 AND 3

BONUS

17. Biology *Multiple Choice* When Yunyi's pet armadillo jumps in his swimming pool, it causes a torrential splash that floods the garden of his neighbor Kian. If Kian wanted to plant a crop whose root system is the best at preventing soil erosion, which of the following should he pick?

W) Tomatoes
X) Castor beans
Y) Roses
Z) Maize

ANSWER: Z) MAIZE

TOSS-UP

18. Earth and Space *Short Answer* The large temperature and pressure in Jupiter's atmosphere causes the liquid and gas states of atmospheric hydrogen to merge. What is the name for this phase of hydrogen?

ANSWER: SUPERCRITICAL FLUID

BONUS

18. Earth and Space *Short Answer* Order the following three layers of the Sun from innermost to outermost:

1) Tachocline
2) Photosphere
3) Chromosphere

ANSWER: 1, 2, 3

TOSS-UP

19. Chemistry *Short Answer* Katherine is observing a second-order reaction and notices that it takes 4 seconds for the sample to reach half its original concentration. How much additional time will it take for the sample to go from a half to a quarter of its original concentration?

ANSWER: 8

BONUS

19. Chemistry *Multiple Choice* Which of the following molecules has the smallest bond angle?

W) CH_4

X) CF_4

Y) NH_3

Z) NF_3

ANSWER: Z) NF_3

TOSS-UP

20. Physics *Short Answer* Order the following three types of radiation by increasing deflection in a magnetic field:

1) Alpha

2) Beta

3) Gamma

ANSWER: 3, 1, 2

BONUS

20. Physics *Short Answer* A charge is moving in uniform circular motion in the presence of a magnetic field perpendicular to its plane of orbit. If the velocity of a moving charge is doubled while the charge and magnetic field are both halved, by what factor is the radius of the charge's orbit multiplied by?

ANSWER: 8

TOSS-UP

21. Math *Short Answer* The remainder when a quadratic polynomial P is divided by x - 1 is 20. When the same polynomial P is divided by x - 2, the remainder is 21. When the same polynomial P is divided by x - 3, the remainder is 24. What is the constant term of the polynomial?

ANSWER: 21

BONUS

21. Math *Short Answer* Two fair six sided dice are rolled. Given that the sum of the faces rolled is divisible by 4, what is the probability the sum of the faces rolled is equal to 8?

ANSWER: 5/9

TOSS-UP

22. Biology *Multiple Choice* A flower that is both perfect and incomplete would most likely have which of the following genes dysfunctional?

W) A

X) B

Y) C

Z) D

ANSWER: W) A

BONUS

22. Biology *Multiple Choice* Which of the following biomes would contain plants most resistant to wildfires?

W) Chaparral

X) Tundra

Y) Temperate broadleaf forest

Z) Savannah

ANSWER: W) CHAPARRAL

TOSS-UP

23. Energy *Short Answer* Students from Montgomery Blair are looking at cool lights in the sky called blue jets. Blue jets above thunderstorm clouds occur when nitrogen is excited by a current. This current flows because the storm's electric field turns normally insulating air into a conductor. What is this phenomenon called?

ANSWER: DIELECTRIC BREAKDOWN

BONUS

23. Synergy *Short Answer* Three cylindrical copper resistors are placed in an equilateral triangle with an area of 1.7 times 10^{-4} meters squared. The length of the resistors is half of the side length of the triangle and each has volume 2 times 10^{-9} meters cubed. Assuming the resistivity of the material used to make the resistors is 3 times 10^{-5} ohm-meters, to one significant figure, what is the equivalent resistance between any two corners of the triangle?

ANSWER: 4