

TJSBT 2025

Round Robin 1

Tossup

1. Biology – *Multiple Choice* Which of the following answer choices is a characteristic unique to prokaryotes?

W) They have only RNA
X) They lack membrane-bound organelles
Y) They are multicellular
Z) They have the ability to carry out enzyme-catalyzed reactions

Answer: X) They lack membrane-bound organelles

Bonus

1. Biology – *Short Answer* By name or number, order the following 3 types of blood vessels from lowest to highest average blood velocity in systemic circulation:

1) Capillaries
2) Arteries
3) Veins

Answer: 1, 3, 2

Tossup

2. Chemistry – *Multiple Choice* Which of the following molecules is polar?

W) CO_2
X) SF_4
Y) SF_6
Z) XeO_4

Answer: X) SF_4

Bonus

2. Chemistry – *Multiple Choice* Which of the following compounds is NOT found as a network solid?

W) Silicon dioxide
X) Boron trifluoride
Y) Boron nitride
Z) Silicon carbide

Answer: X) Boron trifluoride

Tossup

3. Earth and Space – *Multiple Choice* Which of the following geological phenomena is an example of an aeolian process?

W) Creation of U-shaped valleys from ice erosion
X) Formation of sand dunes from particle deposition
Y) Development of river deltas from sediment transport
Z) Formation of stalactites from mineral precipitation

Answer: X) Formation of sand dunes through particle deposition

Bonus

3. Earth and Space – *Short Answer* By name or number, arrange the following 3 stream sediments in chronological order of deposition as the stream's velocity slows:

1) Clay
2) Silt
3) Sand

Answer: 3, 2, 1

Tossup

4. Math – *Short Answer* What is the probability of getting more heads than tails in a series of 7 coin flips?

Answer: $\frac{1}{2}$

Bonus

4. Math – *Short Answer* What is the volume of a cube inscribed in a sphere with radius 3?

Answer: $24\sqrt{3}$

Tossup

5. Physics – *Multiple Choice* Aaryan adds ice to a cup of boiling water. The heat from the water melts the ice, and the system moves toward a state of higher entropy as the ice and water reach a uniform temperature. Which of the following laws of thermodynamics does this demonstrate?

W) Zeroth
X) First
Y) Second
Z) Third

Answer: Y) Second

Bonus

5. Physics – *Short Answer* In simplest radical form, what is the coefficient of static friction of a ramp if the greatest angle at which a box on the ramp is stationary is 30^{o} (read as: 30 degrees)?

Answer: $\frac{\sqrt{3}}{3}$

Tossup

6. Energy – *Short Answer* Students in Thomas Jefferson's Energy Systems lab are modeling adjustable airfoils for sailing keels. To optimize airfoil design, students should apply what fluid dynamics principle, which relates velocity to pressure within a fluid?

Answer: Bernoulli's principle

Bonus

6. Energy – *Multiple Choice* A student runs a linear regression analysis and finds that the R^2 (read as: R squared) value is 0.85. Which of the following is the correct interpretation of this R^2 value?

W) The correlation between the independent and dependent variable is 0.85
X) 85% of the variance in the independent variable is explained by the dependent variable
Y) 85% of the variance in the dependent variable is explained by the independent variable
Z) The regression model has an 85% accuracy in predicting new values

Answer: Y) 85% of the variance in the dependent variable is explained by the independent variable

Tossup

7. Biology – *Multiple Choice* Which of the following is an accurate descriptor of monocots?

W) Parallel leaf venation
X) Taproot system
Y) Flowers with petals in multiples of five
Z) Skinny leaves

Answer: W) Parallel leaf venation

Bonus

7. Biology – *Short Answer* After drinking alcohol, some individuals may exhibit an alcohol flush reaction, characterized by a slowly reddening face. This is caused by the buildup of what toxic byproduct produced during alcoholic fermentation?

Answer: Acetaldehyde

Tossup

8. Chemistry – *Multiple Choice* Which of the following quantities is a path function?

W) Enthalpy
X) Gibbs free energy
Y) Pressure
Z) Work

Answer: Z) Work

Bonus

8. Chemistry – *Multiple Choice* Which of the following answer choices correctly matches a compound with its molecular geometry?

W) CO_2 and trigonal planar
X) NH_3 and trigonal planar
Y) H_2O and bent
Z) SF_6 and square pyramidal

Answer: Y) H_2O and bent

Tossup

9. Earth and Space – *Short Answer* What is the only planet to exhibit spin-orbit resonance with the sun?

Answer: Mercury

Bonus

9. Earth and Space – *Multiple Choice* Rishabh is a star that has just undergone a helium flash. Which of the following describes Rishabh's subsequent trajectory on the H-R diagram?

W) Down and to the right
X) Down and to the left
Y) Up and to the right
Z) Up and to the left

Answer: X) Down and to the left

Tossup

10. Math – *Multiple Choice* If the interior angle of a regular polygon is 170º, how many sides does this polygon have?

W) 30
X) 36
Y) 48
Z) 60

Answer: X) 36

Bonus

10. Math – *Short Answer* How many digits are there in the binary representation of 11111 base 8?

Answer: 13

Tossup

11. Physics – *Multiple Choice* Which of the following is an example of positive work?

W) The work done by friction as you push a block across a floor
X) The work done by a gas when a gas undergoes isobaric expansion
Y) The work done by gravity when a ball is thrown upwards
Z) The work done by an electric field to move a proton from 20 volts to 30 volts

Answer: X) The work done by a gas when a piston undergoes isobaric expansion

Bonus

11. Physics – *Short Answer* In Wien's law, the peak wavelength emitted by a black body is proportional to what power of temperature?

Answer: -1

Halftime

Tossup

12. Energy – *Multiple Choice* Students at Thomas Jefferson's Organic Chemistry Lab are attempting to analyze the various molecules in an unknown sample, by measuring the mass-to-charge ratio. What technique are these students using?

W) Thin-layer chromatography
X) Nuclear magnetic resonance imaging
Y) Spectrophotometry
Z) Mass spectrometry

Answer: Z) Mass spectrometry

Bonus

12. Energy – *Short Answer* In object-oriented programming, what concept characterizes a subclass providing a new implementation of a method previously defined in its parent class, allowing the same method call to result in different behavior, depending on an object's actual type?

Answer: Polymorphism

Tossup

13. Biology – *Short Answer* First proposed by Francis Crick in 1957, what biological principle states that genetic information flows in one direction from DNA to RNA to protein?

Answer: Central dogma

Bonus

13. Biology – *Multiple Choice* Animals such as zebras and rhinos are most closely related to which of the following groups of mammals?

W) Carnivores
X) Cetaceans
Y) Even-toed ungulates
Z) Odd-toed ungulates

Answer: Z) Odd-toed ungulates

Tossup

14. Chemistry – *Short Answer* Lucas is in AP Chemistry hoping to figure out the half life of his reaction. To one significant figure, what is the half life, in seconds, of Lucas's first order reaction if the rate constant for the reaction is 0.0693 s^{-1} (read as inverse seconds)?

Answer: 10

Bonus

14. Chemistry – *Multiple Choice* Which of the following compounds would you expect to act as an electrophile?

W) NaOH
X) NH_3
Y) $AlCl_3$
Z) OH^- (read as: O-H minus)

Answer: Y) $AlCl_3$

Tossup

15. Earth and Space – *Short Answer* If the transit of an exoplanet leads to a 4% reduction in the star's brightness, what is the ratio of the planet's radius to the star's radius?

ANSWER: ⅕

Bonus

15. Earth and Space – *Short Answer* By name or number, order the following three rings of Saturn from innermost to outermost:

1) C ring
2) D ring
3) E ring

Answer: 2, 1, 3

Tossup

16. Math – *Short Answer* What is the sum of the possible values for the fourth term of a geometric series, if the first and third terms are 2 and 18, respectively?

Answer: 0

Bonus

16. Math – *Short Answer* An ant is on a unit cube and can only travel along its surface. What is the minimum distance it needs to travel to get from one vertex to the vertex opposite its space diagonal?

Answer: √5

Tossup

17. Physics – *Short Answer* What is the term for subatomic particles that have integer spin?

Answer: Bosons

Bonus

17. Physics – *Short Answer* Rishabh is spinning a wheel. The wheel is initially rotating counterclockwise at 5 radians per second, decelerates constantly for 2 seconds, and is now spinning clockwise at 1 radian per second. In radians, what was the magnitude of the wheel's displacement during those 2 seconds?

Answer: 4

Tossup

18. Energy – *Multiple Choice* Students at Thomas Jefferson's Biotechnology lab are searching for treatments for fungal infections. If a student incorrectly concluded that a treatment was successful, what type of statistical error has he committed?

W) Type I
X) Type II
Y) Type III
Z) Type IV

Answer: W) Type I

Bonus

18. Energy – *Multiple Choice* What dataset containing handwritten digits from 0 through 9 is commonly used to test image classification machine learning models?

W) MNIST (read as: em-nist)
X) CIFAR-10 (read as: see-far)
Y) COCO
Z) ImageNet

Answer: W) MNIST

Tossup

19. Biology – *Short Answer* After winning the lottery, the first thing Aaryan does is order three cheese pizzas and eat them all. By name or number, arrange in chronological order the following 3 steps in food processing that Aaryan's digestive system will progress through:

1) Digestion
2) Absorption
3) Ingestion

Answer: 3, 1, 2

Bonus

19. Biology – *Short Answer* In sickle cell anemia, certain individuals carrying one normal and one sickle cell allele do not suffer as much from the signs and symptoms of malaria. What is the term given to describe this phenomenon?

Answer: Heterozygote advantage

Tossup

20. Chemistry – *Short Answer* What is the name for the rule that states that every orbital in a sublevel is singly occupied before any orbital is doubly occupied?

Answer: Hund's rule

Bonus

20. Chemistry – *Short Answer* Gases A and B are placed in identical containers under the same temperature and pressure. The molar mass of gas A is 128 g/mol, while the molar mass of gas B is 4 g/mol. In simplest radical form, what is the ratio of the speed of effusion of gas B to gas A?

ANSWER: $4\sqrt{2}$

Tossup

21. Earth and Space – *Short Answer* Alan has decided to skip school and travel the world via hot air balloon. As he travels through the atmosphere, he notices that he somehow becomes warmer as he rises. By name or number, identify all of the following 3 layers of the atmosphere that Alan could be travelling in:

1) Troposphere
2) Stratosphere
3) Mesosphere

Answer: 2 only

Bonus

21. Earth and Space – *Multiple Choice* Travertine is a variety of limestone formed through the precipitation of calcium carbonate in freshwater environments. Which of the following is also a variety of limestone?

W) Dolomite
X) Chalk
Y) Gypsum
Z) Chert

Answer: X) Chalk

Tossup

22. Math – *Multiple Choice* What is the value of 2024^{2024} mod 5?

W) 1
X) 2
Y) 3
Z) 4

Answer: W) 1

Bonus

22. Math – *Short Answer* The Dallas Mavericks beat the LA Clippers 3 to 1 in a 5 game series. If the Mavericks have a ⅔ chance of beating the Clippers in a single game, and the series ends as soon as a team reaches 3 wins, what is the probability that the Mavericks won 3 to 1?

Answer: $\frac{8}{27}$

Tossup

23. Physics – *Multiple Choice* Patrick and Rishabh are driving on the highway when they suddenly slam on the brakes, causing a constant deceleration. However, Rishabh is initially traveling at twice Patrick's speed. Assuming their braking force is the same, how do Rishabh's stopping distance and time compare to Patrick?

W) It takes Rishabh twice the distance and twice as long to stop
X) It takes Rishabh twice the distance and four times as long to stop
Y) It takes Rishabh four times the distance and twice as long to stop
Z) It takes Rishabh four times the distance and four times as long to stop

Answer: Y) It takes Rishabh four times the distance and twice as long to stop

Bonus

23. Physics – *Short Answer* By name or number, identify all of the following 3 particles that are products of beta minus decay:

1) Neutrino
2) Anti-neutrino
3) Electron

Answer: 2 and 3

End of packet