ROUND 10

TOSS-UP

1) Physics – *Short Answer* Choose all 4 of the following properties that are inversely proportional to a resistor's resistance. 1) Length of the Resistor, 2) Cross area of the Resistor, 3) Resistivity of the material, 4) Conductivity of the material

ANSWER: Cross area of the Resistor and Conductivity of the Material, 2 and 4

BONUS

1) Physics – *Short Answer* If a pendulum's frequency on still ground is 30 hz, what would be the frequency of the pendulum in an elevator on Earth accelerating downwards at 2 gs?

ANSWER: 30, 30 hz

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TOSS-UP

2) Chemistry – *Multiple Choice* In a diels-alder reaction, there is a chemical reaction between a conjugated diene and a substituted alkene which is also given what common term?

W) Hexene Derivative
X) Dienophile
Y) Hexnucleophile
Z) Dilectrophile

Answer: X) Dienophile

BONUS

2) Chemistry – *Multiple Choice* Which of the following is one of the conditions for a Diels Alder reaction to occur?

W) The diene must be unconjugated
X) The diene must be in the s-cis conformation
Y) The resulting product will be chiral
Z) The double bond must act as an electrophile
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Answer: X) The diene must be in the s-cis conformation

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TOSS-UP

3) Math – *Short Answer* Three cards are drawn at random from a standard 52 card deck without replacement. What is the probability that the third card drawn is a face card given that the first two cards drawn were face cards?

ANSWER: 1/5

BONUS

3) Math – *Short Answer* Let *S* denote the set of all seven-digit numbers that can be formed from the set of digits open bracket, 1, 2,3, 4, 5, 6, 7, close bracket. How many of these seven-digit numbers are divisible by 7?

ANSWER: 720

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TOSS-UP

4) Biology – *Short Answer* Which of the following four mammals are non-eutherian?

1) Wombat
2) Human
3) Platypus
4) Black Bear

ANSWER: 1 AND 3

BONUS

4) Biology – *Multiple Choice* A trend toward the decrease in the height of birch trees on the slopes of Mount Everest as the altitude increases is an example of which of the following?

W) Directional selection
X) Cline
Y) Genetic drift
Z) Bottleneck effect

ANSWER: X) CLINE

TOSS-UP

5) Earth and Space – *Short Answer* Order the following three supercontinents from oldest to newest:

I) Columbia
II) Rodinia
III) Gondwana

ANSWER: I, II, III (ACCEPT: COLUMBIA, RODINIA, GONDWANA) [SW]

BONUS

5) Earth and Space – *Short Answer* What model describes the periodic opening and closing of ocean basins involved in the formation of supercontinents?

ANSWER: WILSON CYCLES [SW]

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TOSS-UP

6) Math – *Short Answer* Naveen randomly chooses 2024 cards from a very large number of each of the four suits of cards. Akul orders the suits based on the number of cards of each suit in increasing order. Given that Naveen chose a distinct number of cards for each suit, what is the probability Akul arranged the suits as *hearts, spades, clubs, and diamond?*

ANSWER: 1/24

BONUS

6) Math – *Short Answer* An ant is crawling along the surface of a cube, starting from one corner and ending at the opposite corner. If the cube has edge length 4, what is the shortest distance the ant can crawl to reach the opposite corner?

ANSWER: 4sqrt5

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TOSS-UP

7) Chemistry -- *Short Answer* Amide synthesis has reactants of an amine or an ammonia, a coupling agent, and what common chemical group?

Answer: Carboxylic Acid (COOH)

BONUS

7) Chemistry – *Multiple Choice* Which of the following is not a coupling agent that could be used in amide synthesis

W) DCC
X) IBCF
Y) HOBt
Z) ROOR

Answer: Z) ROOR

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TOSS-UP

8) Biology – *Multiple Choice* Which of the following is not true of viroids?

W) They replicate via rolling circle replication
X) They cannot contain double-stranded RNA
Y) They do not possess a protein coat
Z) Viroids primarily infect animals

ANSWER: Z) VIROIDS PRIMARILY INFECT ANIMALS

BONUS

8) Biology – *Short Answer* What type of nephron has a glomerulus near the junction of the cortex and medulla and loops of Henle penetrating deep into the medulla?

ANSWER: JUXTAMEDULLARY

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TOSS-UP

9) Physics – *Multiple Choice* The first known boats appeared in Egypt in the 4th millennium BCE. Boats are designed such that the center of buoyancy is where in relation with the center of gravity?

W) Below
X) Above
Y) Horizontally Level
Z) Overlapping

ANSWER: W) Below

BONUS

9) Physics – *Short Answer* Consider all surfaces as perfectly smooth. A plastic cube floats in a container of water. A person pushes the plastic cube down, such that the cube's entire bottom face is in contact with the container. Choose all of the three following forces that act on the cube: 1) Gravitational Force, 2) Buoyant Force, 3) Normal Force

ANSWER: Gravitational Force and Normal Force, 1 and 3

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TOSS-UP

10) Earth and Space – *Multiple Choice* Emission nebulae often appear to be what color because of their strong emissions of the Balmer Series?

W) Red
X) Yellow
Y) Green
Z) Blue

ANSWER: W) RED [SW]

BONUS

10) Earth and Space – *Short Answer* What is the term for when the carbon-oxygen core of a white dwarf suddenly fuses in a nuclear reaction?

ANSWER: CARBON DEFLAGRATION [SP]

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TOSS-UP

11) Earth and Space – *Short Answer* What term refers to a region of interstellar, ionized atomic hydrogen?

ANSWER: H II (read: H-TWO) [SW]

BONUS

11) Earth and Space – *Multiple Choice* Which of the following is closest to the percentage of hydrogen in the interstellar medium?
W) 60%
X) 70%
Y) 80%
Z) 90%

ANSWER: X) 70% [SW]

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TOSS-UP

12) Physics – *Short Answer* A lumberjack cuts down a five-meter-tall tree one meter above the ground. Assuming the gravitational acceleration of the Earth is 10 meters per second squared and that the tree is flat and is not rotating when it hits the floor, what is the highest speed the log reaches?

ANSWER: 2 sqrt(15), 2 sqrt(15) meters per second

BONUS

12) Physics – *Short Answer* It is said that the rotational symmetry of the Lagrangian of a system about the axis of rotation corresponds to the conservation of angular momentum of the system. What theorem in classical mechanics correlates a symmetry of the Lagrangian of a system to a conservation law?

ANSWER: Noether's Theorem

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TOSS-UP

13) Chemistry – *Multiple Choice* Aldehydes can be synthesized by their oxidation of:

W) Primary alcohols
X) Secondary alcohols
Y) Organic acids
Z) Inorganic acids

Answer: W) Primary alcohols

BONUS

13) Chemistry – *Short Answer* [] How many transition states and intermediates are present, respectively, in the mechanism for the ring flip of cyclohexane?

ANSWER: 3 TRANSITION STATES AND 2 INTERMEDIATES [VN]

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TOSS-UP

14) Biology – *Short Answer* Recently, the Arizona Supreme Court chose to uphold an old 19th century law banning many abortions. Included in the ban is which form of abortion which is most common within the first trimester, and involves using a suction to remove an embryo or fetus through the cervix?

ANSWER: VACUUM ASPIRATION

BONUS

14) Biology – *Multiple Choice* Which of the following is present only in mammals, but not in other tetrapods?

W) Lower jaw composed of a multiple bones
X) Differentiated types of teeth
Y) Lacking mammary glands
Z) A single auditory ossicle

ANSWER: Y) DIFFERENTIATED TYPES OF TEETH

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TOSS-UP

15) Math – *Short Answer* Let *S* denote the set of all edges and diagonals of a scalene convex quadrilateral with no two sides parallel. If two elements from *S* are randomly chosen, what is the probability they intersect inside the quadrilateral?

ANSWER: 1/15

BONUS

15) Math – *Short Answer* Let *P* denote the operation that reorders the elements of the tuple open parenthesis, 1, 2, 3, 4, 5, close parenthesis to open parenthesis, 1, 4, 5, 2, 3, close parenthesis. How many times must *P* be cumulatively applied to the tuple open parenthesis, 1, 2, 3, 4, 5, close parenthesis to return it to itself?

ANSWER: 2

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TOSS-UP

16) Physics – *Short Answer* Identify all of the following three statements that are true concerning AC circuits: 1) The admittance is the inverse of the reactance; 2) For a capacitor, the current leads the voltage; 3) For an inductor, the voltage leads the current.

ANSWER: 2 AND 3

BONUS

16) Physics – *Short Answer* A comet is traveling around the sun in a very elliptical orbit with an eccentricity of 0.9. What is the ratio of the speed of the comet at its closest point to the sun to that at its farthest point? Assume that the mass of the comet stays constant.

ANSWER: 19

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TOSS-UP

17) Math – *Short Answer* What is the slope of the tangent line to the function 4 x cubed minus 9 x squared plus 16 x minus 25 at x equals 1?

ANSWER: 10

BONUS

17) Math – *Short Answer* The tangent line to a differentiable function *f* for any input value of x passes through the point x minus 1 comma 0. If f of 0 equals 2, determine the function f of x.

ANSWER: f(x) = 2e^x

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TOSS-UP

18) Chemistry – *Multiple Choice* Hydroboration-oxidation results in what kind of product?

W) Hoffman
X) Zaitsev
Y) Anti-Markovnikov
Z) Markovnikov

Answer: Y) Anti-Markovnikov

BONUS

18) Chemistry – *Short Answer* During the ozonolysis of benzene, how many ozones bind to each ring?

Answer: 3

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TOSS-UP

19) Biology – *Short Answer* What paradox states that cancer incidence doesn't seem to correlate with the number of cells in an organism, accounting for the fact that humans have similar rates of cancer as compared to organisms with much more cells, such as a T-Rex?

ANSWER: PETO'S PARADOX

BONUS

19) Biology – *Short Answer* Which of the following four statements are dependent on the presence of the SRY gene?

1) Differentiation of Cortex in Embryonic Gonads
2) Encoding of Testes-Determining Factor

3) Formation of the Mullerian Ducts
4) Degeneration of the Wolffian Ducts

ANSWER: 2 ONLY

TOSS-UP

20) Earth and Space – *Short Answer* The triple-alpha process results in the formation of what element?

ANSWER: CARBON [SW]

BONUS

20) Earth and Space – *Short Answer* Besides the r and s-process, what process of nucleosynthesis is responsible for the creation of naturally occurring neutron-deficient isotopes of elements heavier than iron?

ANSWER: P-PROCESS [SW]

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