ROUND 6

TOSS-UP

1) Physics – *Short Answer* If infinity is taken to have a voltage of 0, what is the voltage at a point halfway between two charges of 10 coulombs that are 10 meters apart due to the two charges? Give answers in terms of the Coulomb constant if necessary.

ANSWER: VOLTAGE: 2K

BONUS

1) Physics – *Short Answer* A 12 V battery is connected to a capacitor with plate separation 1 cm. If the plate separation is increased to 2 cm, what is the new voltage between the plates of the charged capacitor?

ANSWER: 12 V

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TOSS-UP

2) Energy – *Short Answer* Lawrence Berkeley National Laboratory has recently conducted research that makes strides in the area of nanomaterial design of what technology which absorbs photons to bring electrons to a higher energy level, and that accelerates the conversion of sunlight to fuel?

ANSWER: PHOTOCATALYST

BONUS

2) Energy – *Short Answer* Researchers at Lawrence Berkeley have found a promising new design of fuel generation that relies on different particles in a mixture playing different roles. One of the particles donates electrons, emitted because of the sunlight, and the other particle accepts them. What specific type of photoelectron spectroscopy did the scientists use to measure the number of electrons transferred from donor to acceptor?

ANSWER: X-RAY PHOTOELECTRON SPECTROSCOPY (ACCEPT: X-RAY)
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ROUND 6

TOSS-UP

3) Chemistry – *Short Answer* Which of the following solutions has the highest boiling point?

W) 0.30*m* (READ: 0.30 molal) glucose
X) 0.20*m* sodium nitrate
Y) 0.15*m* potassium sulfate
Z) 0.10*m* Aluminum nitrate
ANSWER: Y) 0.15*m* POTASSIUM SULFATE

BONUS

3) Chemistry – *Multiple Choice* Given the following information, find the change in enthalpy of the reaction $4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$: $N_2 + 3H_2 \rightarrow 2NH_3$ has $\Delta H = -92$ kJ/mol, $H_2O \rightarrow H_2 + 1/2\ O_2$ has $\Delta H = 286$ kJ/mol.

W) 674 kJ/mol
X) -674 kJ/mol
Y) 1532 kJ/mol
Z) - 1532 kJ/mol

ANSWER: Z) -1532 KJ/MOL

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TOSS-UP

4) Biology – *Multiple Choice* At what level of protein structure are disulfide bridges first formed?

W) Primary
X) Secondary
Y) Tertiary
Z) Quaternary

ANSWER: Y) TERTIARY

BONUS

4) Biology – *Short Answer* What type of protein assists in the folding of other proteins?
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ANSWER: CHAPERONIN

ROUND 6

TOSS-UP

5) Math – *Short Answer* As n approaches infinity, what is the ratio of the $n+1^{th}$ term to the n^{th} term of the Fibonacci sequence?

ANSWER: $(1 + \sqrt{5})/2$

BONUS

5) Math – *Multiple Choice* What are the radius and height respectively of a cone made out of a circular sector with radius 2 and central angle π?

W) radius: 1; height: $\sqrt{3}$
X) radius: 1; height: 2
Y) radius: $\sqrt{3}$; height: 1
Z) radius: $\sqrt{2}$; height: 2

ANSWER: W) RADIUS: 1; HEIGHT: $\sqrt{3}$

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TOSS-UP

6) Earth and Space – *Short Answer* What was the first period of the first era of the Phanerozoic eon?

ANSWER: CAMBRIAN

BONUS

6) Earth and Space – *Short Answer* Trace amounts of what two elements cause a blue tinge in corundum, resulting in blue sapphires?

ANSWER: TITANIUM AND IRON (IN ANY ORDER)
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ROUND 6

TOSS-UP

7) Energy – *Short Answer* A research team at Lawrence Livermore National Laboratory is studying how selenium changes shape as it goes from selenium-70 to selenium-72 and vice versa. A selenium-72 atom could decay into a germanium-68 atom with what single decay type?

ANSWER: ALPHA DECAY

BONUS

7) Energy – *Multiple Choice* To produce the radioactive selenium-72 in the experiment, researchers bombarded a beryllium foil with a krypton beam at 30% of the speed of light. What is the Lorentz Factor to the nearest hundredth for the krypton beam?
W) 0.98
X) 1.05
Y) 1.09
Z) 1.16

ANSWER: X) 1.05

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TOSS-UP

8) Biology – *Multiple Choice* Which of the following components of the cytoskeleton are composed of tubulin dimers?

W) Microfilaments
X) Intermediate Filaments
Y) Microtubules
Z) Myosin

ANSWER: Y) MICROTUBULES

BONUS

8) Biology – *Short Answer* By name or number, identify all of the following that are characteristics of microtubules: 1) They form the cleavage furrow during cell division in animal cells, 2) They help maintain the cell's shape, 3) They make up the nuclear lamina, 4) They make up the centromeres, 5) They are the main component of cilia and flagella

ANSWER: 2, 4, 5 (ACCEPT)
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ROUND 6

TOSS-UP

9) Physics – *Short Answer* In a mass spectrometer, charged particles are fired through perpendicular electric fields and magnetic fields in order to determine the velocity of all particles that travel a straight line path between the plates of the capacitor generating the magnetic field. What is the term for such a region?

ANSWER: VELOCITY SELECTOR

BONUS

9) Physics – *Short Answer* Particles with varying velocities and a charge of 2 μC [2 microcoulombs] are fired through a velocity selector with an electric field of 10 N/C and a magnetic field of 0.2 T. The particles that follow a straight line path through the velocity selector then experience a centripetal acceleration of 10 m/s^2 due to an external magnetic field. What is the radius of the path the particles travel in?

ANSWER: 250 m

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TOSS-UP

10) Chemistry – *Multiple Choice* Which of the following would be plotted vs time to linearize the data for a second order reaction with concentration of the reactant A?

W) A
X) A^2
Y) 1/A
Z) $\sqrt{A}$

ANSWER: Y) 1/A

BONUS

10) Chemistry – *Short Answer* What is the EXACT expression for the half life of a substance in a first order reaction with equilibrium constant K?

ANSWER: (ln 2)/K
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ROUND 6

TOSS-UP

11) Math – *Short Answer* What is the characteristic of the log 123,456,789 [logarithm of 123,456,789]?

ANSWER: 8

BONUS

11) Math – *Short Answer* Find a if a = 3b, and the log of b base a has the same value as the log of a base b.

ANSWER: √3

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TOSS-UP

12) Earth and Space – *Short Answer* What is the most common name for inactive volcanic islands with tops that have been eroded over time, making their tops flat, and have sunk back into the ocean?

ANSWER: GUYOTS

BONUS

12) Earth and Space – *Multiple Choice* Which of the following is true about an accretionary wedge?

W) Accretionary wedges are found at divergent plate boundaries on the ocean floor and is part of the system through which seafloor spreading occurs.
X) Accretionary wedges occur at active continental margins and are sites where material is accumulating due to a piece of subducting oceanic lithosphere pushing sediment together.
Y) Accretionary wedges are found in areas above ground with large amounts of weathering and erosion due to wind and water.
Z) Accretionary wedges occur when sediment is carried into the ocean by currents and spread out in a wedge-like shape on the continental rise.

ANSWER: X) ACCRETIONARY WEDGES OCCUR AT ACTIVE CONTINENTAL MARGINS AND ARE SITES WHERE MATERIAL IS ACCUMULATING DUE TO A PIECE OF SUBDUCTING OCEANIC LITHOSPHERE PUSHING SEDIMENT TOGETHER
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ROUND 6

TOSS-UP

13) Biology – *Short Answer* What is the term for the adaptations a plant makes to growing in a dark environment, which include pale coloring and long, weak stems?

ANSWER: ETIOLATION

BONUS

13) Biology – *Short Answer* By name or number, identify all of the following 4 statements about brassinosteroids that are true: 1) They can inhibit root growth, 2) They can promote root growth, 3) They promote phloem differentiation, 4) They promote pollen tube elongation

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

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TOSS-UP

14) Energy – *Multiple Choice* Nuclear physicists at Brookhaven National Laboratory are studying quantum spin. The exact quantum spin of a proton is ½ of what constant?

ANSWER: REDUCED PLANK CONSTANT (DO NOT ACCEPT: PLANCK'S CONSTANT)

BONUS

14) Energy – *Short Answer* These physicists are studying the "spin tune" of polarized protons. What is spin tune?

W) The number of times the proton axis shifts during a rotation
X) The frequency of the sound emitted by the proton
Y) The number of times the proton rotates during an axis shift
Z) The frequency of rotation divided by the reduced Planck constant"

ANSWER: W) THE NUMBER OF TIMES THE PROTON AXIS SHIFTS DURING A ROTATION
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ROUND 6

TOSS-UP

15) Physics – *Multiple Choice* Find the power of a lens with a focal length 2 cm in SI units.

ANSWER: 0.5 DIOPTERS

BONUS

15) Physics – *Short Answer* Which of the following is closest to the image height formed by a converging lens with focal length 6 cm, if the object is placed at a distance of 4 cm from the center of curvature of the lens and has a height 5 cm?

W) 5 cm
X) 10 cm
Y) 15 cm
Z) 20 cm

ANSWER: Y) 15 CM

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TOSS-UP

16) Earth and Space – *Multiple Choice* Which of the following events generally takes place first in cultural eutrophication?

W) Dissolved oxygen decreases
X) Sunlight is blocked by algae on the surface of the water
Y) A body of water gets an abundance of nutrients
Z) Algal bloom

ANSWER: Y) A BODY OF WATER GETS AN ABUNDANCE OF NUTRIENTS

BONUS

16) Earth and Space – *Multiple Choice* Which of the following is least likely to directly cause cultural eutrophication?

W) Littering
X) Deforestation
Y) Fish farming
Z) Sewage discharge

ANSWER: W) LITTERING
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ROUND 6

TOSS-UP

17) Chemistry – *Multiple Choice* For what values of entropy and enthalpy is a reaction spontaneous at low temperatures and non spontaneous at high temperatures?

W) positive entropy and positive enthalpy
X) positive entropy and negative enthalpy
Y) negative entropy and negative enthalpy
Z) negative entropy and positive enthalpy

ANSWER: Y) NEGATIVE ENTROPY AND NEGATIVE ENTHALPY

BONUS

17) Chemistry – *Short Answer* The dissolution of solid urea in water leads to a temperature drop in the surroundings. Which of the following describes the signs of Delta H and Delta S?

W) Delta H - Negative, Delta S - Positive
X) Delta H -Positive, Delta S - Positive
Y) Delta H - Negative, Delta S - Negative
Z) Delta H -Positive, Delta S - Negative

ANSWER: X) DELTA H - POSITIVE, DELTA S - POSITIVE

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TOSS-UP

18) Math – *Short Answer* If today is Monday, then what day of the week will it be after 1729 days?

ANSWER: MONDAY

BONUS

18) Math – *Short Answer* What is the minimum value of $\sin^4(x) + 1.5\cos^4(x)$ [Sine of x to the fourth power plus 1.5 times the quantity cosine of x to the fourth power]?

ANSWER: ⅗ (ACCEPT .6)
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ROUND 6

TOSS-UP

19) Chemistry – *Short Answer* What term is used to describe the total amount of thermodynamic potential that can be used to perform work at constant pressure and temperature in a system?

ANSWER: GIBBS FREE ENERGY

BONUS

19) Chemistry – *Multiple Choice* What term describes the total amount of thermodynamic potential that can be used to perform work at constant temperature and volume?

ANSWER: HELMHOLTZ FREE ENERGY

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TOSS-UP

20) Physics – *Short Answer* What is the basic unit of information in quantum computing?

ANSWER: QUBIT

BONUS

20) Physics – *Short Answer* Quantum computers used in the field of quantum computing need to be very cold, often under 1 degree Kelvin. Virtually all objects being supercooled to less than 1 microkelvin or even 1 nanokelvin are cooled with what device that relies on the fact that photons have momentum?

ANSWER: LASER

TOSS-UP

21) Earth and Space – *Short Answer* What is the most abundant element in Jupiter by volume?

ANSWER: HYDROGEN

BONUS
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ROUND 6

21) Earth and Space – *Multiple Choice* Plutinos are a class of trans-Neptunian objects that are unique because of their 3:2 resonance with Neptune. What does this mean?

W) For every 3 times that the plutinos orbit the Sun, Neptune orbits the Sun 2 times.
X) For every 2 times that the plutinos orbit the Sun, Neptune orbits the Sun 3 times.
Y) For every 2 revolutions that the plutinos make, Neptune makes 3 revolutions.
Z) The radius of the plutinos' orbit is in the ratio 3:2 with the radius of Neptune's orbit.

ANSWER: X) FOR EVERY 2 TIMES THAT THE PLUTINOS ORBIT THE SUN, NEPTUNE ORBITS THE SUN 3 TIMES

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TOSS-UP

22) Biology – *Short Answer* What popular idea did Redi's experiment disprove?

ANSWER: SPONTANEOUS GENERATION

BONUS

22) Biology – *Multiple Choice* If it is known that nitrogen is present in the R group of an amino acid AND the amino acid is hydrophobic, then which of the following amino acids must it be?

W) Glycine
X) Threonine
Y) Tryptophan
Z) Phenylalanine

ANSWER: Y) Tryptophan
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ROUND 6

TOSS-UP

23) Math – *Multiple Choice* A quadratic F(y) = F(-y) for some value of y. Which of the following can be concluded about the quadratic or the coefficients of the x^2, x, and constant terms?

W) The quadratic is monotonic.
X) The quadratic is odd.
Y) The coefficient of the x term is y.
Z) The coefficient of the x term is 0.

ANSWER: Z) THE COEFFICIENT OF THE X TERM IS 0

BONUS

23) Math – *Short Answer* For a sixth degree polynomial with a leading coefficient of 1, F(n) = 1 for all n = 0, 1, 2, 3, 4, 5. What is F(6)?

ANSWER: 721