

TJSBT 2025

Round Robin 5

Tossup

1. Biology – *Short Answer* Discovered by Barbara McClintock in 1979, what is the name given to segments of DNA that can change its position within the genome?

Answer: Transposon (accept: retrotransposon)

Bonus

1. Biology – *Short Answer* By name or number, identify all of the following 3 processes where substrate-level phosphorylation is the main source of ATP generation:

1) Glycolysis
2) Light reactions
3) Oxidative phosphorylation

Answer: 1 only

Tossup

2. Chemistry – *Short Answer* What is the average bond order for the oxygen-oxygen bonds in ozone?

Answer: 1.5 (accept: 3/2)

Bonus

2. Chemistry – *Short Answer* How many sigma and pi bonds, respectively, are there in the alkyne with the chemical formula C_6H_{10}?

Answer: 15, 2

Tossup

3. Earth and Space – *Short Answer* By name or number, rank the following 3 gases in order of increasing concentration in Neptune's atmosphere:

1) Hydrogen
2) Helium
3) Methane

Answer: 3, 2, 1

Bonus

3. Earth and Space – *Short Answer* What is the name for the region in a gravitational system such as a binary star system or a planet–satellite system where mass transfer occurs if one object exceeds its gravitational boundary?

Answer: Roche lobe (do not accept: Roche limit)

Tossup

4. Math – *Short Answer* How many ways are there to arrange the letters in ‘TJHSST’?

Answer: 180

Bonus

4. Math – *Short Answer* Avnith takes 60 seconds to complete one lap, while Alan takes 75 seconds. Rounded to the nearest second if they start at the same time but run in opposite directions around a track, how long will it take for them to meet?

Answer: 33

Tossup

5. Physics – *Multiple Choice* A car and a truck with greater mass are moving towards each other on a highway. If the car and truck suddenly collide, which vehicle will experience the greater impulse?

W) The car
X) The truck
Y) Both will experience the same impulse
Z) It is impossible to tell without knowing the initial speeds of the vehicles

Answer: Y) Both will experience the same impulse

Bonus

5. Physics – *Multiple Choice* How many possible distinct spectral lines can be produced when an electron in a hydrogen atom falls from the fourth energy level to the ground state?

W) 4
X) 6
Y) 8
Z) 10

Answer: X) 6

Tossup

6. Energy – *Multiple Choice* A programmer is debugging a function that takes an input string and returns whether it is a palindrome. However, the function is incorrectly modifying the original string instead of creating a new copy. Which of the following answer choices best characterizes this issue?

W) The implementation of recursion is incorrect
X) The function is not handling edge cases
Y) The function is returning the wrong data type
Z) The function has side effects due to mutability

Answer: Z) The function has side effects due to mutability

Bonus

6. Energy – *Short Answer* Students at Thomas Jefferson's Engineering Lab are studying levers to optimize the efficiency of energy systems. By name or number, identify all of the following 3 levers in which the direction of the input force is opposite the movement of the load:

1) Class I
2) Class II
3) Class III

Answer: 1

Tossup

7. Biology – *Short Answer* What term describes the rapid propagation of action potentials down an axon between consecutive nodes of Ranvier?

Answer: Saltatory conduction

Bonus

7. Biology – *Short Answer* By name or number, order the following 3 plant tissue types by their relative flexibility, from most to least flexible:

1) Parenchyma
2) Sclerenchyma
3) Collenchyma

Answer: 1, 3, 2

Tossup

8. Chemistry – *Multiple Choice* Which of the following is the best reason for why dimethyl ether has a lower boiling than ethanol?

W) Dimethyl ether has weaker London dispersion forces
X) Dimethyl ether can participate in hydrogen bonding, while ethanol can not
Y) Dimethyl ether can not participate in hydrogen bonding, while ethanol can
Z) Dimethyl ether has stronger ionic bonds than ethanol

Answer: Y) Dimethyl ether can not participate in hydrogen bonding, while ethanol can

Bonus

8. Chemistry – *Short Answer* By name or number, rank the following 3 compounds in order of increasing electrophilicity.

1) AlF_3
2) $AlCl_3$
3) $AlBr_3$

Answer: 3, 2, 1

Tossup

9. Earth and Space – *Short Answer* What term describes the volume of water passing a river per unit time?

Answer: Discharge

Bonus

9. Earth and Space – *Multiple Choice* Which of the following types of material will lead to the formation of a trellis drainage pattern?

W) Highly jointed bedrock
X) Relatively uniform bedrock
Y) Dissected bedrock
Z) Alternating areas of resistant and weak bedrock

Answer: Z) Alternating areas of resistant and weak bedrock

Tossup

10. Math – *Multiple Choice* Chris observes that it always rains during his math test, and whenever it rains he is sad. Which of the following statements is necessarily true based on this information?

W) If there is no math test, it is not raining
X) If it is not raining, Chris is not sad
Y) If there is no math test, Chris is not sad
Z) If Chris is not sad, there is no math test

Answer: Z) If Chris is not sad, there is no math test

Bonus

10. Math – *Short Answer* What is the coefficient of the x^3y term in the expansion of $(2x+3y)^4$?

Answer: 96

Tossup

11. Physics – *Multiple Choice* Josh places two charges of charge +4q and +q at the origin and x=3, respectively. At what position along the line can a test charge be placed such that the net force on that test charge is zero?

W) x = 0.5
X) x = 1
Y) x= 2
Z) x = 3

Answer: Y) x = 2

Bonus

11. Physics – *Short Answer* What principle states that every point on a wavefront acts as a source of secondary wavefronts?

Answer: Huygens' principle

Halftime

Tossup

12. Energy – *Multiple Choice* Students at Thomas Jefferson's Engineering Lab are using the Mond process to produce an important component of many types of batteries. What element is produced through the Mond process?

W) Nickel
X) Aluminum
Y) Copper
Z) Iron

Answer: W) Nickel

Bonus

12. Energy – *Multiple Choice* Students at Thomas Jefferson's Mobile and Web Applications Lab are using the programming language SQL for part of the backend of their applications. For which of the following purposes are they most likely using SQL?

W) Storing and retrieving user account details from a database
X) Designing the user interface of their application
Y) Testing their application
Z) Encryption of network communications

Answer: W) Storing and retrieving user account details from a database

Tossup

13. Biology – *Multiple Choice* Which of the following dispersion patterns would be most common amongst dandelions scattered by the wind?

W) Clumped
X) Uniform
Y) Random
Z) Sporadic

Answer: Y) Random

Bonus

13. Biology – *Short Answer* Aaryan decides to reconnect with nature and go on a hike, where he stumbles across a plant with an egg cell containing 12 chromosomes. How many chromosomes does the plant's endosperm have?

Answer: 36

Tossup

14. Chemistry – *Short Answer* What law states that if two elements form more than one compound, the masses of one element that combine with a fixed mass of the other element are in a ratio of small whole numbers?

Answer: Dalton's law of multiple proportions (accept: Law of multiple proportions)

Bonus

14. Chemistry – *Multiple Choice* Which of the following reactions across a double bond will result in an alkane?

W) Hydration
X) Hydrogenation
Y) Dehydration
Z) Combustion

Answer: X) Hydrogenation

Tossup

15. Earth and Space – *Short Answer* By name or number, arrange the following three mineral groups in Bowen's reaction series from first to last in order of crystallization:

1) Olivine
2) Quartz
3) Pyroxene

Answer: 1, 3, 2

Bonus

15. Earth and Space – *Multiple Choice* Which of the following is true regarding the differences between sleet and freezing rain?

W) Sleet tends to crystallize into a spherical shape, while freezing rain remains an amorphous liquid during precipitation
X) Sleet tends to fall at an occluded front, while freezing rain tends to fall at the head of a cold front
Y) Sleet is partially melted snow that refreezes before reaching the ground, while freezing rain is partially melted snow that refreezes upon touching the ground
Z) Sleet is partially melted hail, while freezing rain is partially frozen rain

Answer: Y) Sleet is partially melted snow that refreezes before reaching the ground, while freezing rain is partially melted snow that refreezes upon touching the ground

Tossup

16. Math – *Short Answer* What is the determinant of a 2 by 2 matrix with first row 0 and 9 and second row 3 and 2?

Answer: -27

Bonus

16. Math – *Short Answer* What is the area of the region in the first quadrant that is bounded by the x-axis, y-axis, and the lines $2x + y = 12$ and $x + 2y = 12$?

Answer: 24

Tossup

17. Physics – *Short Answer* What is the ratio of the root mean square speed of a gas held at 600 K to the same gas in an identical container held at 200 K?

Answer: $\sqrt{3}$

Bonus

17. Physics – *Multiple Choice* A 5 kg cat is standing on scale while riding down on an elevator. What would the scale read during the elevator ride?

W) Always greater than 5 kg
X) Always less than 5 kg
Y) Less than 5 kg at the start and greater than 5 kg at the end
Z) Greater than 5 kg at the start and less than 5 kg at the end

Answer: Y) Less than 5 kg at the start and greater than 5 kg at the end

Tossup

18. Energy – *Multiple Choice* Students at Thomas Jefferson's Computer System Lab are using recursion in a wide variety of problems. In which of the following situations would recursion be least applicable?

W) Traversal of a binary tree
X) Computing the factorial of a number
Y) Finding the greatest common divisor using the Euclidean algorithm
Z) Finding the maximum element in a set

Answer: Z) Finding the maximum element in a set

Bonus

18. Energy – *Short Answer* A researcher is conducting a survey on student study habits but only collects responses from students who voluntarily choose to participate. By name or number, identify all of the following 3 types of bias that could affect the researcher's results:

1) Non-response bias
2) Volunteer bias
3) Confirmation bias

Answer: 1, 2

Tossup

19. Biology – *Multiple Choice* Which of the following structures in a leaf is primarily responsible for controlling gas exchange?

W) Palisade mesophyll
X) Spongy mesophyll
Y) Stomata
Z) Xylem

Answer: Y) Stomata

Bonus

19. Biology – *Short Answer* By name or number, arrange the following 3 structures within the kidney in the order that filtrate will flow through:

1) Proximal convoluted tubule
2) Loop of Henle
3) Bowman's capsule

Answer: 3, 1, 2

Tossup

20. Chemistry – *Short Answer* By name or number, identify all of the following 3 acids that are diprotic:

1) Sulfurous acid
2) Sulfuric acid
3) Arsenic acid

Answer: 1, 2

Bonus

20. Chemistry – *Short Answer* What is the empirical formula for the acid anhydride form of sulfuric acid?

Answer: SO_3

Tossup

21. Earth and Space – *Multiple Choice* In a rock layer, a dike is usually younger than the surrounding strata. Which of the following geologic principles does this demonstrate?

W) Law of inclusions
X) Law of original horizontality
Y) Law of cross-cutting relationships
Z) Law of dikes

Answer: Y) Law of cross-cutting relationships

Bonus

21. Earth and Space – *Multiple Choice* During a sunny afternoon on a beach, which of the following best describes the temperature of the beach relative to the sea and wind direction, respectively?

W) Colder than the sea, towards the sea
X) Warmer than the sea, towards the sea
Y) Colder than the sea, towards the beach
Z) Warmer than the sea, towards the beach

Answer: Z) Warmer than the sea, towards the beach

Tossup

22. Math – *Multiple Choice* Which of the following values is the average rate of change of the function $f(x) = \sin(x)$ over the interval $[-\pi/2, \pi/2]$?

W) $-2/\pi$
X) 0
Y) $1/\pi$
Z) $2/\pi$

Answer: Z) $2/\pi$

Bonus

22. Math – *Short Answer* If the value of a number subtracted by its reciprocal is 8/3, what is the value of this number plus its reciprocal?

Answer: 10/3

Tossup

23. Physics – *Short Answer* What fundamental force is responsible for binding quarks together in the nucleus?

Answer: Strong force

Bonus

23. Physics – *Short Answer* By name or number, rank the following 3 materials in terms of increasing ability to become magnetized:

1) Ferromagnetic
2) Paramagnetic
3) Diamagnetic

Answer: 3, 2, 1

End of packet