

# 2025 Texas Science Bowl Invitational

## Round Robin 4



## Authors

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### TOSS UP

1) MATH *Multiple Choice* Which of the following quadratic equations have no real solutions?

W)  $x^2 + 5x + 3$

X)  $x^2 - 2x - 2$

Y)  $x^2 + 3x + 4$

Z)  $x^2 - x - 8$

ANSWER: Y)  $x^2 + 3x + 4$

### BONUS

1) MATH *Short Answer* How many ways are there to misspell the word "receive" using exactly the letters that appear in "receive"?

ANSWER: 839

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### TOSS UP

2) BIOLOGY *Short Answer* Order the following three processes by increasing CO<sub>2</sub> production if one molecule of glucose is inputted at the beginning of cellular respiration:

1) Pyruvate oxidation

2) Glycolysis

3) Krebs cycle

ANSWER: 2, 1, 3

### BONUS

2) BIOLOGY *Short Answer* Identify all of the following three colors of light that are better absorbed by carotenoids than Chlorophyll A:

1) Purple

2) Green

3) Red

ANSWER: 2 only

### TOSS UP

3) EARTH AND SPACE *Short Answer* Order the following three stars in terms of increasing surface temperatures:

- 1) The Sun
- 2) Sirius
- 3) Betelgeuse

ANSWER: 3, 1, 2

### BONUS

3) EARTH AND SPACE *Short Answer* Identify all of the following three statements that are true regarding gravitational waves:

- 1) They travel at the speed of light
- 2) They are released by neutron star mergers
- 3) They are detected by the LIGO observatory

ANSWER: All

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### TOSS UP

4) PHYSICS *Short Answer* Torricelli's Law can be derived from the application of what principle in fluid dynamics, which states that an increase in a fluid's speed results in a simultaneous decrease in height or pressure, and has an equation that was derived by Leonhard Euler?

ANSWER: Bernoulli's Principle [DO NOT ACCEPT: Bernoulli's Equation]

### BONUS

4) PHYSICS *Multiple Choice* A block of mass  $m$  is released from rest at the top of a frictionless ramp, 10 meters off the ground. Which condition maximizes the speed at the bottom of the ramp?

- W) Using a block of mass  $m/3$
- X) Using a block of mass  $2m$
- Y) Giving the block an initial speed of 8 meters per second
- Z) Using a ramp of height 15 meters instead of 10 meters

ANSWER: Z) Using a ramp of height 15 meters instead of 10 meters

### TOSS UP

5) CHEMISTRY *Short Answer* In atomic orbitals, what is the term for a region where the probability of finding an electron is zero?

ANSWER: Node

### BONUS

5) CHEMISTRY *Short Answer* How many radial nodes does a 4f orbital have?

ANSWER: 0

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### TOSS UP

6) MATH *Multiple Choice* What is the contrapositive of the statement "If an integer is odd, then it is prime"?

- W) If an integer is not odd, then it is not prime
- X) If an integer is not prime, then it is not odd
- Y) If an integer is prime, then it is odd
- Z) If an integer is not prime, then it is odd

ANSWER: X) If an integer is not prime, then it is not odd

### BONUS

6) MATH *Multiple Choice* Mark is playing a game on a chalkboard. Initially, he wrote the number  $X$ . In one step, he will erase  $X$ , then replace it with  $X - 1$  if  $X$  is odd or  $X/2$  if  $X$  is even. Which of the following numbers will take the fewest number of steps to reach 0?

- W) 7
- X) 8
- Y) 9
- Z) 10

ANSWER: X) 8

### TOSS UP

7) BIOLOGY *Short Answer* A spliceosome is made of snRNA and protein subunits with the snRNA catalyzing the mRNA splicing. What is the name of this general class of RNAs that function in catalyzing chemical reactions?

ANSWER: Ribozymes

### BONUS

7) BIOLOGY *Multiple Choice* Identify all of the following three taxonomic groups that contain chemoautotrophic organisms:

- 1) Cyanobacteria
- 2) Purple-sulfur bacteria
- 3) Methanogens

ANSWER: 2 and 3 only

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### TOSS UP

8) EARTH AND SPACE *Short Answer* Which of the following types of lava forms underwater?

- W) A'a
- X) Pahoehoe
- Y) Pillow lava
- Z) Blocky lava

ANSWER: Y) Pillow lava

### BONUS

8) EARTH AND SPACE *Short Answer* Order the following three cloud types in order of increasing elevation:

- 1) Altostratus
- 2) Cirrocumulus
- 3) Stratocumulus

ANSWER: 3, 1, 2

### TOSS UP

9) PHYSICS *Multiple Choice* If the ends of a standing wave are fixed, how many nodes does the  $n$ th normal mode have?

- W)  $n - 1$
- X)  $n$
- Y)  $n + 1$
- Z)  $n + 2$

ANSWER: Y)  $n + 1$

### BONUS

9) PHYSICS *Multiple Choice* A set of objects all sit at the top of a ramp, and are let go at the same time to roll down. All objects have the same mass and radius. If the surface has some friction, which object will reach the bottom first?

- W) Thin hoop
- X) Hollow sphere
- Y) Solid sphere
- Z) Solid cylinder

ANSWER: Y) Solid sphere

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### TOSS UP

10) CHEMISTRY *Short Answer* What analytical technique is used to determine the molecular mass of a compound by ionizing chemical species and sorting the ions based on their mass-to-charge ratio?

ANSWER: Mass Spectrometry

### BONUS

10) CHEMISTRY *Short Answer* What is the name of the most stable three-dimensional conformation of cyclohexane, characterized by minimal torsional strain?

ANSWER: Chair

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### TOSS UP

11) MATH *Short Answer* Let  $ABCDEF$  be a regular hexagon. What is the ratio of the length of  $AC$  to  $AD$ ?

ANSWER:  $\frac{\sqrt{3}}{2}$

### BONUS

11) MATH *Short Answer* What is the inverse of the function  $f(x) = x^2 - 6x + 9$  when the domain is non-negative real numbers?

ANSWER:  $\sqrt{x} + 3$

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### TOSS UP

12) BIOLOGY *Short Answer* What is the term for the phenomenon in which a pair of chromosomes fails to separate during cell division?

ANSWER: Nondisjunction

### BONUS

12) BIOLOGY *Multiple Choice* Which cortical lobe contains Wernicke's area?

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

ANSWER: Y) Temporal lobe

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### TOSS UP

13) EARTH AND SPACE *Short Answer* Anvil clouds maintain their flat top shape due to a thermal inversion at what atmospheric boundary?

ANSWER: Tropopause

### BONUS

13) EARTH AND SPACE *Multiple Choice* Which of the following is closest to the period, in Earth years, of an asteroid in the asteroid belt with a semi-major axis of 3 AU?

W) 4.4

X) 4.8

Y) 5.2

Z) 5.6

ANSWER: Y) 5.2

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### TOSS UP

14) PHYSICS *Multiple Choice* What is not true about ferromagnetic materials?

W) They all have a permanent magnetic dipole

X) They all display magnetic hysteresis

Y) They all tend to lose ferromagnetic properties at high temperatures

Z) They all tend to lose ferromagnetic properties at low temperatures

ANSWER: Z) They all tend to lose ferromagnetic properties at low temperatures

### BONUS

14) PHYSICS *Short Answer* Two points with charges  $+q$  and  $+2q$  are placed a distance  $d$  apart. If they are pulled away from each other to make their distance  $2d$ , the work performed is  $E$ . If they are instead pushed together to make their distance  $0.5d$ , what is the work performed?

ANSWER:  $-2E$



### TOSS UP

15) CHEMISTRY *Short Answer* Which of the following ions has the largest atomic radius?

W)  $\text{O}^{2-}$

X)  $\text{F}^-$

Y)  $\text{Na}^+$

Z)  $\text{Mg}^{2+}$

ANSWER: W)  $\text{O}^{2-}$

### BONUS

15) CHEMISTRY *Short Answer* A certain liquid has a heat of vaporization of 40 kJ/mol and a normal boiling point of 127 degrees Celsius. To the nearest integer, what is the entropy change for the vaporization of this liquid?

ANSWER: 100

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### TOSS UP

16) MATH *Multiple Choice* What is the least common multiple between the 6th and 7th Fibonacci numbers?

- W) 40
- X) 104
- Y) 273
- Z) 714

ANSWER: X) 104

### BONUS

16) MATH *Multiple Choice* Consider 2 independent events, A and B. The probability of A happening is 0.6 and the probability of B happening is 0.4. What is the probability of A or B happening, but not both?

- W) 0.24
- X) 0.50
- Y) 0.52
- Z) 0.76

ANSWER: Y) 0.52

### TOSS UP

17) BIOLOGY *Short Answer* When helicase unwinds the DNA double helix, the untwisting causes tighter twisting and strain ahead of the replication fork. What enzyme relieves this strain by breaking and rejoining the DNA strands?

ANSWER: Topoisomerase

### BONUS

17) BIOLOGY *Short Answer* Identify all of the three DNA sequences that are usually methylated:

- 1) Centromere of a chromosome
- 2) Barr body
- 3) Promoter region of an essential gene

ANSWER: 1 and 2 only

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### TOSS UP

18) EARTH AND SPACE *Short Answer* Order the following three components of the universe in order of increasing percentage by composition:

- 1) Dark matter
- 2) Dark energy
- 3) Baryonic matter

ANSWER: 3, 1, 2

### BONUS

18) EARTH AND SPACE *Multiple Choice* Which of the following types of tides can only occur when the moon is in the first or third quarter?

- W) Spring tide
- X) Neap tide
- Y) Diurnal tide
- Z) Semidiurnal tide

ANSWER: X) Neap tide

### TOSS UP

19) PHYSICS *Short Answer* Which of the following statements about the collision between 2 objects in an isolated system is always true?

- W) Momentum will always be conserved
- X) If the objects stick together, kinetic energy is conserved
- Y) The objects will always move in opposite directions after the collision
- Z) If an object flips direction, it will move slower after colliding

ANSWER: W) Momentum will always be conserved

### BONUS

19) PHYSICS *Multiple Choice* A square loop with side length 50 cm lies on the x-y plane. A magnetic field flowing through the loop goes in the -z direction, and increases from 3 Teslas to 6 Teslas in 1.5 seconds. What is the average induced EMF in Volts, and in what direction will the current travel?

- W) 0.5, counterclockwise
- X) 0.5, clockwise
- Y) 2, counterclockwise
- Z) 2, clockwise

ANSWER: W) 0.5, counterclockwise

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### TOSS UP

20) CHEMISTRY *Short Answer* Aidan dissolves a compound in water and dips a wooden splint into the solution, which is then placed in a flame. The flame glows yellow. Which metal is likely present in the compound?

ANSWER: Sodium

### BONUS

20) CHEMISTRY *Short Answer* Rank the following 3 elements in increasing electron affinity:

- 1) Fluorine
- 2) Chlorine
- 3) Bromine

ANSWER: 3, 1, 2

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