ROUND 1

TOSS-UP

1) Physics – *Multiple Choice* A circuit consists of a 10V battery and two resistors in parallel. Which of the following will increase the current in the circuit?

W) Making the two resistors in series.
X) Taking out one of the resistors.
Y) Adding another resistor in parallel with the two resistors.
Z) Adding another resistor in series with one of the resistors.

ANSWER: Y) ADDING ANOTHER RESISTOR IN PARALLEL WITH THE TWO RESISTORS

BONUS

1) Physics – *Short Answer* A circuit consists of a 10 V battery, two resistors in series, and another resistor in parallel with the other two. If one of the resistors in series has a resistance of 2 Ω [Ohm], the one in parallel has a resistance of 6 Ω, and the current in the circuit is 3 A, find the resistance of the remaining resistor.

ANSWER: 11/2 (ACCEPT: 5.5)

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TOSS-UP

2) Energy – *Short Answer* Scientists at Argonne National Laboratory are studying neutron matter, a dense form of matter composed mainly of neutrons with very few protons or electrons. This type of matter can be found in what stellar objects that can result from the death of a massive star?

ANSWER: NEUTRON STAR

BONUS

2) Energy – *Multiple Choice* The data generated from the research on neutron matter can help scientists understand neutron star mergers. Which of the following can best be used to detect such a merger?
W) Infrared radiation
X) Gravitational Waves
Y) Microwaves
Z) Ultraviolet radiation

ANSWER: X) GRAVITATIONAL WAVES
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ROUND 1

TOSS-UP

3) Chemistry – *Multiple Choice* Which of the following equations/laws is used to describe the cell voltage of nonstandard cells?

W) Nernst Equation
X) Boyle's Law
Y) Arhennius Equation
Z) Standard Cell Potential Equation

ANSWER: W) NERNST EQUATION

BONUS

3) Chemistry – *Short Answer* The Nernst Equation applies to electrochemical cells. What kind of reaction occurs in these cells?

ANSWER: REDOX

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TOSS-UP

4) Biology – *Multiple Choice* What is the viral reproduction cycle that results in the destruction of the infected cell and its membrane?

W) Lysogenic
X) Lytic
Y) Prophase
Z) Translation

ANSWER: X) LYTIC

BONUS

4) Biology – *Short Answer* What glycoprotein does a HIV virus bind with?

ANSWER: CD4 (DO NOT ACCEPT T-CELLS)
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ROUND 1

TOSS-UP

5) Math – *Short Answer* What is the period of the equation y equals tangent of x?

ANSWER: π

BONUS

5) Math – *Short Answer* Order the following 3 functions of x from least to greatest at π/3: 1) x, 2) tangent of x, 3) sine of x

ANSWER: 3, 1, 2

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TOSS-UP

6) Earth and Space – *Multiple Choice* Which of the following is not a characteristic of O spectral type stars

W) Ionized helium
X) Strongest hydrogen lines
Y) Blue color
Z) Highest temperature class

ANSWER: X) STRONGEST HYDROGEN LINES

BONUS

6) Earth and Space – *Short Answer* If you were to discover a white star with a surface temperature of 8,000 K, what spectral class would that star be in?

ANSWER: A
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ROUND 1

TOSS-UP

7) Energy – *Short Answer* Researchers at SLAC National Accelerator Laboratory are using powerful lasers to simulate conditions in supernovae that create shock waves. These shock waves release streams of high-energy particles, which are known as what?

ANSWER: COSMIC RAYS

BONUS

7) Energy – *Multiple Choice* Which of the following is a way that supernovae form?

W) A white dwarf reaches a mass lower than the Chandrasaker limit
X) A white dwarf reaches a mass greater than the Chandrasekhar limit
Y) A massive star undergoes a helium flash
Z) A protostar begins fusion

ANSWER: X) A WHITE DWARF REACHES A MASS GREATER THAN THE CHANDRASEKHAR LIMIT

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TOSS-UP

8) Biology – *Multiple Choice* Which of the following make up the backbone of fats and oils?

W) Glycerol
X) Glucose
Y) Carboxylic Acid
Z) Phosphate Group

ANSWER: W) GLYCEROL

BONUS

8) Biology – *Short Answer* Which two amino acids are normally not found in alpha helices?

ANSWER: PROLINE AND GLYCINE
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ROUND 1

TOSS-UP

9) Physics – *Short Answer* What is the term for a conductor that loses its electrical resistance under certain conditions, usually at lower temperatures?

ANSWER: SUPERCONDUCTOR

BONUS

9) Physics – *Multiple Choice* Room temperature superconductors and their discovery are relevant to the progression of science in which of the following ways?

W) They would allow scientists to use superconductors is environments cooled to near absolute zero
X) They would make the superconductor have less resistance, increasing efficiency
Y) They would allow superconductors to be used in a much wider variety of environments, increasing versatility
Z) They would make the temperature of the room go down

ANSWER: Y) THEY WOULD ALLOW SUPERCONDUCTORS TO BE USED IN A MUCH WIDER ARRAY OF ENVIRONMENTS, INCREASING VERSATILITY

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TOSS-UP

10) Chemistry – *Multiple Choice* What is the chemical formula of hexanol?

W) C_4H_{10}
X) C_6H_{14}
Y) $C_6H_{14}O$
Z) C_3H_8O

ANSWER: Y) $C_6H_{14}O$

BONUS

10) Chemistry – *Short Answer* What is the term for compounds which have the same chemical formula, but a different arrangement of atoms?

ANSWER: ISOMERS

TOSS-UP
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ROUND 1

11) Math – *Multiple Choice* Simplify $\sqrt{(25 - x^2)}$ [Square root of the quantity 25 minus x squared] for x = 5 sine of theta in the range of 0 to π/2.
W) sine of theta
X) 5 cosine of theta
Y) 5 secant of theta
Z) 25 tangent of theta

ANSWER: X) 5 cosine of theta

BONUS

11) Math – *Short Answer* What is (tan 5)(2 sin 5)(3 csc 5)(5 cot 5) [The quantity tangent of 5 times the quantity 2 sine of 5 times the quantity 3 cosecant of 5 times the quantity 5 cotangent of 5]?

ANSWER: 30

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TOSS-UP

12) Earth and Space – *Short Answer* The boundary between two air masses of different density and/or temperature is known by what term?

ANSWER: FRONT

BONUS

12) Earth and Space – *Multiple Choice* Which of the following fronts exhibits a steep slope, forms dark clouds, and ushers in heavy rains and high wind speeds?

W) Warm Fronts
X) Cold Fronts
Y) Stationary Fronts
Z) Occluded Fronts

ANSWER: X) COLD FRONTS
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ROUND 1

TOSS-UP

13) Biology – *Multiple Choice* Which of the following is not a condition necessary for Hardy-Weinberg equilibrium?

W) Natural selection does not act on the population
X) The population size is finite
Y) An absence of gene flow
Z) Individuals within the population mate randomly

ANSWER: X) THE POPULATION SIZE IS FINITE

BONUS

13) Biology – *Short Answer* A population is in Hardy-Weinberg equilibrium. If 36% of the members are homozygous dominant for a certain allele, what percentage of the population is heterozygous for that allele?

ANSWER: 48%

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TOSS-UP

14) Energy – *Short Answer* Researchers at Argonne National Laboratory are studying the structure of an enzyme that uses carbon dioxide, water, and sunlight to create a liquid fuel, whose chemical formula is CH_3OH. What is the common name for this chemical?

ANSWER: METHANOL

BONUS

14) Energy – *Short Answer* What is the name for the technique that the researchers used to identify the structure of the enzyme, which is used to determine atomic and molecular structure of a crystallized protein?

ANSWER: X-RAY CRYSTALLOGRAPHY
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ROUND 1

TOSS-UP

15) Physics – *Short Answer* An object as rest accelerates at 2 meters per second squared for 5 seconds. Assuming the object starts at position x = 0, what is the final position of the object?

ANSWER: 25

BONUS

15) Physics – *Short Answer* An object is travelling down a ramp with constant acceleration. If the displacement of the object in a time of 2 seconds was 20 meters with an initial velocity of 5 meters per second, what is the magnitude of the acceleration the object experiences?

ANSWER: 5

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TOSS-UP

16) Earth and Space – *Short Answer* What common group of minerals tends to cleave into thin sheets and includes the mineral Muscovite?

ANSWER: MICA

BONUS

16) Earth and Space – *Short Answer* Cleavage is the tendency of a mineral to break along a plane or planes of weak bonding. How many planes of cleavage does fluorite have?

ANSWER: 4
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ROUND 1

TOSS-UP

17) Chemistry – *Short Answer* What is the noble gas configuration of the element with electron configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$?

ANSWER: [Ne] $3s^2\ 3p^5$

BONUS

17) Chemistry – *Short Answer* What principle states that we can never measure the exact position or velocity of a particle at any time?

ANSWER: HEISENBERG UNCERTAINTY PRINCIPLE

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TOSS-UP

18) Math – *Short Answer* What is the term for a function that is always increasing or always decreasing?

ANSWER: MONOTONIC

BONUS

18) Math – *Short Answer* What is the derivative of $3x^3$ at $x = 2$?

ANSWER: 36
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ROUND 1

TOSS-UP

19) Chemistry – *Short Answer* What is the oxidation number of oxygen in hydrogen peroxide?

ANSWER: -1

BONUS

19) Chemistry – *Short Answer* What is the oxidation number of chlorine in NaOCl [N A O C L]?

ANSWER: +1 (ACCEPT 1)

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TOSS-UP

20) Physics – *Short Answer* What is the total capacitance of two 2 farad capacitors placed in series with each other?

ANSWER: 1 FARAD

BONUS

20) Physics – *Short Answer* A fully charged capacitor is disconnected from a battery source when a piece of paper is placed between its plates. Identify whether the following 3 quantities will increase, decrease, or remain the same: voltage, electric field, charge?

ANSWER: VOLTAGE DECREASES, ELECTRIC FIELD DECREASES, CHARGE REMAINS CONSTANT
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ROUND 1

TOSS-UP

21) Earth and Space – *Multiple Choice* Which of the following types of volcanoes are formed in a single, short-lived eruptive event and are relatively small, with heights typically between 30 and 300 meters?

W) Composite Volcanoes
X) Shield Volcanoes
Y) Lava domes
Z) Cinder Cones

ANSWER: Z) CINDER CONES

BONUS

21) Earth and Space – *Short Answer* What term is given to a mudflow caused by the saturation of volcanic debris and results in a downward flow of volcanic material?

ANSWER: LAHAR

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TOSS-UP

22) Biology – *Short Answer* By name or number, order the following 4 parts of the plant stem in order from the center of the stem to the surface: 1) Pith, 2) Xylem, 3) Epidermis, 4) Phloem.

ANSWER: PITH, XYLEM, PHLOEM, EPIDERMIS (ACCEPT 1,2,4,3)

BONUS

22) Biology – *Short Answer* You find a small hard cell with lignified cell walls. Which type of ground tissue cell is it?

ANSWER: SCLEREID (ACCEPT SCLERENCHYMA)
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ROUND 1

TOSS-UP

23) Math – *Short Answer* What is the minimum value of $x^2 - 2x - 6$?

ANSWER: -7

BONUS

23) Math – *Multiple Choice* What is the limit as x approaches 0 from the positive side of x^x [read as x to the power of x]?
W) 0
X) 1
Y) e
Z) Does Not Exist

ANSWER: X) 1