ROUND 4

TOSS-UP

1) Physics – *Multiple Choice* A solid metal sphere has a positive net charge. How is the charge distributed on the sphere?

W) It is concentrated at the center of the sphere.
X) It is uniformly distributed throughout the sphere.
Y) It is uniformly distributed on the surface of the sphere.
Z) It depends on how the sphere was charged.

ANSWER: Y) IT IS UNIFORMLY DISTRIBUTED ON THE SURFACE OF THE SPHERE

BONUS

1) Physics – *Short Answer* A train traveling along a North to South train line experiences a 1000 N force from wind travelling from East to West. Over 100 meters of displacement of the train, how much work does the wind do on the train?

ANSWER: 0

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TOSS-UP

2) Energy – *Short Answer* New Regional Climate Models, also known as RCMs, are able to better simulate the complex pattern of airflow over mountains, showing that not as much moisture is lost as previously thought. What is the name for the effect that typically results in droughts on the leeward side of mountains?

ANSWER: RAINSHADOW EFFECT

BONUS

2) Energy – *Multiple Choice* The RCMs show that more moisture is retained as air flows over mountains in the southeast U.S. than previously believed. Which of the following best explains how these findings change thoughts about the climate in the southeast U.S.?

W) The southeast is less susceptible to droughts than previously thought.
X) The southeast is more susceptible to droughts than previously thought.
Y) The southeast has a more arid climate than previously thought.
Z) The southeast has fewer thunderstorms than previously thought.

ANSWER: W) THE SOUTHEAST IS LESS SUSCEPTIBLE TO DROUGHTS THAN PREVIOUSLY THOUGHT
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ROUND 4

TOSS-UP

3) Chemistry – *Short Answer* What is the standard cell potential, in volts, of a concentration cell?

ANSWER: 0

BONUS

3) Chemistry – *Short Answer* Give the chemical formulas for what forms at the cathode and anode in the electrolysis of molten NaCl?

ANSWER: CATHODE - Na, ANODE - Cl_2

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TOSS-UP

4) Biology - *Short Answer* Which amino acid is known to form disulfide bonds?

ANSWER: CYSTEINE

BONUS

4) Biology - *Multiple Choice* What is the most abundant storage polysaccharide in animals?

W) Starch
X) Glycogen
Y) Cellulose
Z) Lactose

ANSWER: W) GLYCOGEN
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ROUND 4

TOSS-UP

5) Math – *Multiple Choice* Which of the following is not an undefined term of geometry?

W) A triangle
X) A plane
Y) A point
Z) A line

ANSWER: W) A TRIANGLE

BONUS

5) Math – *Short Answer* How many solutions does sec x = 1/2 (READ secant of x equals one half) have for an unrestricted domain?

ANSWER: NONE

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TOSS-UP

6) Earth and Space - *Short Answer* When astronomers observed Uranus in the night sky, they noticed that a star would dim before its occultation by Uranus. What objects were discovered through this observation?

ANSWER: URANUS' RINGS (ACCEPT: RINGS)

BONUS

6) Earth and Space - *Multiple Choice* Which of the following planets can be observed in the night sky, but always stays within 28 degrees of the Sun?

W) Jupiter
X) Mars
Y) Mercury
Z) Uranus

ANSWER: Y) MERCURY
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ROUND 4

TOSS-UP

7) Energy – *Short Answer* Researchers at Argonne National Laboratory are studying how a subfamily of glucosidase enzymes is involved in the production of biofuels from biomass. These enzymes catalyze the hydrolysis of what common polysaccharide in plants, which is typically found in cell walls, into simple fermentable sugars.

ANSWER: CELLULOSE

BONUS

7) Energy – *Short Answer* What imaging technique did these researchers use to determine the structure of the protein, which utilizes x-ray diffraction?

ANSWER: X-RAY CRYSTALLOGRAPHY

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TOSS-UP

8) Biology - *Short Answer* Which replication enzyme separates the two strands of DNA at the replication fork?

ANSWER: DNA HELICASE

BONUS

8) Biology - *Short Answer* Which protein is responsible for providing structural support for DNA by packing and ordering it?

ANSWER: HISTONES
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ROUND 4

TOSS-UP

9) Physics – *Multiple Choice* In which of the following circuits would a lightbulb with resistance 10 ohms have the greatest brightness at time t = 0 if the circuit always has one battery with voltage V = 10 volts?

W) A circuit with two resistors in parallel each with resistance 5 ohms and lightbulb in series with the battery
X) A circuit with two resistors in parallel each with resistance 5 ohms and lightbulb in series with one of the resistors
Y) A circuit with two resistors in series each with resistance 5 ohms and lightbulb also in series
Z) A circuit with two resistors in series each with resistance 5 ohms and lightbulb in parallel to the resistors.

ANSWER: Z) A CIRCUIT WITH TWO RESISTORS IN SERIES EACH WITH RESISTANCE 5 OHMS AND LIGHTBULB IN PARALLEL TO THE RESISTORS

BONUS

9) Physics – *Short Answer* Two resistors both with resistance 10 ohms are connected in parallel in a circuit that has a current of 5 A. What is the voltage of the circuit?

ANSWER: 25 V

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TOSS-UP

10) Chemistry – *Multiple Choice* Which of the following indicators would be the most appropriate for the titration of a weak acid with a strong base?

W) Methyl Orange
X) Bromothymol Blue
Y) Phenolphthalein
Z) Methyl Red

ANSWER: Y) PHENOLPHTHALEIN

BONUS
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ROUND 4

10) Chemistry – *Short Answer* What is the term for the point in a titration at which the indicator changes color?

ANSWER: ENDPOINT

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TOSS-UP

11) Math – *Short Answer* What is the shape of the polar graph defined by r = 3?

ANSWER: CIRCLE

BONUS

11) Math – *Short Answer* A Gaussian integer is a complex number such that the real and imaginary parts are both integral. How many Gaussian integers have magnitude 5?

ANSWER: 12

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TOSS-UP

12) Earth and Space - *Multiple Choice* Which of the following best describes a perched water table?

W) a water table that has been raised by tectonic movement in the Earth's crust, creating a hump in the unsaturated zone where groundwater can exist
X) a water table that has been lowered by tectonic movement in the Earth's crust, creating a cone-shaped section in the saturated zone where groundwater cannot exist
Y) a water table that exists below the main water table formed when the roots of a large mountain or other landmass causes the original water table to separate over time
Z) a water table that exists above the main water table due to the presence of an aquitard stopping the downward movement of water from the unsaturated zone towards the saturated zone

ANSWER: Z) A WATER TABLE THAT EXISTS ABOVE THE MAIN WATER TABLE DUE TO THE PRESENCE OF AN AQUITARD STOPPING THE DOWNWARD MOVEMENT OF WATER FROM THE UNSATURATED ZONE TOWARDS THE SATURATED ZONE

ROUND 4

BONUS

12) Earth and Space - *Short Answer* What characteristic of a rock determines the ability of the material to allow a fluid to flow and, along with porosity, is the most important factor affecting the rate of groundwater movement?

ANSWER: PERMEABILITY

ROUND 4

TOSS-UP

13) Biology - *Short Answer* What is the name of the phylum that fish belong to?

ANSWER: CHORDATA

BONUS

13) Biology - *Short Answer* By name or number, identify all of the following 4 organisms that can be hermaphrodites: 1) sponges, 2) starfish, 3) snails, 4) squids

ANSWER: 1, 2, 3 (ACCEPT ALL BUT 4)

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TOSS-UP

14) Energy – *Short Answer* Scientists are studying the effect of higher temperatures on the decomposition of organic matter and release of carbon dioxide. What would this be an example of, assuming higher temperatures resulted in the increase of decomposition, which in turn results in higher temperatures?

ANSWER: POSITIVE FEEDBACK LOOP (ACCEPT POSITIVE FEEDBACK)

BONUS

14) Energy – *Multiple Choice* In this experiment, there was initially no detectable increase in decomposition. However, over time the carbon-use efficiency for complex compounds of the microbes increased with higher temperatures. After 15 years, there began a detectable increase in carbon dioxide emissions in areas with higher temperatures. What do the results of this experiment suggest about the effect of temperature on the decomposition of organic matter?

W) Higher temperatures increased the decomposition of both simple and complex carbon compounds.
X) Higher temperatures increased the decomposition of simple, but not complex carbon compounds.
Y) Higher temperatures increased the decomposition of complex, but not simple carbon compounds.
Z) Higher temperatures had no effect on the decomposition of both simple and complex carbon compounds.

ANSWER: Y) HIGHER TEMPERATURES INCREASED THE DECOMPOSITION OF COMPLEX, BUT NOT SIMPLE CARBON COMPOUNDS
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ROUND 4

TOSS-UP

15) Physics – *Multiple Choice* A current in a long wire is travelling from east to west. In what direction is the magnetic field at a point directly above the wire?

W) North
X) South
Y) Down
Z) Up

ANSWER: W) NORTH

BONUS

15) Physics – *Short Answer* What rule says that the sum of the potential differences around a closed loop is 0?

ANSWER: KIRCHOFF'S LOOP RULE

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TOSS-UP

16) Earth and Space - *Short Answer* Which layer of the atmosphere, known for being extremely cold, is hard to access due to the fact that neither the highest reaching research balloons nor the lowest orbiting satellites can reach it?

ANSWER: MESOSPHERE

BONUS

16) Earth and Space - *Multiple Choice* Which of the following types of fog forms as heat is given off by the surface of Earth, typically during the night, causing the temperature of the surrounding air to drop and eventually form a fog?

W) valley fog
X) advection fog
Y) upslope fog
Z) radiation fog

ANSWER: Z) RADIATION FOG
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ROUND 4

TOSS-UP

17) Chemistry – *Short Answer* What is the oxidation state of oxygen in barium peroxide?

ANSWER: -1

BONUS

17) Chemistry – *Short Answer* What is the oxidation number of platinum in cisplatin, which has molecular formula $Pt(NH_3)_2Cl_2$ [P T open parentheses N H 3 close parenthesis 2 C L 2]?

ANSWER: +2 (ACCEPT 2)

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TOSS-UP

18) Math – *Short Answer* Angles A and B are supplementary. What is the arithmetic mean of $m\angle A$ and $m\angle B$(READ the measure of angle A and the measure of angle B) in degrees?

ANSWER: 90

BONUS

18) Math – *Short Answer* What is of an equilateral triangle with side length 4? Express your answer in simplest radical form.

ANSWER: $4\sqrt{3}$
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ROUND 4

TOSS-UP

19) Chemistry – *Short Answer* What is the name of the compound Ni_2Se_3?

ANSWER: NICKEL (III) SELENIDE

BONUS

19) Chemistry – *Short Answer* To the nearest integer, what is the percent by mass of oxygen in ammonium nitrate?

ANSWER: 60

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TOSS-UP

20) Physics – *Multiple Choice* In which of the following scenarios requires the least amount of force to make a 10 kg box travel at a constant speed along a rough surface?

W) Pull the box on a horizontal slope with a force at an angle above the horizontal.
X) Pull the box on a horizontal slope with a force at an angle below the horizontal.
Y) Push the box on a horizontal slope with a force at an angle above the horizontal.
Z) Push the box up on an upward slope with a force at the horizontal.

ANSWER: W) PULL THE BOX ON A HORIZONTAL SLOPE WITH A FORCE AT AN ANGLE ABOVE THE HORIZONTAL

BONUS

20) Physics – *Short Answer* If two sounds with similar frequencies are played, the frequency of the beat heard as a result of their interference is what function of the frequencies of the initial sounds?

ANSWER: ABSOLUTE DIFFERENCE (ACCEPT: DIFFERENCE)
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ROUND 4

TOSS-UP

21) Earth and Space - *Multiple Choice* Which of the following is NOT one of the three requirements set by the International Astronomical Union that must be met by a celestial body in order for it to be considered a planet?

W) the celestial body must orbit a star
X) the celestial body must be large enough to assume a round, spherical shape
Y) the celestial body must have "cleared" any objects near to or along the path of its orbit
Z) the celestial body must be large enough to maintain a thin atmosphere

ANSWER: Z) THE CELESTIAL BODY MUST BE LARGE ENOUGH TO MAINTAIN A THIN ATMOSPHERE

BONUS

21) Earth and Space - *Short Answer* By name or number, select all of the following 5 choices that are dwarf planets: 1) Eris, 2) Io, 3) Haumea, 4) Makemake, 5) Ganymede.

ANSWER: ERIS, HAUMEA, MAKEMAKE (ACCEPT 1, 3, 4)

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TOSS-UP

22) Biology - *Multiple Choice* Which is the most abundant immunoglobulin?

W) IgA
X) IgD
Y) IgE
Z) IgG

ANSWER: Y) IGG

BONUS

22) Biology - *Multiple Choice* What is the order of blood flow through the heart?

W) Right ventricle, right atrium, lungs, left ventricle, left atrium, body
X) Right ventricle, right atrium, body, left ventricle, left atrium, lungs
Y) Right atrium, right ventricle, lungs, left atrium, left ventricle, body
Z) Right atrium, right ventricle, body, left atrium, left ventricle, lungs
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ANSWER: Y) RIGHT ATRIUM, RIGHT VENTRICLE, LUNGS, LEFT ATRIUM, LEFT VENTRICLE, BODY

ROUND 4

TOSS-UP

23) Math – *Short Answer* What is the name of the graph defined by $4x^2 - y^2 = 4$?

ANSWER: HYPERBOLA

BONUS

23) Math – *Short Answer* How many cubic nanometers are in a cubic kilometer? Express your answer as a power of 10.

ANSWER: 10^{36}