ROUND 3

TOSS-UP

1) Physics – *Multiple Choice* To the nearest 10,000, how many gauss are in 0.2 teslas?

W) 1,000 Gauss
X) 2,000 Gauss
Y) 3,000 Gauss
Z) 4,000 Gauss

ANSWER: X) 2,000 GAUSS

BONUS

1) Physics – *Multiple Choice* Which of the following is a non-conservative force?

W) Gravity
X) Electrostatic force
Y) The restoring force of a Hooke's Law spring
Z) Friction

ANSWER: Z) FRICTION

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TOSS-UP

2) Energy – *Short Answer* Researchers at the Pacific Northwest National Laboratory are developing new computational methods to predict how amino acids will fold into a three-dimensional structure. What level of protein structure is maintained by hydrogen bonds between amide hydrogens and carbonyl oxygens of the peptide backbone?

ANSWER: SECONDARY STRUCTURE

BONUS

2) Energy – *Multiple Choice* In order to confirm if the proteins folded as predicted, the researchers used high-field nuclear magnetic resonance (NMR) spectrometers .What wavelength of electromagnetic radiation does NMR primarily use?

W) Gamma Rays
X) Radio Waves
Y) X-Rays
Z) Microwaves
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ANSWER: X) RADIO WAVES

ROUND 3

TOSS-UP

3) Chemistry – *Short Answer* What is the term for the number of moles of an ionic solid that can be dissolved in 1 L of solution?

ANSWER: MOLAR SOLUBILITY

BONUS

3) Chemistry – *Multiple Choice* The solubility product constant for AgCl in water is 1.77×10^{-10} at room temperature. How many moles of AgCl can dissolve in 100 mL of water with 2 significant digits?

W) 1.3×10^{-6}
X) 1.3×10^{-5}
Y) 2.6×10^{-10}
Z) 1.8×10^{-10}

ANSWER: W) 1.3×10^{-6}

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TOSS-UP

4) Biology - *Short Answer* Alpha helices and beta pleated sheets are found in which level of protein structure?

ANSWER: SECONDARY

BONUS

4) Biology - *Short Answer* Denaturation of a protein does not affect which level of protein structure?

ANSWER: PRIMARY
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ROUND 3

TOSS-UP

5) Math – *Short Answer* In a conic, what is the term for the ratio of the distance between the foci to the length of the major axis?

ANSWER: Y) ECCENTRICITY

BONUS

5) Math – *Multiple Choice* Which of the following is not possible?

W) An irrational number plus an irrational number is rational
X) An irrational number raised to an irrational power is rational
Y) A rational number raised to a rational power is irrational
Z) A rational number plus an irrational number is rational

Z) A RATIONAL NUMBER PLUS AN IRRATIONAL NUMBER IS RATIONAL

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TOSS-UP

6) Earth and Space - *Multiple Choice* Which of the following is the name for the region along the equator where trade winds from the Northern and Southern Hemispheres collide, creating an area of low pressure and few surface winds?

W) Subtropical Convergence Zone
X) Intertropical Divergence Zone
Y) Doldrums
Z) Horse Latitudes

ANSWER: Y) DOLDRUMS

BONUS

6) Earth and Space - *Short Answer* What is the name for the wind cell responsible for the trade winds and the weather patterns present between 30 degrees north and 30 degrees south latitude?

ANSWER: HADLEY CELL (ACCEPT: HADLEY)
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ROUND 3

TOSS-UP

7) Energy – *Short Answer* Researchers have developed a systems-level computational model named FoldME, which can accurately predict how E. coli responds to temperature changes and genetic mutations. What two regulators turn E.coli's lac operon "on" and "off" in response to lactose and glucose levels?

ANSWER: THE LAC REPRESSOR AND CATABOLITE ACTIVATOR PROTEIN (CAP)

BONUS

7) Energy – *Multiple Choice* One factor these researchers studied is how chaperonins in E.coli respond to temperature changes. Which of the following processes would be most affected by a change in chaperonin activity?

W) The production of ATP
X) The modification of steroids
Y) The production of functional enzymes
Z) The transport of water across the cell membrane

ANSWER: Y) THE PRODUCTION OF FUNCTIONAL ENZYMES

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TOSS-UP

8) Biology - *Short Answer* By name or number, list the following 3 steps of DNA replication in chronological order: 1) Termination, 2) Initiation, 3) Elongation

ANSWER: 2, 3, 1

BONUS

8) Biology - *Short Answer* What type of RNA is responsible for interpreting a codon as an amino acid?

ANSWER: tRNA
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ROUND 3

TOSS-UP

9) Physics – *Short Answer* What is the physical phenomenon responsible for the fact that sometimes, a pair of particles can behave in such a way so that their quantum states become interdependent, even at very large distances?

ANSWER: QUANTUM ENTANGLEMENT

BONUS

9) Physics – *Multiple Choice* What color is generally associated with the highest frequency?

W) Red
X) Blue
X) Yellow
Z) Violet
ANSWER: Z) VIOLET

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TOSS-UP

10) Chemistry – *Multiple Choice* Which of the following reactions will produce a precipitate?

W) Lead nitrate and sodium acetate
X) Silver sulfate and calcium chloride
Y) Potassium iodide and calcium hydroxide
Z) Ammonium nitrate and aluminum fluoride

ANSWER: X) SILVER SULFATE AND CALCIUM CHLORIDE

BONUS

10) Chemistry – *Multiple Choice* Which of the following is not a colligative property?

W) Boiling point elevation
X) Freezing point depression
Y) Elevation of vapor pressure
Z) Osmotic pressure

ANSWER: Y) ELEVATION OF VAPOR PRESSURE
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ROUND 3

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TOSS-UP

11) Math – *Short Answer* An infinite geometric series has first term 12 and common ratio $\frac{-2}{3}$. What is the sum of the series?

ANSWER: 7.2 (ACCEPT 36/5)

BONUS

11) Math – *Short Answer* What is the sum of the squares of the first ten positive integers?

ANSWER: 385

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TOSS-UP

12) Earth and Space - *Multiple Choice* Which of the following is true of native elements?

W) they are naturally-occurring elements not made in laboratories
X) they are elements of high-worth and are not commonly found in the Earth
Y) they are elements that can exist naturally in their pure form
Z) they are metallic elements with melting points over 950 degrees Celsius

ANSWER: Y) THEY ARE ELEMENTS THAT CAN EXIST NATURALLY IN THEIR PURE FORMS

BONUS

12) Earth and Space - *Short Answer* By name or number, identify all of the following 5 minerals that do NOT belong to the halide group: 1) Dolomite, 2) Fluorite, 3) Pyrite, 4) Halite, 5) Sylvite.

ANSWER: DOLOMITE, PYRITE (ACCEPT: 1, 3)

ROUND 3

TOSS-UP

13) Biology - *Short Answer* Which enzyme initiates photorespiration when it adds oxygen instead of carbon dioxide to the Calvin cycle?

ANSWER: RUBISCO

BONUS

13) Biology - *Short Answer* How are electrons in Photosystem II replenished?

ANSWER: SPLITTING OF WATER

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TOSS-UP

14) Energy – *Short Answer* Researchers at the Princeton Plasma Physics Laboratory are researching auroras on Jupiter's largest moon. What is the name of this Galilean moon?

ANSWER: GANYMEDE

BONUS

14) Energy – *Short Answer* Ganymede is the only moon known in our solar system that displays auroras. What fundamental particle is released during auroras, creating the observed displays?

ANSWER: PHOTONS
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ROUND 3

TOSS-UP

15) Physics – *Short Answer* To the nearest integer, find the rate of change of acceleration for a car speeding up from 5 m/s, to 8 m/s in 2 seconds at a constant acceleration?

ANSWER: 0 (Solution: Jerk, not acceleration)

BONUS

15) Physics – *Multiple Choice* What is the derivative of the integral of the rate of change of velocity?

W) Displacement
X) Velocity
Y) Acceleration
Z) Jerk

ANSWER: Y) ACCELERATION

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TOSS-UP

16) Earth and Space - *Short Answer* On which planet in the Solar System are the Great Dark Spots found?

ANSWER: NEPTUNE

BONUS

16) Earth and Space - *Short Answer* By name or number, select all of the following 4 people credited with the identification of Neptune as a planet: 1) Galileo Galilei, 2) Urbain Le Verrier, 3) John Couch Adams, 4) Gerard Kuiper.

ANSWER: URBAN LE VERRIER, JOHN COUCH ADAMS (ACCEPT: 2, 3)
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ROUND 3

TOSS-UP

17) Chemistry – *Multiple Choice* A substance has a high melting point and does not conduct electricity as a solid or in a molten state. Which of the following could it be?

W) Sodium chloride
X) Silicon carbide
Y) Calcium carbonate
Z) Potassium nitrate

ANSWER: X) SILICON CARBIDE

BONUS

17) Chemistry – *Short Answer* By number, rank the following four compounds from strongest to weakest ionic bond strength: 1) Aluminum Oxide, 2) Rubidium Iodide, 3) Calcium Fluoride, 4) Sodium Chloride

ANSWER: 1, 3, 4, 2

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TOSS-UP

18) Math – *Multiple Choice* Which of the following choices correctly describe a property of ALL non - degenerate parabolas?

W) Eccentricity equals 0
X) Concave up
Y) Concave down
Z) Eccentricity equals 1

ANSWER: Z) ECCENTRICITY EQUALS 1

BONUS

18) Math – *Multiple Choice* Which fraction is the largest?

W) 9/11
X) 19/23
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Y) 4/5
Z)13/17

ANSWER: X) 19/23

ROUND 3

TOSS-UP

19) Chemistry – *Multiple Choice* Which of the following gas laws explains why submerging a balloon underwater decreases its volume?

W) Charles' Law
X) Boyle's Law
Y) Avogadro's Law
Z) Gay-Lussac's Law

ANSWER: X) BOYLE'S LAW

BONUS

19) Chemistry – *Short Answer* Two moles of solid mercury (II) oxide decomposes at STP and the gas from the reaction is collected. To the nearest tenth, in liters, what volume does the gas occupy?

ANSWER: 22.4 L

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TOSS-UP

20) Physics – *Short Answer* What law explains why energy available to organisms decreases as trophic level increases?

ANSWER: SECOND LAW OF THERMODYNAMICS

BONUS

20) Physics – *Multiple Choice* According to the Second Law of Thermodynamics, the universe is tending towards which of the following?

W) State of Total Disorder; Available Energy Decreases
X) State of Total Disorder; Available Energy Stays the Same
Y) Heat Death; Universe expands too fast
Z) State of Total Order; Available Energy Increases

ANSWER: W) STATE OF TOTAL DISORDER; AVAILABLE ENERGY DECREASES

TOSS-UP
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ROUND 3

21) Earth and Space - *Short Answer* What is the name of the phenomenon that causes the tail of a comet to always point away from the Sun?

ANSWER: SOLAR WIND

BONUS

21) Earth and Space - *Multiple Choice* Which of the following changes would cause the greatest temperature increase during winter in the Northern Hemisphere of Earth?

W) decreasing the tilt of the Earth's axis to 7 degrees off the vertical
X) increasing the tilt of the Earth's axis 30 degrees off the vertical
Y) moving the Earth closer to the Sun by .1 AU
Z) moving the Earth farther from the Sun by .1 AU

ANSWER: W) DECREASING THE TILT OF THE EARTH'S AXIS TO 7 DEGREES OFF THE VERTICAL

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TOSS-UP

22) Biology - *Multiple Choice* Which of the following is not a formed element in blood?

W) Plasma
X) Red Blood Cells
Y) White Blood Cells
Z) Platelets

ANSWER: W) PLASMA

BONUS

22) Biology - *Multiple Choice* Which type of white blood cell increases in the presence of an allergic reaction?

W) Basophils
X) Eosinophils
Y) Natural Killer Cells
Z) Neutrophils

ANSWER: X) EOSINOPHILS
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ROUND 3

TOSS-UP

23) Math – *Short Answer* If the sum of two primes is 63, what is the positive difference between those two primes?

ANSWER: 59

BONUS

23) Math – *Short Answer* Find the sum of the distinct prime factors of $3^5 + 3$

ANSWER: 46