

ROUND ROBIN 2

TOSS-UP

1) Biology - *Short Answer* Surfactants coat the insides of what pulmonary structures that are found at the ends of bronchioles [**BRON-kee-ohls**] and facilitate gas exchange?

ANSWER: Alveoli [**al-vee-OHL-eye**] (ACCEPT: Alveolus)

BONUS

1) Biology - *Multiple Choice* In marine ecosystems, there is often an inverted trophic [**TROH-fic**] pyramid in which the biomass of the consumers is higher than the producers. Which of the following best explains why this is possible in such ecosystems?

- W) Strongly influential keystone species maintain species diversity
- X) Tertiary consumers fiercely compete against each other, keeping the total biomass of the trophic pyramid relatively low
- Y) Primary producers reproduce at a rapid rate in the face of rampant predation
- Z) Highly efficient resource partitioning allows consumers to thrive with limited food options

ANSWER: Y) Primary producers reproduce at a rapid rate in the face of rampant predation

TOSS-UP

2) Energy - *Multiple Choice* Scientists at Stanford's Bio-X Institute are studying hypertrophic [hy-pur-TROH-fic] cardiomyopathy [car-dee-oh-my-aw-PATH-ee]. Hypertrophic cardiomyopathy is caused by a two-base deletion in the MyBPC gene, which would fall under what type of mutation?

- W) Frameshift
- X) Silent
- Y) Missense
- Z) Nonsense

ANSWER: W) Frameshift

BONUS

2) Energy - *Short Answer* Scientists at the Center for Turbulence Research at Stanford are modeling wave and current generation in the open ocean. To do this, their calculations are based on what equations, which accurately describe the physics of viscous fluid flow?

ANSWER: Navier-Stokes [NAH-vee-ay STOKES] equations (ACCEPT: Navier-Stokes)

TOSS-UP

3) Earth and Space - *Multiple Choice* Which of the following best describes the universe?

- W) Anisotropic [**an-iso-TROH-pic**] and homogenous
- X) Anisotropic and heterogeneous
- Y) Isotropic and homogenous
- Z) Isotropic and heterogeneous

ANSWER: Y) Isotropic and homogenous

BONUS

3) Earth and Space - *Short Answer* Identify all of the following three features that are associated with star formation: 1) Bok [**BAWK**] globules; 2) Protoplanetary disks; 3) Herbig-Haro objects.

ANSWER: All

TOSS-UP

4) Chemistry - *Short Answer* Hess's Law is used to calculate total enthalpy change by summing the enthalpy changes of intermediate steps. This is possible because enthalpy is an example of what type of function?

ANSWER: State function (ACCEPT: State)

BONUS

4) Chemistry - *Multiple Choice* In the redox reaction Zn + CuSO₄ yields ZnSO₄ + Cu, which of the following species acts as a reducing agent?

- W) Cu
- X) Zn
- Y) CuSO₄
- Z) ZnSO₄

ANSWER: X) Zn

TOSS-UP

5) Physics - *Multiple Choice* An electron is traveling in the positive x direction through a magnetic field directed in the positive y direction. In which of the following directions will the electron accelerate?

- W) Positive y
- X) Negative y
- Y) Positive z
- Z) Negative z

ANSWER: Z) Negative z

BONUS

5) Physics - *Short Answer* Galileo drops two bowling balls of weights 6 pounds and 16 pounds from the Leaning Tower of Pisa at the same time. If the balls experience air resistance, identify all of the following three statements that are true of this system: 1) After one second, the 16-pound ball experiences a larger gravitational force; 2) After one second, the 16-pound ball experiences a larger drag force; 3) The two balls hit the ground at the same time.

ANSWER: 1 and 2

TOSS-UP

- 6) Math - *Short Answer* Bobert throws a dart that lands uniformly in a unit square. What is the probability that the dart is closer to the center of the square than to a vertex?

ANSWER: $\frac{1}{2}$ (ACCEPT: 50%, 0.5)

BONUS

- 6) Math - *Short Answer* The arithmetic mean of 2, 0, 2, 5 and x is 2025. Find the value of x .

ANSWER: 10116

TOSS-UP

7) Biology - *Multiple Choice* During which of the following stages in the cell cycle would you find DNA not bound to histones?

- W) G1 phase
- X) S phase
- Y) Prophase
- Z) Telophase

ANSWER: X) S phase

BONUS

7) Biology - *Multiple Choice* Which of the following is true about all arteries in the human body?

- W) All arteries carry oxygenated blood
- X) All arteries supply oxygen to tissues away from the heart
- Y) All arteries have a wider internal lumen than veins
- Z) All arteries carry blood at higher pressures than veins

ANSWER: Z) All arteries carry blood at higher pressures than veins

TOSS-UP

8) Chemistry - *Multiple Choice* Which of the following variables is NOT present in the Beer-Lambert law?

- W) Absorptivity constant
- X) Absorbance
- Y) Path length
- Z) Wavelength

ANSWER: Z) Wavelength

BONUS

8) Chemistry - *Short Answer* A 45 liter container is filled with pure helium until it reaches standard temperature and pressure. To the nearest integer, how many moles of helium are in the container?

ANSWER: 2

TOSS-UP

9) Earth and Space - *Multiple Choice* Which of the following is the primary reason why the Northern Hemisphere becomes cooler in winter?

- W) Earth is at aphelion [**ap-HEEL-ee-on**]
- X) Earth's axis rotates away from the Sun due to precession
- Y) Earth is tilted away from the Sun
- Z) Earth orbits with greater eccentricity around the Sun

ANSWER: Y) Earth is tilted away from the Sun

BONUS

9) Earth and Space - *Short Answer* Identify all of the following three changes that would increase the magnitude of the Coriolis force on winds in the Northern Hemisphere: 1) Increase in wind speed; 2) Increase in latitude; 3) Increase in Earth's rate of rotation.

ANSWER: All

TOSS-UP

10) Math - *Short Answer* Identify all of the following three shapes that necessarily have a convex interior: 1) Rhombus; 2) Crescent; 3) Star.

ANSWER: 1 only

BONUS

10) Math - *Short Answer* Thanos' right glove can snap away one half of the remaining population every 20 minutes. His left glove can snap away one third of the remaining population every 10 minutes. If he can only use one glove, what is the smallest possible fraction of the population remaining after 1 hour?

ANSWER: $\frac{64}{729}$

TOSS-UP

11) Physics - *Multiple Choice* The mechanical advantage of an inclined plane is directly proportional to which of the following functions of its angle θ [**theta**]?

- W) $\sin(\theta)$ [**sine theta**]
- X) $\cos(\theta)$ [**cosine theta**]
- Y) $\sec(\theta)$ [**SEE-cant theta**]
- Z) $\csc(\theta)$ [**co-SEE-cant theta**]

ANSWER: Z) $\csc(\theta)$

BONUS

11) Physics - *Short Answer* Order the following three quantities by increasing amount of energy per unit mass: 1) Latent heat of fusion of water; 2) Latent heat of vaporization of water; 3) Energy needed to heat liquid water from 0 to 100 degrees Celsius.

ANSWER: 1, 3, 2

TOSS-UP

12) Biology - *Multiple Choice* The majority of phloem [**FLOW-um**] sap is made of which of the following carbohydrates?

- W) Starch
- X) Sucrose
- Y) Glucose
- Z) Maltose

ANSWER: X) Sucrose

BONUS

12) Biology - *Short Answer* Order the following three types of DNA sequences by increasing abundance in the human genome: 1) Introns [**IN-trons**]; 2) Transposons [**trans-POH-sons**]; 3) Exons [**EX-ons**].

ANSWER: 3, 1, 2

TOSS-UP

13) Chemistry - *Short Answer* In an electrochemical cell, what device allows ions to flow between the half-cells to prevent charge buildup and maintain electrical neutrality?

ANSWER: Salt bridge

BONUS

13) Chemistry - *Multiple Choice* Which of the following best explains why the $4s$ orbital is filled before the $3d$ orbital in the ground-state electron configuration of most transition metals?

- W) The $4s$ orbital has a lower energy in isolated atoms
- X) The shielding effect is stronger for the $4s$ orbital
- Y) The $3d$ orbital overlaps with nearby atoms
- Z) Electrons in the $3d$ orbital are easily lost to their surroundings

ANSWER: W) The $4s$ orbital has a lower energy in isolated atoms

TOSS-UP

14) Energy - *Multiple Choice* Researchers in the Fisher group at Stanford are improving methods for growing high-quality crystal samples. By definition, a perfect crystal minimizes which of the following thermodynamic properties?

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

ANSWER: X) Entropy

BONUS

14) Energy - *Short Answer* A researcher in Stanford's Center for Data Science Research is using a graph to determine the correlation between two variables. Identify all of the following three changes that could affect the correlation coefficient of the data: 1) Doubling each point's x-value; 2) Doubling each point's y-value; 3) Rotating the graph by 90°.

ANSWER: 3 only

TOSS-UP

15) Math - *Short Answer* The degree measures of the angles of a triangle can be expressed as x , $2x - 20$, and $x - 40$. What is the value of x ?

ANSWER: 60

BONUS

15) Math - *Short Answer* Including 1 and itself, how many divisors does 2025 have?

ANSWER: 15

TOSS-UP

16) Earth and Space - *Short Answer* Identify all of the following three planets that contain metallic hydrogen in their interior: 1) Jupiter; 2) Saturn; 3) Uranus.

ANSWER: 1 and 2

BONUS

16) Earth and Space - *Multiple Choice* Which of the following statements best describes why Mercury is denser than expected for its size?

- W) Its mantle is much more iron-rich than other planets
- X) Its core is much more iron-rich than other planets
- Y) It has a much larger mantle than other planets
- Z) It has a much larger core than other planets

ANSWER: Z) It has a much larger core than other planets

TOSS-UP

17) Physics - *Multiple Choice* Which of the following quantities is NOT considered a state function?

- W) Internal energy
- X) Pressure
- Y) Entropy
- Z) Heat

ANSWER: Z) Heat

BONUS

17) Physics - *Short Answer* Aarav is in a spaceship moving at a constant velocity. Brian, an inertial observer, observes that Aarav is moving at speed $0.5c$ directly away from him. Brian then sends a beam of light directly towards the spaceship. In terms of c , when Aarav observes the beam of light, what speed will it have in his reference frame?

ANSWER: c

TOSS-UP

18) Chemistry - *Multiple Choice* Which of the following pairs of substances are NOT allotropes of each other?

- W) Iron and steel
- X) Oxygen and ozone
- Y) Graphite and fullerenes [**FOOL-ur-eens**]
- Z) White phosphorus and red phosphorus

ANSWER: W) Iron and steel

BONUS

18) Chemistry - *Multiple Choice* A student prepares a 0.1 molar solution of acetic [**uh-SEE-tic**] acid and measures both the pH and concentration of acetic acid. Which of the following describes how these quantities would change if a small amount of hydrochloric acid was added to the solution?

- W) pH increases, acetic acid concentration increases
- X) pH increases, acetic acid concentration decreases
- Y) pH decreases, acetic acid concentration increases
- Z) pH decreases, acetic acid concentration decreases

ANSWER: Y) pH decreases, acetic acid concentration increases

TOSS-UP

19) Energy - *Short Answer* Researchers in the Wender Lab at Stanford recently discovered a new drug that could be used to combat HIV infections. This drug is part of a larger class of compounds designed to target what family of viruses, which function by injecting their RNA genome into the DNA of the host cell?

ANSWER: Retroviruses (ACCEPT: Retroviridae)

BONUS

19) Energy - *Short Answer* Researchers in the Dai Lab at Stanford are investigating the properties of carbon-based nanomaterials such as graphene. Identify all of the following three statements that are true of graphene: 1) It has a repeating hexagonal structure; 2) Its atoms are sp^3 hybridized; 3) It is electrically conductive.

ANSWER: 1 and 3

TOSS-UP

20) Math - *Short Answer* Leif has 3 red socks, 6 green socks, and 5 black socks in a bag. What is the minimum number of socks that Leif needs to randomly draw from the bag to guarantee having 2 socks of one color and another 2 socks of a different color?

ANSWER: 9

BONUS

20) Math - *Short Answer* Joe, Donald, and Robert are competing in a race with two other people. Assuming that there are no ties, in how many different orders can the five people finish given that Joe, Donald, and Robert must finish consecutively?

ANSWER: 36

TOSS-UP

21) Earth and Space - *Multiple Choice* Hydrothermal vents most commonly occur near which of the following seafloor features?

- W) Abyssal plain
- X) Continental shelf
- Y) Oceanic trench
- Z) Mid-ocean ridge

ANSWER: Z) Mid-ocean ridge

BONUS

21) Earth and Space - *Short Answer* Identify all of the following three quantities whose variations are defined by the Milankovitch cycles: 1) Obliquity [**oh-BLIK-wuh-tee**]; 2) Libration [**ly-BRAY-shin**]; 3) Precession.

ANSWER: 1 and 3

TOSS-UP

22) Biology - *Short Answer* Ehlers-Danlos [**EH-lerz DAN-lowz**] syndrome is characterized by hypermobility, skin hyperextensibility, and tissue fragility. This disorder is caused by mutations in genes that affect the synthesis of what protein, the most abundant in the human body?

ANSWER: Collagen

BONUS

22) Biology - *Multiple Choice* The reading frame of an mRNA sequence reads: [**read slowly**] 5 prime, A-U-G-G-U-C-U-A-A, 3 prime. Which of the following nucleotides could most likely be mutated into another nucleotide to produce a silent mutation?

- W) Adenine [**AD-uh-neen**]
- X) Cytosine [**CY-toh-seen**]
- Y) Guanine [**GWA-neen**]
- Z) Uracil [**YUR-uh-sil**]

ANSWER: X) Cytosine

TOSS-UP

23) Physics - *Short Answer* To the nearest second and neglecting air resistance, how long will it take for a ball to hit the ground if it is dropped from a tower of height 20 meters?

ANSWER: 2

BONUS

23) Physics - *Short Answer* Daniel makes an onion burger by sandwiching a thin, circular ring of onion between two disk-shaped hamburger buns. The onion and buns all have the same mass and radius r . If the mass of the overall burger is m , what is the moment of inertia of the burger about its axis of rotational symmetry?

ANSWER: $\frac{2}{3}mr^2$