

ROUND ROBIN 4

TOSS-UP

1) Chemistry - *Short Answer* In brass, atoms of copper and zinc are approximately the same size, allowing them to take the same positions in the structure of the alloy. This makes brass an example of what type of alloy?

ANSWER: Substitutional

BONUS

1) Chemistry - *Multiple Choice* Which of the following statements is NOT true regarding catalysts?

- W) Catalysts do not appear in the balanced equation of a reaction
- X) Palladium can act as a heterogeneous catalyst to capture hydrogen
- Y) Catalysts change the mechanism of a reaction but do not change the energy of the reactants or products
- Z) All enzyme catalysts speed up a reaction by breaking up molecules into smaller components

ANSWER: Z) All enzyme catalysts speed up a reaction by breaking up molecules into smaller components

TOSS-UP

2) Energy - *Short Answer* Researchers in the Kavli Institute at Stanford are using supernovae to measure the accelerating expansion of the universe. These researchers are using what type of supernovae, which are used as standard candles because they always have the same absolute magnitude?

ANSWER: Type Ia [**one-A**]

BONUS

2) Energy - *Multiple Choice* Researchers in the Devereaux group at Stanford are using repeated simulated experiments to determine properties of a multi-particle quantum system. Which of the following statistical methods are the researchers using?

- W) Bayesian
- X) Euler
- Y) Hamiltonian
- Z) Monte Carlo

ANSWER: Z) Monte Carlo

TOSS-UP

3) Biology - *Short Answer* The Yellowstone fires of 1988 collectively formed the largest wildfire in the recorded history of the national park. What type of ecological succession followed these fires, which left the soil intact?

ANSWER: Secondary succession (ACCEPT: Secondary)

BONUS

3) Biology - *Multiple Choice* Which of the following mechanisms of speciation does not play a role in both allopatric and sympatric speciation?

- W) Differing selection pressures
- X) Sexual selection
- Y) Eventual cease of gene flow
- Z) Genetic drift

ANSWER: X) Sexual selection

TOSS-UP

4) Physics - *Multiple Choice* A block is at rest on a plane and the plane is tilted until just before the block begins to slip. The block is then pushed slightly such that it begins moving. Neglecting air resistance, which of the following best describes the motion of the block after it is pushed?

- W) It comes to a stop
- X) It continues traveling at a constant speed
- Y) It accelerates, then decelerates to a constant speed
- Z) It accelerates indefinitely

ANSWER: Z) It accelerates indefinitely

BONUS

4) Physics - *Multiple Choice* Let ΔS [delta S] denote the change in entropy of a sample for an irreversible process from state A to state B. A different reversible process then causes a change from state A to state B. Which of the following best describes how the change in entropy of this second process compares to ΔS ?

- W) Greater than ΔS
- X) Less than ΔS
- Y) The same as ΔS
- Z) Depends on the process

ANSWER: X) Less than ΔS

TOSS-UP

5) Earth and Space - *Multiple Choice* The oldest known galaxies generally fall under which of the following galaxy types?

- W) Elliptical
- X) Spiral
- Y) Barred spiral
- Z) Irregular

ANSWER: W) Elliptical

BONUS

5) Earth and Space - *Multiple Choice* Laura decides to connect every planet in the Solar System with a wire and produce energy using solar panels on their surfaces. On average, which of the following planets would have the greatest amount of solar energy per square meter available at the surface?

- W) Venus
- X) Earth
- Y) Mars
- Z) Jupiter

ANSWER: X) Earth

TOSS-UP

6) Chemistry - *Multiple Choice* Which of the following is closest to the pH of 0.01 molar hydroiodic acid?

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

ANSWER: X) 2

BONUS

6) Chemistry - *Multiple Choice* Lanthanide contraction refers to the decrease in atomic radius as more electrons are added to which of the following orbitals?

- W) $3d$
- X) $4d$
- Y) $4f$
- Z) $5f$

ANSWER: Y) $4f$

TOSS-UP

7) Biology - *Short Answer* Order the following three stages of embryonic development from earliest to latest: 1) Gastrula; 2) Zygote; 3) Blastula.

ANSWER: 2, 3, 1

BONUS

7) Biology - *Multiple Choice* The amino acid alanine [**AL-uh-neen**] has a methyl side chain. Which of the following is its molecular formula at neutral pH?

- W) C₂H₆NO
- X) C₃H₆NO
- Y) C₃H₆NO₂
- Z) C₃H₇NO₂

ANSWER: Z) C₃H₇NO₂

TOSS-UP

- 8) Math - *Short Answer* A two-digit positive integer b is formed by reversing the digits of the two-digit positive integer a . What is the largest integer that divides $a+b$ for all values of a ?

ANSWER: 11

BONUS

- 8) Math - *Short Answer* A tree is chasing a bear around a track. The tree finishes a lap in 30 seconds, while the bear finishes a lap in 50 seconds. If they start 0.2 laps apart, how long in seconds will it take for the tree to catch up with the bear?

ANSWER: 15

TOSS-UP

9) Energy - *Multiple Choice* Scientists in the Bergmann Group at Stanford are investigating how plants with different photosynthetic pathways respond to climate change. As global temperatures rise, which of the following statements best explains why C4 and CAM plants are likely to have an advantage over C3 plants?

- W) They possess adaptations that reduce photorespiration
- X) Their leaves have higher stomatal density to minimize water loss
- Y) They possess longer taproots that enhance water absorption
- Z) They rely on heat-resistant enzymes for photosynthesis

ANSWER: W) They possess adaptations that reduce photorespiration

BONUS

9) Energy - *Short Answer* Researchers at SLAC are studying electron pairing in p-type cuprate **[COO-prate]** superconductors. Identify all of the following three elements that would create a p-type compound when substituted into silicon: 1) Nitrogen; 2) Phosphorus; 3) Aluminum.

ANSWER: 3 only

TOSS-UP

10) Earth and Space - *Multiple Choice* Which of the following is closest to the value of Earth's albedo?

- W) 0.1
- X) 0.3
- Y) 0.5
- Z) 0.7

ANSWER: X) 0.3

BONUS

10) Earth and Space - *Short Answer* Identify all of the following three organisms that are significant sources of siliceous [suh-LISH-is] ooze: 1) Forams; 2) Diatoms; 3) Radiolarians.

ANSWER: 2 and 3

TOSS-UP

11) Math - *Short Answer* Chris Paul is exactly 6 feet tall, and his hand is 9 inches long. If a 26-foot-tall statue of Chris Paul is built, how long should the hands of the statue be in inches?

ANSWER: 39

BONUS

11) Math - *Short Answer* What is the probability that a randomly chosen factor of 2025 is divisible by 3?

ANSWER: $\frac{4}{5}$ (ACCEPT: 80%, 0.8)

TOSS-UP

12) Physics - *Short Answer* A hollow metal sphere is charged to a potential V . In terms of V , what is the potential at the center of this sphere?

ANSWER: V

BONUS

12) Physics - *Short Answer* Identify all of the following three descriptions that would apply to the graviton if it was found to exist: 1) Boson; 2) Fermion; 3) Hadron.

ANSWER: 1 only

TOSS-UP

13) Chemistry - *Multiple Choice* Calorimetry is most directly useful for measuring which of the following quantities of a chemical reaction?

- W) Entropy
- X) Enthalpy
- Y) Gibbs free energy
- Z) Helmholtz free energy

ANSWER: X) Enthalpy

BONUS

13) Chemistry - *Short Answer* Identify all of the following three noble gases that have a lower first ionization energy than fluorine: 1) Helium; 2) Neon; 3) Argon.

ANSWER: 3 only

TOSS-UP

14) Biology - *Short Answer* For two genes on separate chromosomes, the phenotypic ratio of a dihybrid cross is 9:3:3:1. This ratio supports the assertions of what law, which states that the inheritance of one trait does not influence the inheritance of another?

ANSWER: Law of independent assortment

BONUS

14) Biology - *Multiple Choice* In signal reception, epinephrine [**ep-uh-NEF-rin**] binds to a GPCR, which then activates adenylyl [**uh-DEN-ul-ul**] cyclase to synthesize cyclic AMP. During which of the following steps of signal reception would GTP be attached to the G-protein?

- W) When the G-protein is diffusing back to the GPCR
- X) When the G-protein is diffusing to adenylyl cyclase
- Y) Just before epinephrine is bound to the GPCR
- Z) Just after adenylyl cyclase is inactivated

ANSWER: X) When the G-protein is diffusing to adenylyl cyclase

TOSS-UP

15) Physics - *Short Answer* What quasiparticle represents the absence of an electron in a metal or semiconductor?

ANSWER: Hole (ACCEPT: Electron hole)

BONUS

15) Physics - *Multiple Choice* Sonny is standing atop a building. He throws ball A downwards with speed v , ball B to the side with speed $2v$, and ball C upwards with speed $3v$. Given that v is nonzero, which ball will have the highest kinetic energy when it hits the ground?

- W) Ball A
- X) Ball B
- Y) Ball C
- Z) Depends on v

ANSWER: Y) Ball C

TOSS-UP

16) Earth and Space - *Multiple Choice* Which of the following best describes the Schwarzschild radius of a black hole?

- W) The distance at which light can no longer escape the black hole's gravity
- X) The physical size of the black hole's singularity
- Y) The boundary at which time stops for an outside observer
- Z) The maximum distance at which tidal forces dominate

ANSWER: W) The distance at which light can no longer escape its gravity

BONUS

16) Earth and Space - *Multiple Choice* Cepheid [SEH-fee-uhd] variables are examples of which of the following types of variable stars?

- W) Eclipsing
- X) Eruptive
- Y) Pulsating
- Z) Rotating

ANSWER: Y) Pulsating

TOSS-UP

17) Math - *Short Answer* Zhongli spent 48 dollars on tea per week for two weeks. In the first week, a box of tea was 4 dollars. In the second week, a box of tea was 6 dollars. Over the two weeks and in dollars, what was the average amount Zhongli paid per box of tea?

ANSWER: \$4.80 (ACCEPT: 4.8)

BONUS

17) Math - *Short Answer* Two tangent unit circles are centered at $(-1, 0)$ and $(1, 0)$. A circle C of radius 2 is tangent to both unit circles. How many different points could be the center of circle C ?

ANSWER: 5

TOSS-UP

18) Biology - *Multiple Choice* Which of the following microscopy techniques would be best for visualizing the cristae [**KRI-stay**] of mitochondria?

- W) Light microscopy
- X) Cryo-electron microscopy
- Y) Scanning electron microscopy
- Z) Transmission electron microscopy

ANSWER: Z) Transmission electron microscopy

BONUS

18) Biology - *Short Answer* Order the following three groups by increasing number of organisms it contains: 1) Mammalia; 2) Arthropoda; 3) Eukarya.

ANSWER: 1, 2, 3

TOSS-UP

19) Energy - *Multiple Choice* Researchers at Stanford's Causal Science Center are analyzing how different COVID-19 policies affect mean virus concentrations in wastewater. If the researchers are comparing a small number of data points with an unknown standard deviation, which of the following statistical tests should be used to determine whether the mean virus concentrations in different sources are statistically different?

- W) Z-test
- X) T-test
- Y) Chi-square test [**kai square test**]
- Z) Linear regression

ANSWER: X) T-test

BONUS

19) Energy - *Short Answer* Researchers in the Kivelson group at Stanford are researching strongly correlated quantum states. When two particles' states are perfectly correlated, they are described by what quantum effect, which Einstein described as "spooky action at a distance"?

ANSWER: Entanglement

TOSS-UP

20) Earth and Space - *Short Answer* What name is given to the fast, sediment-rich flows of water that travel along the seafloor through submarine canyons?

ANSWER: Turbidity currents

BONUS

20) Earth and Space - *Multiple Choice* Which of the following best explains why modern seismologists primarily use the moment magnitude scale in favor of the Richter scale?

- W) The Richter scale provides results that take longer to compute
- X) The Richter scale requires specialized instruments that are more expensive to produce
- Y) The Richter scale cannot measure earthquakes with foci beneath a certain depth
- Z) The Richter scale cannot effectively distinguish between large earthquakes

ANSWER: Z) The Richter scale cannot effectively distinguish between large earthquakes

TOSS-UP

21) Math - *Multiple Choice* Dr. Doofenshmirtz has three strains of bacteria labeled W, X, and Y. Strain W doubles every 2 hours, strain X triples every 3 hours, and strain Y quadruples every 4 hours. Which strain will grow the fastest?

- W) W
- X) X
- Y) Y
- Z) Multiple strains grow at the same fastest rate

ANSWER: X) X

BONUS

21) Math - *Short Answer* If the roots of the quadratic equation $x^2 - px + 12 = 0$ are positive integers, find the sum of all possible values of p .

ANSWER: 28

TOSS-UP

22) Chemistry - *Multiple Choice* Which of the following is not one of the assumptions of kinetic molecular theory?

- W) All gas molecule collisions are elastic
- X) No intermolecular forces act on gas molecules
- Y) The volume of gas molecules is negligible
- Z) Gas molecules do not collide with each other

ANSWER: Z) Gas molecules do not collide with each other

BONUS

22) Chemistry - *Short Answer* Order the following three types of solids by increasing average boiling point: 1) Ionic; 2) Molecular; 3) Covalent network.

ANSWER: 2, 1, 3

TOSS-UP

23) Physics - *Multiple Choice* A capacitor is connected in series with a battery and resistor. After a long time, the capacitor is equivalent to which of the following circuit elements?

- W) Wire
- X) Cut wire
- Y) Resistor
- Z) Inductor

ANSWER: X) Cut wire

BONUS

23) Physics - *Short Answer* Two sinusoidal waves with amplitude A are out of phase by $\pi/3$ radians. In terms of A , what is the amplitude of the superposition of the two waves?

ANSWER: $A\sqrt{3}$