ROUND 8

TOSS-UP

1) Physics – *Multiple Choice* A charged particle moves at a constant velocity into a large region of space containing a constant magnetic field. Which of the following is not a possible flight path for the charged particle?

W) A straight line
X) A circle
Y) A spiral
Z) A non-circular ellipse

ANSWER: Z) A NON-CIRCULAR ELLIPSE

BONUS

1) Physics – *Short Answer* Rank the following three temperatures from lowest to highest: 1) -41° F, 2) -41° C, 3) 241° K

ANSWER: 2, 1, 3

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TOSS-UP

2) Energy – *Short Answer* Scientists at Lawrence Berkeley National Laboratory are sequencing the bacteria *Catenulispora acidiphila* to obtain specific enzymes from the bacteria that can be used in future production of biofuels. What is the name for the group of enzymes that these scientists are looking for, which catalyzes the breakdown of the most abundant organic compound on Earth?

ANSWER: CELLULASE

BONUS

2) Energy – *Short Answer* The bacteria that these researchers used, *Catenulispora acidiphilia*, belongs to what gram-positive phylum of bacteria that are noted for their economic importance?

ANSWER: ACTINOBACTERIA
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ROUND 8

TOSS-UP

3) Chemistry – *Multiple Choice* Which of the following molecules is not amphoteric?

W) H_2O
X) HSO_4^-
Y) Al_2O_3
Z) CO_3^{2-}

ANSWER: Z) CO_3^{2-}

BONUS

3) Chemistry – *Short Answer* What is the pH of solution of 0.5 M acetic acid with 0.05 M sodium acetate, given the pK_b of acetate is 9.25?

ANSWER: 3.75

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TOSS-UP

4) Biology - *Multiple Choice* Low levels of which neurotransmitter is associated with Parkinson's Disease?

W) Serotonin
X) Glutamate
Y) Acetylcholine
Z) Dopamine

ANSWER: Z) DOPAMINE

BONUS

4) Biology - *Multiple Choice* Which of the following drugs is not an agonist to acetylcholine?

W) Black Widow Spider Venom
X) Nicotine
Y) Botulism
Z) Muscarine
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ANSWER: Y) BOTULISM

ROUND 8

TOSS-UP

5) Math – *Short Answer* What is the maximum number of relative extrema that a 7th degree polynomial can have?

ANSWER: 6

BONUS

5) Math – *Short Answer* What is the sum of the squares of the roots of the polynomial $7x^5 - 3x^4 + 2x^3 - 8 = 0$

ANSWER: $\frac{-19}{49}$

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TOSS-UP

6) Earth and Space - *Multiple Choice* Evaporites are a type of ocean sediment that form when evaporation leads to seawater becoming saturated with minerals, which then begin to precipitate. Which of the following categories of ocean sediment classifications do evaporites fall under?

W) terrigenous sediments
X) biogenous sediments
Y) hydrogenous sediments
Z) turbidites

ANSWER: Y) HYDROGENOUS SEDIMENTS

BONUS

6) Earth and Space - *Multiple Choice* Which of the following is true of calcareous ooze, a common biogenous sediment?

W) calcareous ooze forms in waters deeper than 4500 meters where higher levels of carbon dioxide completely dissolve organic material
X) calcareous ooze forms when organisms living in the deep ocean die and bacteria decomposes their remains
Y) calcareous ooze is a slush slightly more viscous than seawater filled with microscopic particles of dead organisms
Z) calcareous ooze forms when organisms living near the surface of the ocean die and their remains are partially dissolved by seawater
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ANSWER: Z) CALCAREOUS OOZE FORMS WHEN ORGANISMS LIVING NEAR THE SURFACE OF THE OCEAN DIE AND THEIR REMAINS ARE PARTIALLY DISSOLVED BY SEAWATER

ROUND 8

TOSS-UP

7) Energy – *Multiple Choice* An international team of scientists at Lawrence Berkeley National Laboratory are studying a species of fungi that is unique for its possession of lignases. Which of the following best explains the effect that these fungi would have on coal formation?

W) Decrease
X) Slightly Increase
Y) Greatly Increase
Z) No Effect

ANSWER: W) DECREASE

BONUS

7) Energy – *Short Answer* The introduction of this species about 300 million years ago is believed to be a likely cause of the decrease in coal formation after what geologic time period, which is named for the large coal deposits that were formed during this time?

ANSWER: CARBONIFEROUS (DO NOT ACCEPT MISSISSIPPIAN OR PENNSYLVANIAN)

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TOSS-UP

8) Biology - *Short Answer* By name or number, identify all the following 4 traits that are characteristic of monocots: 1) One cotyledon, 2) Netlike veins, 3) Taproot root system, 4) Scatter vascular tissue

ANSWER: 1, 4 IN ANY ORDER

BONUS

8) Biology - *Multiple Choice* Which of the following clades contains the largest amount of angiosperms?

W) Monocots
X) Dicots
Y) Basal Angiosperms
Z) Magnoliids

ANSWER: X) DICOTS
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ROUND 8

TOSS-UP

9) Physics – *Short Answer* The orbital period of an object orbiting around a much larger body is T, and the semi-major axis of the orbit is R. In terms of R, what could the semi-major axis be increased to in order to multiply the period by 27?

ANSWER: 9R (DO NOT ACCEPT: 9)

BONUS

9) Physics – *Short Answer* For a planet, what quantitative effect does a doubling in radius while keeping the mass constant have on the density to gravitational acceleration ratio?

ANSWER: HALVES (doubling the radius halves the ratio of density to gravitation acceleration)

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TOSS-UP

10) Chemistry – *Multiple Choice* Which of the following ions is paramagnetic?

W) O_2^{2-} (READ O 2, 2 minus)
X) F_2^{2+}
Y) N_2^{2+}
Z) B_2^{2-}

ANSWER: X) F_2^{2+}

BONUS

10) Chemistry – *Short Answer* Give the bond orders of the following three molecules, respectively: O_2^+, O_2, O_2^-

ANSWER: 2.5, 2, 1.5

TOSS-UP
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ROUND 8

11) Math – *Short Answer* In terms of pi, what is the lateral surface area of a cone with base diameter 8 and height 3?

ANSWER: *20π*

BONUS

11) Math – *Short Answer* What is the theorem that states that the product of the distances from the intersection points of a line and a given circle to a given point remains constant for all lines through the given point that intersect the given circle?

ANSWER: POWER OF A POINT

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TOSS-UP

12) Earth and Space - *Multiple Choice* Which of the following best describes how an elliptical galaxy forms?

W) forms as a spiral galaxy ages and rotation starts to slow, eventually morphing into an elliptical galaxy
X) forms as two or more smaller spiral galaxies collide with each other and merge to become an elliptical galaxy
Y) forms as the bulge width of a disk galaxy decreases while the halo lengthens due to a weakening of gravitational forces, creating an elliptical galaxy
Z) forms as a section of a large disk galaxy is cut off due to a massive cataclysmic event, possibly forming an elliptical galaxy

ANSWER: X) FORMS AS TWO OR MORE SMALLER SPIRAL GALAXIES COLLIDE WITH EACH OTHER AND MERGE TO BECOME AN ELLIPTICAL GALAXY

BONUS

12) Earth and Space - *Short Answer* What is the collective name for the two spiral galaxies located in the constellation Coma Berenices characterized by their long tails and which are likely to merge with each other within the next billion years?

ANSWER: MICE GALAXIES (ACCEPT: NGC 4676)
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ROUND 8

TOSS-UP

13) Biology - *Multiple Choice* A patient is experiencing bone pain and fragile bones due to the overproduction of a certain hormone. Of the following, which is most likely to be the hormone?

W) Growth Hormone
X) Thyroid Hormone
Y) Parathyroid Hormone
Z) Adrenaline

ANSWER: Y) PARATHYROID

BONUS

13) Biology - *Short Answer* By name or number, identify all of the following knee ligaments that attach the tibia to the femur: 1) ACL, 2) LCL, 3) MCL, 4) PCL.

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

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TOSS-UP

14) Energy – *S*Energy – *Short Answer* Researchers at the Thomas Jefferson National Accelerator Laboratory are developing new imaging tools named PhytoPET and PhytoBeta, which allow for better imaging of plants. These imaging tools were used to better understand what process in plants that leads to carbon sequestering?

ANSWER: PHOTOSYNTHESIS

BONUS

14) Energy – *Short Answer* For the PhytoPET and PhytoBeta, researchers use an isotope of carbon and track it as it moves through the plant to better understand the process of photosynthesis. Given that these imaging tools detect positron emissions, what isotope of carbon is used in this research?

ANSWER: CARBON-11
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ROUND 8

TOSS-UP

15) Physics – *Short Answer* Objects A and B both have mass 18 kg. They are sliding directly toward each other on a frictionless surface. A has speed *78* $\frac{m}{s}$ while B has speed *80* $\frac{m}{s}$. The collision between them is perfectly inelastic. What is the final speed of object B?

ANSWER: *1* $\frac{m}{s}$

BONUS

15) Physics – *Multiple Choice* An object of mass 42 kg has constant acceleration of 0.5 $\frac{m}{s^2}$. If the object starts from rest at position x = 0 m and moves in the positive x direction, which of the following is the total impulse of the object (in $\frac{kg*m}{s}$) in the time that it takes the object to travel from x = 4 m to x = 16 m?

W) 84
X) 252
Y) 6
Z) 2

ANSWER: W) 84

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TOSS-UP

16) Earth and Space - *Multiple Choice* The axial precession of Earth will eventually result in Polaris being replaced as the "North Star" by this star of variable brightness often called the second most important star after the Sun. What is the name of this star?

W) Vega
X) Arcturus
Y) Betelgeuse
Z) Canopus

ANSWER: W) VEGA

BONUS
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16) Earth and Space - *Short Answer* The famed Summer Triangle consists of three stars, one of which is Vega. What are the names of the other two stars?

ANSWER: ALTAIR AND DENEB

ROUND 8

TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following molecular geometries is not possible with a trigonal bipyramidal electron pair geometry?

W) T-Shaped
X) Seesaw
Y) Linear
Z) Square Planar

ANSWER: Z) SQUARE PLANAR

BONUS

17) Chemistry – *Short Answer* What element serves as the catalyst in the Heck reaction?

ANSWER: PALLADIUM

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TOSS-UP

18) Math – *Short Answer* How many ordered pairs of positive integers (x, y) exist such that $x + y = 100$?

ANSWER: 99

BONUS

18) Math – *Short Answer* Factor the following completely: $x^3 - 12x^2 + 41x + 30$

ANSWER: (x-5)(x-6)(x-1) (ACCEPT IN ANY ORDER)
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ROUND 8

TOSS-UP

19) Chemistry – *Multiple Choice* Which of the following is true about a catalyst?

W) It is consumed during a reaction
X) It affects both the forward and reverse reaction rate
Y) It increases the activation energy of the reaction
Z) It cannot be in the overall rate law

ANSWER: X) IT AFFECTS BOTH THE FORWARD AND REVERSE REACTION RATE

BONUS

19) Chemistry – *Short Answer* In the two-step reaction of nitrogen oxide with molecular oxygen to form nitrogen dioxide, what is the term for dinitrogen dioxide, formed in the first step of the reaction and consumed in the second?

ANSWER: INTERMEDIATE

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TOSS-UP

20) Physics – *Multiple Choice* When two different materials are charged via the triboelectric effect, which gets positively charged?

W) The more electronegative material.
X) The less electronegative material.
Y) The material with a larger coefficient of kinetic friction.
Z) The material with a smaller coefficient of kinetic friction.

ANSWER: X) THE LESS ELECTRONEGATIVE MATERIAL

BONUS

20) Physics – *Short Answer* The top of a ladder is 4 meters from the ground. The bottom is 3 meters from the wall which is perpendicular to the ground. If the bottom of the ladder slides at a rate of 2 meters per second at what rate does the top of the ladder fall instantaneously in meters per second?

ANSWER: 1.5
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ROUND 8

TOSS-UP

21) Earth and Space - *Multiple Choice* Which of the following is a long, narrow, rigid structure that points outwards at a 90 degree angle from the shore and is designed to prevent the erosion of beaches by trapping sand particles before they are carried out to sea by longshore currents?

W) flood barrier
X) tackifier
Y) groin
Z) coastal levee

ANSWER: Y) GROIN

BONUS

21) Earth and Space - *Multiple Choice* Tidal resonance is a phenomenon that can occur in semi-enclosed bodies of water when the frequency of the tides coming in and out match with the seiche [**saysh**] of the body of water. Which of the following best explains what seiche is?

W) a standing wave found in a body of water that creates a natural rocking motion within the semi-enclosed area
X) an occasional influx of water caused by the build up and subsequent release of energy from various natural sources in the form of a wave heading away from shore
Y) a surface current caused by differences in the salinity of water found near and far from the shore
Z) a surface current caused by differences in temperature between colder waters found deeper in the semi-enclosed body of water and warmer waters found closer to the surface

ANSWER: W) A STANDING WAVE FOUND IN A BODY OF WATER THAT CREATES A NATURAL ROCKING MOTION WITHIN THE SEMI-ENCLOSED AREA

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TOSS-UP

22) Biology - *Short Answer* What is the scientific name of the animal where sex-linked traits were first discorved?

ANSWER: DROSOPHILA MELANOGASTER (DO NOT ACCEPT FRUIT FLY)

BONUS
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22) Biology - *Short Answer* In flies there is a gene that codes for a grey or black body, and there is a gene that codes for normal or vestigial wings. A cross between a grey fly with normal wings and a black fly with vestigial wings results in 70 grey flies with vestigial wings, 123 black flies with normal wings, 377 black flies with vestigial wings, and 430 grey flies with normal wings. To the nearest tenth, how many map units apart are the two genes?

ANSWER: 19.3

ROUND 8

TOSS-UP

23) Math – *Multiple Choice* Which of the following is the shape of the graph of r = 4 on the polar coordinate system?

W) A vertical line
X) A horizontal line
Y) A hyperbola
Z) A circle

ANSWER: Z) A CIRCLE

BONUS

23) Math – *Short Answer* What is the center of the circle defined by the graph of $r = 4 \sin \theta - 6 \cos \theta$ on the polar coordinate system?

ANSWER (-3, 2)