

TJSBT 2025

Round Robin 3

Tossup

1. Biology – *Multiple Choice* Which of the following types of speciation occur when a mountain separates two populations and prevents interbreeding?

W) Allopatric
X) Sympatric
Y) Parapatric
Z) Peripatric

Answer: W) Allopatric

Bonus

1. Biology – *Multiple Choice* Which of the following organisms produces the least amount of energy per kilogram of body mass?

W) Mouse
X) Human
Y) Kangaroo
Z) Elephant

Answer: Z) Elephant

Tossup

2. Chemistry – *Multiple Choice* Which of the following is the correct expanded electron configuration for carbon?

W) $1s^2\ 2s^1\ 2p^3$ (read as: 1-s-2, 2-s-1, 2-p-3)
X) $1s^2\ 2s^2\ 2p^2$
Y) $1s^2\ 2s^2\ 3p^2$
Z) $1s^1\ 2s^2\ 2p^3$

Answer: X) $1s^2\ 2s^2\ 2p^2$

Bonus

2. Chemistry – *Multiple Choice* Sophia is starting a fire and wants to know how many moles of o-xylene she is burning. What is the sum of the smallest integer coefficients in the balanced and complete combustion of o-xylene, which has a chemical formula of C_8H_{10}?

W) 24
X) 25
Y) 49
Z) 50

Answer: Y) 49

Tossup

3. Earth and Space – *Short Answer* At approximately 1.4 solar masses, what limit denotes the maximum mass of a white dwarf?

Answer: Chandrasekhar limit

Bonus

3. Earth and Space – *Short Answer* Rohan is standing on a planet that absorbs *200* $\frac{W}{m^2}$ of incoming solar radiation. At the surface, *50* $\frac{W}{m^2}$ is reflected and *40* $\frac{W}{m^2}$ is emitted as longwave radiation. What is the albedo of the planet's surface?

Answer: 0.2

Tossup

4. Math – *Short Answer* If x percent of 30 is equal to 60, what is 60 percent of x?

Answer: 120

Bonus

4. Math – *Short Answer* Sophia and Aaryan are sharing a pizza that is the size of a unit circle. Aaryan decides to be fair and portion the pizza equally into sectors that he denotes A, B, and C. What is the crust length of the pizza sector A if the area of sector A is 1?

Answer: 2

Tossup

5. Physics – *Short Answer* In a capacitor, what is the name of the material that resists current flow and increases the capacitor's capacitance?

Answer: Dielectric (do not accept: Insulator)

Bonus

5. Physics – *Multiple Choice* Sophia is making pizza crust using a disk-shaped piece of dough with moment of inertia I. She uses a cookie cutter with a radius half that of the dough's radius to remove a circular piece from the center. In terms of I, what is the new moment of inertia of the pizza crust after removing the center piece?

W) 1/2 I
X) 3/4 I
Y) 7/8 I
Z) 15/16 I

Answer: Z) 15/16 I

Tossup

6. Energy – *Short Answer* Students at Thomas Jefferson's Computer Systems Lab are using CUDA to speed up the runtime of their projects. CUDA is a computer application that takes advantage of the parallel nature of what hardware component for computing tasks in addition to graphics processing?

Answer: Graphics processing unit (accept: GPU)

Bonus

6. Energy – *Multiple Choice* Students at Thomas Jefferson's Biotechnology Lab are using a particular device to sterilize equipment and prevent contamination. What is the most likely identity of this device?

W) Centrifuge
X) Pipette
Y) Incubator
Z) Autoclave

Answer: Z) Autoclave

Tossup

7. Biology – *Short Answer* Sophia grows two Paramecium species and finds that both species survive when grown separately, but one species tends to outcompete the other when grown together. What ecological principle does this demonstrate, in which two species cannot coexist and one will often outcompete the other while sharing the same resources?

Answer: Competitive exclusion principle (accept: Gause's law)

Bonus

7. Biology – *Multiple Choice* Which of the following plant processes is NOT a result of ethylene?

W) Triple response
X) Fruit ripening
Y) Mycorrhizal associations
Z) Leaf senescence

Answer: Y) Mycorrhizal associations

Tossup

8. Chemistry – *Short Answer* What fundamental constant relates the energy of a photon to its frequency, and also defines the quantized nature of energy?

Answer: Planck's constant

Bonus

8. Chemistry – *Short Answer* Rishabh has a beaker of solution, but he forgot to label it. Rishabh does know however that the solution either contains Ag^{+}, Cu^{2+}, or Na^{+}. To determine which of these cations is present in his solution, Rishabh decides to react 1 mL of his solution with 1 mL of 0.1 M (read as: 0.1 molar) hydrochloric acid. If his solution is colorless, and a precipitate is formed when the acid is added, which cation is present in his solution?

Answer: Ag^{+}

Tossup

9. Earth and Space – *Multiple Choice* Which of the following is the primary driver of monsoon circulation?

W) Seasonal reversal of land-sea temperature contrasts
X) Interaction of the jet stream with mountain ranges
Y) Movement of the Intertropical Convergence Zone
Z) Equatorial winds

Answer: W) Seasonal reversal of land-sea temperature contrasts

Bonus

9. Earth and Space – *Multiple Choice* After being shrunk with a shrink ray and given a miniature boat, Alan goes sailing up a nearby mountain stream. Which of the following rocks is characteristic of a mountain stream environment?

W) Schist
X) Shale
Y) Conglomerate
Z) Siltstone

Answer: Y) Conglomerate

Tossup

10. Math – *Short Answer* What is the ceiling of $\log_5(2024)$ (read as: log base 5 of 2024)?

Answer: 5

Bonus

10. Math – *Multiple Choice* Farmer Bob has 3-legged and 5-legged animals on his farm. If there are 50 animals on the farm with a total of 176 legs, how many 3-legged animals are there?

W) 11
X) 13
Y) 37
Z) 39

Answer: Y) 37

Tossup

11. Physics – *Short Answer* What dimensionless quantity is equal to the ratio of a fluid's inertial and viscous forces and predicts a fluid's flow pattern?

Answer: Reynold's number

Bonus

11. Physics – *Short Answer* Eshaan observes two photons, where Photon A has twice the energy of photon B. Which of the following statements must be true of Photons A and B?

1) The momentum of photon A must be greater than that of photon B
2) The wavelength of photon A must be greater than that of photon B
3) The speed of photon A must be greater than that of photon B

Answer: 1 only

Halftime

Tossup

12. Energy – *Multiple Choice* Students at Thomas Jefferson's Neuroscience Lab are studying the effects of music genres on brain activity. If the students want to understand how the brain processes auditory signals, what region of the brain should they focus on?

W) Frontal lobe
X) Parietal lobe
Y) Temporal lobe
Z) Occipital lobe

Answer: Y) Temporal lobe

Bonus

12. Energy – *Multiple Choice* Student's at Thomas Jefferson's Computer Systems Lab are studying graph theory algorithms. If a student wants to find the shortest path in an unweighted graph, which of the following algorithms would be most applicable?

W) Depth-first search
X) Breadth-first search
Y) Dijkstra's algorithm (read as: Dike-struh)
Z) Floyd-Warshall algorithm

Answer: X) Breadth-first search

Tossup

13. Biology – *Multiple Choice* What is the probability that a son will inherit a sex-linked, recessive disease from his parents if his mother is currently affected by the disease but his father isn't?

W) 0%
X) 25%
Y) 50%
Z) 100%

Answer: Z) 100%

Bonus

13. Biology – *Short Answer* In another another life, Aaryan went to Mars and discovered two strange species that he named R1 and R2. By name or number, identify all of the following 3 situations that would classify as postzygotic reproductive barriers preventing interbreeding between R1 and R2:

1) Reduced fertility of R1 and R2 offspring
2) Inability for R1 sperm to fuse with R2 ova
3) Aaryan alters all R1 organisms so their fertile period does not align with that of R2

Answer: 1 only

Tossup

14. Chemistry – *Multiple Choice* Which part of the electromagnetic spectrum is associated with molecular rotational transitions?

W) Ultraviolet
X) Visible
Y) Infrared
Z) Microwave

Answer: Z) Microwave

Bonus

14. Chemistry – *Short Answer* Rishabh decides to add 16 M NH_3 into his solution of 0.1 M Ag^+ ions. Indicating charge, what is the chemical formula of the complex ion that is the product of this reaction?

Answer: $Ag[(NH_3)_2]^+$

Tossup

15. Earth and Space – *Multiple Choice* On average, which of the following types of galaxies contains the oldest stars?

W) Spiral
X) Barred spiral
Y) Elliptical
Z) Irregular

Answer: Y) Elliptical

Bonus

15. Earth and Space – *Short Answer* By name or number, order the following 4 stellar classifications in the evolution of the Sun from youngest to oldest:

1) Protostar
2) White dwarf
3) Red giant
4) Main-sequence

Answer: 1, 4, 3, 2

Tossup

16. Math – *Multiple Choice* In a Multivariable calculus class, students may only use a 3 by 5 notecard for exams. Unfortunately, Arjun forgot about this policy and brought a larger note card. As punishment, the teacher multiplies his exam score by the ratio of the area of the allowed note card to that of the area of Arjun's note card. If Arjun's score decreased from a 96% to a 60%, which of the following could be the dimensions of his notecard?

W) 3 by 6
X) 4 by 6
Y) 5 by 8
Z) 8 by 9

Answer: X) 4 by 6

Bonus

16. Math – *Short Answer* Abhi rolls 6 fair six-sided dice. What is the probability that exactly three of the numbers on the top faces of the dice are divisible by 3?

Answer: 160/729

Tossup

17. Physics – *Multiple Choice* A block of mass m is submerged in a container of liquid and held by a massless string connected to the bottom of the container. If the string is completely taut and the block is stationary and g is Earth's gravitational acceleration, which of the following best describes the buoyant force exerted on the block?

W) Less than mg
X) Greater than mg
Y) Equal to mg
Z) It depends the density of the liquid

Answer: X) Greater than mg

Bonus

17. Physics – *Short Answer* When light of a certain frequency hits a metal surface, electrons are ejected causing electromagnetic radiation to be emitted. This is an example of what effect?

Answer: Photoelectric effect

Tossup

18. Energy – *Multiple Choice* Students at Thomas Jefferson's Engineering Lab are developing their own batteries. If the energy efficiency of a battery decreases by a factor of ½ every hour, what percentage of its initial efficiency remains after 4 hours?

W) 25
X) 12.5
Y) 6.25
Z) 3.125

Answer: Y) 6.25

Bonus

18. Energy – *Short Answer* A researcher is attempting to predict the grade of cancer using a Convolutional Neural Network and wants to use a confusion matrix to summarize his results. If there are 4 different grades of cancer, what would be the dimensions of the confusion matrix?

Answer: 4 by 4

Tossup

19. Biology – *Short Answer* By name or number, order the following 3 zones of root growth from earliest to latest:

1) Zone of cell division
2) Zone of cell differentiation
3) Zone of elongation

Answer: 1, 3, 2

Bonus

19. Biology – *Multiple Choice* Which of the following neurotransmitters can induce an inhibitory postsynaptic potential?

W) Glutamate
X) Glycine
Y) GABA
Z) Dopamine

Answer: Y) GABA

Tossup

20. Chemistry – *Multiple Choice* Aaryan is titrating acetic acid, with a pKa of 4.76, with sodium hydroxide. Which of the following values is closest to the half equivalence point of the titration?

W) 2.24
X) 4.76
Y) 5.24
Z) 9.24

Answer: X) 4.76

Bonus

20. Chemistry – *Short Answer* What is the molar solubility of a binary salt with a K_{sp} value of $4 * 10^{-4}$?

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

Tossup

21. Earth and Space – *Short Answer* Avnith and Aaryan are trying to locate extrusive rocks around them for their last Geosystems project. By name or number, identify all of the following 3 rocks that are extrusive:

1) Granite
2) Diorite
3) Gabbro

Answer: None

Bonus

21. Earth and Space – *Short Answer* Rishabh the deep-sea diver is lost and has now swam himself into an ice shelf off the coast of Antarctica. By name or number, identify all of the following 3 locations Rishabh could swim to where the surface salinity of the ocean would be higher:

1) Tropic of Capricorn
2) Intertropical Convergence Zone
3) Tropic of Cancer

Answer: All

Tossup

22. Math – *Multiple Choice* What is the equation of the line perpendicular to y = 3x - 7 and passes through the point (15, 8)?

W) y = 3x - 37
X) y = 3x + 13
Y) y = -x/3 - 37
Z) y = -x/3 + 13

Answer: Z) y = -x/3 + 13

Bonus

22. Math – *Short Answer* Rohan is designing a 3D-printed spinning top for his Design & Tech class. If the top consists of a unit square revolved about its diagonal, what is the volume of the resulting solid?

Answer: $\frac{\sqrt{2}}{6}\pi$

Tossup

23. Physics – *Short Answer* The voltage between two points can be found by integrating what quantity along a path connecting those two points?

Answer: Electric field

Bonus

23. Physics – *Short Answer* Given identical and standard conditions, rank the following 3 thermodynamic processes in order of increasing work done by the gas:

1) Adiabatic expansion
2) Isobaric expansion
3) Isochoric expansion

Answer: 3, 1, 2

End of packet