

TJSBT 2025

Round Robin 2

Tossup

1. Biology – *Multiple Choice* For human cells, how many sister chromatids are in a cell during metaphase I and metaphase II of meiosis, respectively?

W) 46, 46
X) 46, 23
Y) 92, 46
Z) 92, 92

Answer: Y) 92, 46

Bonus

1. Biology – *Short Answer* By name or number, identify all of the following 3 hormones that utilize G-protein coupled receptors in their signal transmission sequence:

1) Insulin
2) Epinephrine
3) Estrogen

ANSWER: 2

Tossup

2. Chemistry – *Multiple Choice* Which of the following compounds has the highest lattice energy?

W) NaCl
X) NaBr
Y) $MgCl_2$
Z) MgO

Answer: Z) MgO

Bonus

2. Chemistry – *Short Answer* What is the hybridization of the central xenon atom in the molecule xenon tetrafluoride with a chemical formula of XeF_4?

Answer: sp^3d^2 (accept: d^2sp^3)

Tossup

3. Earth and Space – *Multiple Choice* Which of the following types of moraines is created by the merging of two glaciers?

W) Terminal
X) Lateral
Y) Medial
Z) Zonal

Answer: Y) Medial

Bonus

3. Earth and Space – *Short Answer* Rishabh is a deep-sea diver who has swum down to the ocean floor, and notices many different substances present. By name or number, identify all of the following 3 substances that would be classified as lithogenous sediments:

1) Red clay
2) Beach sand
3) Volcanic ash

Answer: All

Tossup

4. Math – *Multiple Choice* A triangle with all integer side lengths has two sides of length 100 and 101. How many possible lengths are there for the 3rd side?

W) 196
X) 197
Y) 198
Z) 199

Answer: Z) 199

Bonus

4. Math – *Short Answer* What are all of the roots of the polynomial $x^3 - 3x^2 - 4x + 12$?

Answer: -2, 2, and 3

Tossup

5. Physics – *Multiple Choice* Lucas is calculating the speed of sound. In which of the following mediums would Lucas expect the speed of sound to be the lowest?

W) Partial vacuum
X) Water
Y) Ice
Z) Aluminum

Answer: W) Partial vacuum

Bonus

5. Physics – *Short Answer* Lucas then drops a block off of a cliff with height 80 meters. In seconds and to one significant figure, how much time does the block take to reach the ground?

Answer: 4

Tossup

6. Energy – *Multiple Choice* Students at Thomas Jefferson are studying the OneR algorithm for classification. Which of the following answer choices is a disadvantage of using the OneR classification model?

W) It is computationally expensive
X) It only uses a single attribute to make decisions, which may oversimplify the model
Y) It is difficult to interpret the results
Z) It may struggle with handling large datasets

Answer: X) It only uses a single attribute to make decisions, which may oversimplify the model

Bonus

6. Energy – *Short Answer* What phenomenon occurs when distant galaxies appear distorted due to the gravitational influence of massive objects?

Answer: Gravitational lensing

Tossup

7. Biology – *Short Answer* What name is given to organisms that are the first to colonize an area after an ecological disturbance?

Answer: Pioneer species

Bonus

7. Biology – *Multiple Choice* Which of the following organisms would contain flame bulb cells in their excretory system?

W) Desert locust
X) Giant Gippsland earthworm
Y) New Zealand flatworm
Z) Blue dragon sea slug

Answer: Y) New Zealand flatworm

Tossup

8. Chemistry – *Multiple Choice* Which of the following plots would produce a linear graph for a second order reaction?

W) Concentration vs time
X) Natural logarithm of concentration vs time
Y) One over concentration vs time
Z) One over the natural logarithm of concentration vs time

Answer: Y) One over concentration vs time

Bonus

8. Chemistry – *Short Answer* Suppose photons with a kinetic energy of K are being shot at a metal with work function W, with K being less than W. In terms of K and W, what will be the energy of the electrons that are ejected?

Answer: 0

Tossup

9. Earth and Space – *Short Answer* Located on Mars, what is the name given to the largest volcano in the solar system?

Answer: Olympus Mons

Bonus

9. Earth and Space – *Short Answer* Aarushi is transferring her 6th grade Reach for the Stars knowledge to Sophia by taking her stargazing. By name or number, identify all of the following 3 constellations that Sophia could see at night from her house in Virginia during wintertime:

1) Orion
2) Canis Major
3) Sagittarius

Answer: 1, 2

Tossup

10. Math – *Multiple Choice* The standard deviation of a set of numbers is σ (read as: *sigma*) and the mean is $\bar{x}$ (read as: *x bar*). If 3 is added to every number in the set, which of the following represents the new standard deviation and mean, respectively?

W) σ, $\bar{x}$
X) 3σ, $\bar{x}$
Y) σ+3, $\bar{x}$
Z) σ, $\bar{x}$+3

Answer: Z) σ, $\bar{x}$+3

Bonus

10. Math – *Short Answer* Consider all possible triangles that can be formed by selecting three vertices of a regular decagon. What is the smallest possible angle that one of these triangles can have?

Answer: 18°

Tossup

11. Physics – *Multiple Choice* Which of the following laws in electromagnetism gives an expression for the magnetic field produced at a point in space by a segment of a current-carrying wire?

W) Gauss's law
X) Ampere's law
Y) Biot-Savart law
Z) Faraday-Lenz law of induction

Answer: Y) Biot-Savart law

Bonus

11. Physics – *Multiple Choice* Aaryan is digging a hole to the other side of the Earth. If he drops a penny through the hole, what will happen to the penny?

W) The penny will get stuck at the center of the Earth
X) The penny will get stuck between where it was dropped and the center of the Earth
Y) The penny will oscillate between the two ends of the Earth
Z) The penny will oscillate between where it was dropped and the center of the Earth

ANSWER: Y) The penny will oscillate between the two ends of the earth.

Halftime

Tossup

12. Energy – *Multiple Choice* As the number of degrees of freedom in a t-distribution approaches infinity, which of the following distributions does the t-distribution get closer and closer to?

W) Chi-square
X) Poisson (read as: pwah-son)
Y) Normal
Z) Binomial

Answer: Y) Normal

Bonus

12. Energy – *Short Answer* Students at Thomas Jefferson are studying machine learning. Patrick's machine learning model has a training accuracy of 99%, while his testing accuracy was only 63%. What phenomenon is Patrick's model experiencing?

Answer: Overfitting

Tossup

13. Biology – *Multiple Choice* Rishabh keeps getting himself into accidents where he's losing a lot of blood. Fed up, his doctor sends him to the pharmacy with an order to purchase a certain fat-soluble vitamin so he does not bleed out as frequently. Which of the following vitamins has Rishabh been ordered to purchase?

W) Vitamin A
X) Vitamin D
Y) Vitamin E
Z) Vitamin K

Answer: Z) Vitamin K

Bonus

13. Biology – *Short Answer* By name or number, order the following 4 layers of stem tissue from innermost to outermost:

1) Primary phloem
2) Secondary phloem
3) Primary xylem
4) Secondary xylem

Answer: 3, 4, 2, 1

Tossup

14. Chemistry – *Short Answer* By name or number, identify all of the following 3 changes that will cause more ammonia to be produced in the reaction $3H_2 + N_2 \rightarrow 2NH_3$ (read as: three H–2 plus N–2 yields 2 N–H–3) with a negative ΔH (delta H):

1) Increasing the temperature of the reaction
2) Adding inert helium gas to the reaction vessel
3) Increasing the pressure of the reaction vessel

Answer: 3 only

Bonus

14. Chemistry – *Multiple Choice* Which of the following terms best describes the conversion of H_2O and Cl_2 to HCl and HClO?

W) Comproportionation
X) Disproportionation
Y) Nucleophilic substitution
Z) Single replacement

ANSWER: X) Disproportionation

Tossup

15. Earth and Space – *Multiple Choice* Which of the following forces is most typical of a transform fault?

W) Shear force
X) Compressional force
Y) Extensional force
Z) Drag force

Answer: W) Shear force

Bonus

15. Earth and Space – *Multiple Choice* Which air mass serves as the primary source for Nor'easter storms that bring heavy snow and coastal flooding to the northeastern United States?

W) Continental arctic
X) Continental polar
Y) Maritime polar
Z) Maritime tropical

Answer: Y) Maritime polar

Tossup

16. Math – *Short Answer* What is csc(690°) (read as: the cosecant of 690 degrees)?

Answer: -2

Bonus

16. Math – *Short Answer* By name or number, identify all of the following 3 cross-sections that could be created when a plane intersects a cube:

1) Scalene triangle
2) Pentagon
3) Hexagon

Answer: All

Tossup

17. Physics – *Short Answer* What equation in quantum mechanics describes how the wave function of a particle changes over time?

ANSWER: Schrödinger equation

Bonus

17. Physics – *Short Answer* On planet XYZ, Sophia throws a ball straight up and it reaches a maximum height of 50 meters above Sophia. Furthermore, it takes 4 seconds for the ball to land back in Sophia's hand. To the nearest meter per second squared, what is the magnitude of the acceleration due to gravity on XYZ?

ANSWER: 25 m/s^2

Tossup

18. Energy – *Multiple Choice* Students at Thomas Jefferson's Quantum Lab are studying Shor's algorithm. Shor's algorithm has the potential to crack what encryption method, relying on the difficulty of factoring large prime numbers?

W) Symmetric encryption
X) ECC encryption
Y) RSA encryption
Z) Blowfish encryption

Answer: Y) RSA encryption

Bonus

18. Energy – *Short Answer* Students at Thomas Jefferson's Geosystems Lab are studying biomes. By name or number, identify all of the following 3 biomes for which the average temperature difference between winter and summer is greater than 10° C:

1) Tropical rainforest
2) Desert
3) Chaparral

Answer: 2, 3

Tossup

19. Biology – *Multiple Choice* Eshaan is working with a model cell and plans to reinforce its cell wall by adding structural polysaccharides. Which of the following is NOT a structural polysaccharide?

W) Cellulose
X) Chitin
Y) Peptidoglycan
Z) Glycogen

Answer: Z) Glycogen

Bonus

19. Biology – *Multiple Choice* If the body detects certain genetic abnormalities within a cell, it may arrest the cell at a certain phase in its life cycle. If a cell fails to replicate its chromosomes, during what stage of the cell cycle will it become arrested?

W) G1
X) G2
Y) M
Z) S

Answer: W) G1

Tossup

20. Chemistry – *Multiple Choice* Which of the following silver salts is the most soluble in water?

W) Silver iodide
X) Silver bromide
Y) Silver chloride
Z) Silver fluoride

Answer: Z) Silver fluoride

Bonus

20. Chemistry – *Short Answer* To one significant figure, what is the pH of a solution of a binary acid with pKa of 4 and a concentration of 10^{-2} M [read as molar]?

ANSWER: 3.0

Tossup

21. Earth and Space – *Multiple Choice* Which of the following prevents a white dwarf from collapsing?

W) Nuclear fusion
X) Electron degeneracy pressure
Y) Neutron degeneracy pressure
Z) Electromagnetic radiation

Answer: X) Electron degeneracy pressure

Bonus

21. Earth and Space – *Short Answer* Rishabh is a star on the H-R diagram and is hoping to live forever. Which type of star should Rishabh hope to emulate, as it has the longest main-sequence lifetime?

Answer: Type-M (accept: Red dwarf)

Tossup

22. Math – *Multiple Choice* Alan writes the positive integers 1 through 100 on a chalkboard. He first erases all the perfect squares. Then, he erases all the perfect cubes. After this process, how many numbers are left?

W) 87
X) 88
Y) 89
Z) 90

Answer: X) 88

Bonus

22. Math – *Multiple Choice* In base 10 representation, how many trailing zeros does 200! (read as: 200 factorial) have?

W) 45
X) 47
Y) 49
Z) 51

Answer: Y) 49

Tossup

23. Physics – *Short Answer* For an object spinning about a fixed axis, the object's torque is equal to the time derivative of what quantity?

ANSWER: Angular momentum

Bonus

23. Physics – *Short Answer* A 4 coulomb particle is moving at 5 meters per second at an angle of 30° with a uniform magnetic field with field strength 1.2 teslas. In newtons, what is the magnitude of the magnetic force acting on the object?

Answer: 12

End of packet