ROUND 12

TOSS-UP

1) Physics – *Short Answer* Discrepancies in experimental measurements of rotational motion and theoretical plots of galaxies undergoing rotational motion led to the proposal of what substance?

ANSWER: DARK MATTER

BONUS

1) Physics – *Multiple Choice* Tim throws a beach ball vertically upward, and it falls in the presence of air resistance. At what moment in its fall is the magnitude of the ball's acceleration greatest?

W) When it first leaves Tim's hand
X) When it reaches the apex of its trajectory
Y) The moment before it hits the ground
Z) The acceleration is constant throughout the ball's flight

ANSWER: W) WHEN IT FIRST LEAVES TIM'S HAND

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TOSS-UP

2) Energy – *Short Answer* Scientists are studying how an increase in nitrogen in an environment affects the decomposition of dead plant materials by fungi and microbes. What is the term for how fungi obtain their nutrients?

ANSWER: SAPROPHYTIC NUTRITION (ACCEPT SAPROPHYTIC FEEDING)

BONUS

2) Energy – *Multiple Choice* The research shows that an increase in nitrogen in an environment results in a decrease in the decomposition of dead plant materials. Which of the following events would result in a decrease in decomposition in an environment?

W) A decrease in nitrogen fixing bacteria.
X) An increase in agricultural runoff.
Y) A nuclear meltdown occurs nearby.
Z) An decrease in acidic rain.

ANSWER: X) AN INCREASE IN AGRICULTURAL RUNOFF
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ROUND 12

TOSS-UP

3) Chemistry – *Short Answer* What is the name for the type of reaction in which two chemical species are joined together with the aid of a metal catalyst?

ANSWER: COUPLING REACTION

BONUS

3) Chemistry – *Short Answer* What is the name for the effect in which light is scattered by the particles in a colloid?

ANSWER: TYNDALL EFFECT

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TOSS-UP

4) Biology - *Multiple Choice* Which of the following BEST describes why hydras are unique compared to other hydrozoans?

W) They exist only in the polyp stage
X) They exist only in the medusa stage
Y) They can exist in both the medusa and polyp stage
Z) They exist in a third stage that is different from polyp or medusa

ANSWER: W) THEY EXIST ONLY IN THE POLYP STAGE

BONUS

4) Biology - *Multiple Choice* The phylum cycliophora contains only one species. What bizarre property does this species have that makes it unique?

W) It is born without a mouth
X) Females are born pregnant
Y) They have a lophosphere
Z) It will break its own bones to intimidate enemies

ANSWER: X) FEMALES ARE BORN PREGNANT
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ROUND 12

TOSS-UP

5) Math – *Multiple Choice* Which of the following is not a common name given to a type of limacon (Leem-uh-sohn)?

W) Concave Limacon
X) Dimpled limacon
Y) Cardioid
Z) Convex limacon

ANSWER: W) CONCAVE LIMACON

BONUS

5) Math – *Short Answer* Find the arclength of the graph of y =$\sqrt{4 - x^2}$ (READ y equals the square root of 4 minus x squared) from x = 0 to x = 2.

ANSWER: π

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TOSS-UP

6) Earth and Space - *Multiple Choice* What would an increase in the concentration of oxygen-18 in ocean sediments from a specific time period signify about that period?

W) sea levels were higher than usual
X) sea levels were lower than usual
Y) there was an ice age in that period
Z) that period had warmer temperatures than usual

ANSWER: Y) THERE WAS AN ICE AGE IN THAT PERIOD

BONUS

6) Earth and Space - *Short Answer* By name or number, identify all of the following 4 organisms that were present during the Tertiary Period: 1) Trilobites, 2) Ammonites, 3) Marsupials, 4) Birds.

ANSWER: 3, 4 (ACCEPT: MARSUPIALS, BIRDS)
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ROUND 12

TOSS-UP

7) Energy – *Short Answer* Researchers at the DOE BioEnergy Science Center are analyzing how well a bacterium, *Clostridium phytofermentans* converts different types of biofuel into ethanol. What is the name for the catabolic process that is generally used to convert biofuel to ethanol?

ANSWER: FERMENTATION

BONUS

7) Energy – *Multiple Choice* In this experiment, differences in ethanol production are based on the compounds found in the biomass. There was a significant difference in ethanol production of biomass that came from different individuals of the same species. Which of the following best explains the reason for this difference?

W) There were subtle genetic differences between individuals.
X) Some of the individuals were drier than other individuals, affecting the composition of the biomass.
Y) There was human error in the experiment, resulting in the significant difference.
Z) The difference was simply due to random chance.

ANSWER: W) THERE WERE SUBTLE GENETIC DIFFERENCES BETWEEN INDIVIDUALS

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TOSS-UP

8) Biology - *Short Answer* What is the name of the solution that is typically added after the addition of the crystal violet dye in order to strengthen the bonds between the dye and the bacterial cell membrane?

ANSWER: LUGOL'S IODINE (ACCEPT AQUEOUS IODINE OR STRONG IODINE)

BONUS

8) Biology - *Short Answer* By name or number, identify all of the following 4 diseases that are caused by bacteria: 1) African sleeping sickness, 2) Botulism, 3) Typhoid fever, 4) Toxoplasmosis.

ANSWER: 2, 3
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ROUND 12

TOSS-UP

9) Physics – *Short Answer* An ideal monatomic gas at pressure $4.0 * 10^4$Pa undergoes an isobaric process that raises its volume from $2.0 * 10^{-3}\ m^3$ to $2.0 * 10^{-2}\ m^3$. How many joules of work does the gas do on its environment?

ANSWER: $7.2 * 10^2$ (ACCEPT: 720) (*MUST BE POSITIVE*)

BONUS

9) Physics – *Short Answer* The radiation emitted by an ideal blackbody triples. What would be the associated change in temperature?

ANSWER: $\sqrt[4]{3}$

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TOSS-UP

10) Chemistry – *Multiple Choice* Consider the following equilibrium reaction, FeO(solid) + CO(gas) ↔ Fe(solid) + CO_2(gas), where ΔH (read as: delta H) equals −10 kilojoules. Which of the following would have a similar effect on the equilibrium as increasing the temperature?

W) Decreasing the volume
X) Adding carbon monoxide
Y) Adding a catalyst
Z) Adding carbon dioxide

ANSWER: Z) ADDING CARBON DIOXIDE

BONUS

10) Chemistry – *Short Answer* What type of covalent bond is formed by two electrons from the same atom?

ANSWER: DATIVE (ACCEPT: DIPOLAR OR COORDINATE)

TOSS-UP
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ROUND 12

11) Math – *Short Answer* What function counts the number of natural numbers less than a given positive integer n that are relatively prime to n?

ANSWER: EULER'S TOTIENT FUNCTION

BONUS

11) Math – *Short Answer* Find the limit of the fraction with numerator $x^3 + 2x^2 + 7x - 30$ (READ x cubed plus 2 x squared plus 7 x minus 30) and denominator $x^2 - 4x + 4$ as x approaches 2

ANSWER: 8

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TOSS-UP

12) Earth and Space - *Multiple Choice* Which of the following best describes a fold where the oldest rock is on the top and located at the center of the fold?

W) synformal syncline
X) synformal anticline
Y) antiformal syncline
Z) antiformal anticline

ANSWER: X) SYNFORMAL ANTICLINE

BONUS

12) Earth and Space - *Multiple Choice* What is the term for the process that likely created Earth's first primitive atmosphere by releasing large amounts of water vapor, carbon dioxide, and sulfur dioxide?

ANSWER: OUTGASSING (DO NOT ACCEPT: VOLCANIC ERUPTIONS)
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ROUND 12

TOSS-UP

13) Biology - Which of the following general structures of viruses does the tobacco mosaic virus possess?

W) Helical
X) Icosahedral
Y) Viral envelope
Z) Bacteriophage

ANSWER: W) HELICAL

BONUS

13) Biology - *Multiple Choice* The CRISPR Cas9 system utilizes the natural immune system of bacteria against bacteriophages. Which of the following parts of the bacterial genome is made up of parts of the DNA of bacteriophages that tried to infect the cell in the past?

W) Leader
X) Spacer
Y) Repeat
Z) Cas9 gene

ANSWER: X) SPACER

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TOSS-UP

14) Energy – *Short Answer* Research at the Relativistically Heavy Ion Collider (RHIC) has developed a quark-gluon plasma soup that imitates matter in the early universe through Heavy Ion collisions. The spins of all the particles in the plasma soup will all be pointed in a random direction, but the average spin should have the same direction as what quantity of the system?

ANSWER: ANGULAR MOMENTUM

BONUS

14) Energy – *Short Answer* The fluid created at RHIC sets a new record for what quantity that has to do with the swirling motion in a fluid and that identifies the local spinning motion near some point in a continuum.

ANSWER: VORTICITY
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ROUND 12

TOSS-UP

15) Physics – *Short Answer* If a source moving above the speed of sound emits a sound, what is the term for the shock wave that is formed?

ANSWER: SOUND BARRIER

BONUS

15) Physics – *Short Answer* Calculate the voltage in the center of a square with point charges +2 Coulombs, +3 Coulombs, +4 Coulombs, +5 Coulombs at the vertices, clockwise around the center, and a side length of √2 meters. Approximate the Coulomb constant as $9.0 * 10^9$.

ANSWER: $1.26 * 10^{10}$ V

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TOSS-UP

16) Earth and Space - *Short Answer* By name or number, identify all of the following 4 conditions that must be present in order for an artesian system to form: 1) An elevation greater than 75 meters, 2) An inclined aquifer with one end pointed towards the surface, 3) An aquitard above and below an aquifer, 4) An average rainfall of at least 85 centimeters per year.

ANSWER: 2, 3 (ACCEPT: AN INCLINED AQUIFER WITH ONE END POINTED TOWARDS THE SURFACE, AN AQUITARD ABOVE AND BELOW AN AQUIFER)

BONUS

16) Earth and Space - *Short Answer* What is the name for the lowered water table located around a well caused when large quantities of groundwater are extracted from the well, the result of a process known as drawdown?

ANSWER: CONE OF DEPRESSION
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ROUND 12

TOSS-UP

17) Chemistry – *Short Answer* What term describes a compound that can act as an acid or a base?

ANSWER: AMPHOTERIC

BONUS

17) Chemistry – *Short Answer* By number, identify all of the following that are Lewis acids: 1) BF_3 2) Fe^{3+} 3) SiF_4

ANSWER: ALL (ACCEPT 1, 2, 3)

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TOSS-UP

18) Math – *Short Answer* Convert the polar point $(4, \frac{9\pi}{4})$ to rectangular coordinates.

ANSWER: $(2\sqrt{2}, 2\sqrt{2})$

BONUS

18) Math – *Short Answer* What is the remainder when $x^3 - 3x^2 + 4x - 2$ is divided by the quantity $x - 3$?

ANSWER: 10
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ROUND 12

TOSS-UP

19) Chemistry – *Short Answer* In the endothermic dissociation of H_2CO_3 into H^+ and HCO_3^-, which of the following would cause the pH to increase?

W) Increasing the temperature
X) Adding sodium bicarbonate
Y) Adding sodium chloride
Z) Adding carbon dioxide

ANSWER: X) ADDING SODIUM BICARBONATE

BONUS

19) Chemistry – *Multiple Choice* Which of the following is the strongest acid?

W) H_2SO_4
X) HNO_3
Y) HBr
Z) $HClO_3$

ANSWER: Y) HBr

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TOSS-UP

20) Physics – *Multiple Choice* What is the time constant for a RC circuit with resistance 2 ohms, and capacitance 5 microfarads?

W) $2.5 * 10^{-6}$
X) $3 * 10^{-5}$
Y) $7 * 10^{-6}$
Z) $1 * 10^{-5}$

ANSWER: Z) $1 * 10^{-5}$

BONUS
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20) Physics – *Short Answer* The time before a capacitor in an RC circuit reaches nearly maximum charge is known as the transient period. What is the term for the time after the circuit has become almost fully charged?

ANSWER: STEADY STATE PERIOD

ROUND 12

TOSS-UP

21) Earth and Space - *Short Answer* What are the equivalent terms for latitude and longitude, respectively, when dealing with coordinates in the celestial sphere?

ANSWER: DECLINATION AND RIGHT ASCENSION (IN THAT ORDER)

BONUS

21) Earth and Space - *Short Answer* What are the declination and right ascension of the Sun at the vernal equinox? Include units in your answer.

ANSWER: 0 DEGREES (DECLINATION) AND 0 HOURS (RIGHT ASCENSION)
(ACCEPT: 0 MINUTES OR 0 SECONDS INSTEAD OF 0 HOURS)

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TOSS-UP

22) Biology - *Short Answer* What type of depressant decreases central nervous system activity, can disturb memory and judgment, and decreases anxiety?

ANSWER: BARBITURATES (ACCEPT TRANQUILIZERS) (DO NOT ACCEPT DEPRESSANTS)

BONUS

22) Biology - *Multiple Choice* Lysergic acid diethylamide, which is also known as LSD, can be classified as what form of drug?

W) Hallucinogen
X) Stimulant
Y) Depressant
Z) Narcotic

ANSWER: W) HALLUCINOGEN
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ROUND 12

TOSS-UP

23) Math – *Short Answer* What is the value of i^{-15} (READ i to the negative 15)?

ANSWER: i

BONUS

23) Math – *Short Answer* Find the length of the latus rectum of the graph defined by $4y^2 = x - 16$.

ANSWER: $\frac{1}{4}$ (ACCEPT: 0.25)