2025 Texas Science Bowl Invitational

Round Robin 5

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TOSS UP

1) CHEMISTRY *Short Answer*   For a reaction with the rate law Rate = k[NO]^2[Cl] [READ: *rate equals k times the concentration of N-O squared times the concentration of Cl*], what is the overall order of the reaction?

ANSWER: 3

BONUS

1) CHEMISTRY *Short Answer*   What is the IUPAC name of the compound with the molecular formula CH_3CH_2COOH?

ANSWER: Propanoic Acid [ACCEPT: Butyric acid, Propionic acid]

TOSS UP

2) MATH *Multiple Choice*   Goldbach's Conjecture states that every even number greater than 2 can be written as the sum of 2 primes. Which of the following would disprove Goldbach's Conjecture?

  W) An odd number greater than 2 that can be written as the sum of 2 primes.
  X) An odd number greater than 2 that cannot be written as the sum of 2 primes.
  Y) An even number greater than 2 that can be written as the sum of 2 primes.
  Z) An even number greater than 2 that cannot be written as the sum of 2 primes.

ANSWER: Z) An even number greater than 2 that cannot be written as the sum of 2 primes

BONUS

2) MATH *Multiple Choice*   What is the average value of sin x from x = 0 to x = π?

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

ANSWER: Y) $2/\pi$

TOSS UP

3) PHYSICS *Short Answer*   Daniel looks into a clear liquid with refractive index 1.4. He sees a block that appears to be 7 meters below the surface. In meters, what is the actual depth?

ANSWER: 9.8

BONUS

3) PHYSICS *Short Answer*   A general traveling wave solution takes the form $A\cos(\omega t - kx - \phi)$ [READ: *A times cosine left parenthesis omega times t minus k times x minus phi close parenthesis*]. Identify all the constants that are determined by initial conditions.

1) A
2) ω [*omega*]
3) ϕ [*phi*]

ANSWER: 1 and 3 only

TOSS UP

4) EARTH AND SPACE *Multiple Choice*   Which of the following constellations does not lie on the ecliptic?

W) Aries
X) Orion
Y) Virgo
Z) Libra

ANSWER: X) Orion

BONUS

4) EARTH AND SPACE *Short Answer*   Identify all of the following statements that are true regarding lunar maria:

1) They are predominantly mafic
2) They have a higher albedo than the lunar highlands
3) They are formed from volcanic activity

ANSWER: 1 and 3 only

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5) BIOLOGY *Short Answer*   When placed inside a hypotonic environment, plant cells rarely undergo lysis because their cell walls exert what kind of force that pushes back on the cell to oppose further water intake?

ANSWER: Turgor pressure

BONUS

5) BIOLOGY *Short Answer*   Order the following three phyla by increasing number of embryonic germ layers:

1) Echinodermata
2) Porifera
3) Cnidaria

ANSWER: 2, 3, 1

TOSS UP

6) CHEMISTRY *Multiple Choice*   Which of the following metals exhibits the strongest inert-pair effect?

W) Silicon
X) Germanium
Y) Tin
Z) Lead

ANSWER: Z) Lead

BONUS

6) CHEMISTRY *Short Answer*   A vessel initially filled with Helium gas has a small hole through which the gas effuses. If the helium gas is replaced by sulfur dioxide by what factor will the rate of effusion be multiplied by?

ANSWER: 1/4

TOSS UP

7) MATH *Multiple Choice*   Which of the following is not a solution to the inequality $2y > -x + 3$ [READ: *two y is greater than negative x plus 3*]?

  W) $(1, 1)$
  X) $(-1, 3)$
  Y) $(-2, 5)$
  Z) $(0, 2)$

ANSWER: W) $(1, 1)$

BONUS

7) MATH *Short Answer*   How many ways are there to color a 2 by 2 chessboard with black and white tiles if rotations and reflections are considered to be the same?

ANSWER: 6

TOSS UP

8) PHYSICS *Short Answer*   A block begins at rest, and accelerates uniformly at a rate of 16 meters per second squared. How many seconds does it take to achieve a displacement of 392 meters?

ANSWER: 7

BONUS

8) PHYSICS *Short Answer*   A spring with a mass of 5 kilograms and a spring constant of 100 Newtons per meter oscillates with a period that is half that of a pendulum. If the acceleration due to gravity is 10 meters per second squared, what is the length of the pendulum rope in meters?

ANSWER: 2

TOSS UP

9) EARTH AND SPACE *Short Answer*   Order the following three soil horizons in order of increasing depth:

1) E horizon
2) B horizon
3) O horizon

ANSWER: 3, 1, 2

BONUS

9) EARTH AND SPACE *Short Answer*   Identify all of the following three plate boundaries that can be found at a mid-ocean ridge:

1) Convergent
2) Divergent
3) Transform

ANSWER: 2 and 3 only

TOSS UP

10) BIOLOGY *Multiple Choice*   Which of the following codons, each read in the 5 prime to 3 prime direction, will NOT bind to a corresponding tRNA?

W) GUA
X) AUG
Y) UGG
Z) UAA

ANSWER: Z) UAA

BONUS

10) BIOLOGY *Multiple Choice*   Which of the following is not true about mitosis in plant cells?

W) The mitotic spindle begins to form at a centrosome
X) The nuclear envelope fragments in prometaphase
Y) Anaphase is the shortest phase of mitosis
Z) Nonkinetochore [*non-kin-eto-core*] microtubules overlap at the metaphase plate

ANSWER: W) The mitotic spindle begins to form at a centrosome

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11) CHEMISTRY *Multiple Choice*   Which of the following statements accurately describes the freezing of water at 25 degrees Celsius at 1 atmospheric pressure?

  W) Delta G less than 0, Delta S less than 0
  X) Delta G less than 0, Delta S greater than 0
  Y) Delta G greater than 0, Delta S less than 0
  Z) Delta G greater than 0, Delta S greater than 0

ANSWER: Y) Delta G greater than 0, Delta S less than 0

BONUS

11) CHEMISTRY *Short Answer*   Aidan dissolves two moles of sodium chloride into 500g of water. Assuming the boiling point elevation constant is 0.5 degrees Celsius per molal, what is the boiling point of the solution in degrees Celsius?

ANSWER: 104

TOSS UP

12) MATH *Short Answer*   What is the 2025th digit to the right of the decimal point of the fraction 13/99?

ANSWER: 1

BONUS

12) MATH *Short Answer*   A standard cup of coffee has 100 mg of caffeine, and decaffeinated coffee removes 99.7% of the caffeine from coffee. To the nearest integer, how many cups of decaffeinated coffee does it take to equal the caffeine content of a regular cup of coffee?

ANSWER: 333

TOSS UP

13) PHYSICS *Short Answer*   When magnesium-23 undergoes positron [*paw-si-tron*] emission, it produces a sodium-23 atom, a positron, and what other particle?

ANSWER: Electron neutrino [DO NOT ACCEPT: Neutrino]

BONUS

13) PHYSICS *Short Answer*   A speaker plays a sound at 90 decibels. If 30 identical speakers played the sound simultaneously, what is the sound intensity in decibels to the nearest integer?

ANSWER: 105

TOSS UP

14) EARTH AND SPACE *Multiple Choice*   Which of the following rocks would you be most likely to find in the center of a batholith?

  W) Limestone
  X) Sandstone
  Y) Gabbro
  Z) Breccia [*bre-chee-a*]

ANSWER: Y) Gabbro

BONUS

14) EARTH AND SPACE *Multiple Choice*   Which of the following is closest to the temperature, in Kelvin, of the cosmic microwave background radiation?

  W) 3
  X) 30
  Y) 3,000
  Z) 3,000,000

ANSWER: W) 3

TOSS UP

15) BIOLOGY *Multiple Choice*   Animals which exhibit uniform dispersion would most likely exhibit which of the following characteristics?

  W) Territoriality
  X) Parasitism
  Y) Cryptic Coloration
  Z) Altruism

ANSWER: W) Territoriality

BONUS

15) BIOLOGY *Short Answer*   When the stem of a potato plant reaches light, stem elongation slows, leaves expand, and chlorophyll production begins. What term best describes the response the plant is experiencing?

ANSWER: De-etiolation

TOSS UP

16) CHEMISTRY *Short Answer*   What is the technique that measures heat transfer in reactions or phase changes using an insulated container and a thermometer?

ANSWER: Calorimetry

BONUS

16) CHEMISTRY *Short Answer*   In a mixture of non-reacting gases, the total pressure exerted is equal to the sum of the partial pressures of each component gas. Which gas law describes this relationship?

ANSWER: Dalton's Law [ACCEPT: Law of Partial Pressures]

TOSS UP

17) MATH *Multiple Choice*   How many perfect squares are there between 200 and 800, inclusive?

  W) 13
  X) 14
  Y) 15
  Z) 16

ANSWER: X) 14

BONUS

17) MATH *Short Answer*   The sum of the squares of the reciprocals of all positive integers is $\pi^2/6$. What is the sum of the squares of the reciprocals of all positive integers that are not multiples of 3?

ANSWER: $4\pi^2/27$

TOSS UP

18) PHYSICS *Short Answer*   Gases A and B have molar masses of 18 amu and 54 amu respectively. What is the effusion rate ratio of A to B?

ANSWER: $\sqrt{3}$ [ACCEPT: $\sqrt{3}$ to 1]

BONUS

18) PHYSICS *Short Answer*   A 1-meter metal rod expands to 1.01 meters with a temperature increase of X degrees Celsius. What is the percent increase in length for a 7-meter rod of the same material when heated by $2X$ degrees Celsius?

ANSWER: 2

TOSS UP

19) EARTH AND SPACE *Short Answer*   Which dwarf planet is located closest to Earth?

ANSWER: Ceres

BONUS

19) EARTH AND SPACE *Short Answer*   Identify all of the following three latitudes where a high pressure region is present:

1) 0 degrees
2) 30 degrees
3) 60 degrees

ANSWER: 2 only

TOSS UP

20) BIOLOGY *Short Answer*   In signaling transduction pathways, protein kinases act as relay molecules that activate each other in a sequence. What term best describes these series of enzymatic reactions, which eventually lead to a cellular response?

ANSWER: Phosphorylation cascade [ACCEPT: kinase cascade]

BONUS

20) BIOLOGY *Multiple Choice*   If DNA replication followed the dispersive model, which of the following best describes what Meselson and Stahl would see in the centrifuge after 2 rounds of replication on the lighter nitrogen isotope?

W) Two light bands
X) Two intermediate bands
Y) One heavy band and one light band
Z) One heavy band and one intermediate band

ANSWER: X) Two intermediate bands