ROUND 9

TOSS-UP

1) Math – *Short Answer* What is the volume of the solid obtained by rotating the graph of y equals 2 over open parenthesis x plus 1 close parenthesis around the x-axis?

ANSWER: 4pi

BONUS

1) Math – *Short Answer* Four circles, each of radius 1, are arranged in such a way that they are each externally tangent to exactly two other circles. What is the smallest possible radius of a circle that completely encloses all four of these circles?

ANSWER: 1+sqrt2

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TOSS-UP

2) Earth and Space – *Multiple Choice* Which of the following is the erosional feature that forms ventifacts?

W) Water
X) Solifluction
Y) Radiation
Z) Wind

ANSWER: Z) WIND [SP]

BONUS

2) Earth and Space – *Short Answer* What is the term for a layer in a body of water where salinity rapidly increases with depth?

ANSWER: Halocline [SP]

TOSS-UP
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3) Chemistry – *Short Answer* Benzene reacts with nitric acid in the presence of sulfuric acid to form what major product

Answer: Nitrobenzene

BONUS

3) Chemistry – *Multiple Choice* In the fischer esterification reaction between ethanol and acetic acid, what is the chemical formula of the ester product?

W) $C_4H_8O_3$
X) $C_2H_5O_2$
Y) $C_4H_8O_2$
Z) $C_2H_8O_3$

Answer: Y) $C_4H_8O_2$

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TOSS-UP

4) Biology – *Multiple Choice* The loss of NH2 groups from adenine results in hypoxanthine, causing hypoxanthine to bind to thymine. Which of the following protein combinations would be most helpful in repairing such damage?

W) Nuclease, DNA polymerase, DNA ligase
X) Telomerase, primase, DNA polymerase
Y) Telomerase, helicase, ssbp
Z) DNA ligase, replication fork proteins, adenylyl cyclase

ANSWER: W) NUCLEASE, DNA POLYMERASE, DNA LIGASE

BONUS

4) Biology – *Short Answer* What small opening in the surface of an ovule, through which the pollen tube penetrates, allows water to enter the seed helping with germination?
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ANSWER: MICROPYLE

TOSS-UP

5) Physics – *Multiple Choice* In a circuit consisting solely of a capacitor and an inductor, the energy initially stored in the capacitor oscillates between the capacitor and the inductor. Which of the following is the name of this oscillation phenomenon?

W) Electromagnetic Fluctuation
X) LC Oscillation
Y) Electromagnetic Oscillation
Z) Energy Pulsing

ANSWER: Y) Electromagnetic Oscillation

BONUS

5) Physics – *Short Answer* Superconductivity has been the center of multiple Nobel prize winning research papers. Superconductors are unique in many ways. Choose all of the following physical phenomena that are in the interior of a superconductor. 1) Magnetic Field, 2) Electric Field, 3) Charge Carriers, 4) Resistance

ANSWER: None

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TOSS-UP

6) Chemistry – *Multiple Choice* In coordination chemistry, the donor atom of a ligand is a:

W) atom that shares an electron pair with the metal
X) atom that shares accepts an electron pair with the metal
Y) counter ion
Z) central metal atom

Answer: W) the atom that shares an electron pair with the metal

BONUS

6) Chemistry -- *Short Answer* Unlike in polydentate ligands, ambidentate ligands attach to the central atom in how many distinct locations
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Answer: 2

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TOSS-UP

7) Math – *Multiple Choice* Which of the following is the heart-shaped graph of the polar equation r equals two plus two times sine of theta on the polar coordinate plane?
W) Cardioid [car – dee – oid]
X) Spiral
Y) Circle
Z) Rose

ANSWER: W) Cardioid

BONUS

7) Math – *Short Answer* What is the area of the region enclosed by the cardioid with equation r equals 2 plus 2 times sine of theta on the polar coordinate plane?

ANSWER: 6pi

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TOSS-UP

8) Physics – *Multiple Choice* Twin A is aboard a spaceship traveling close to the speed of light, while Twin B stays on a stationary Earth. The spaceship flies far away from Earth, such that each twin observes the other traveling at a high speed. After the ship returns to Earth, which twin is younger?

W) Twin A
X) Twin B
Y) The same age
Z) Depends on Reference frame

ANSWER: W) Twin A

BONUS

8) Physics – *Short Answer* Rushil is traveling on a spaceship in deep space with momentum 600 Newton seconds when he activates three thrusters, each of which can generate 50 Newtons of force for 2 seconds and can fire in any direction. What is the maximum angle that the spaceship can go off course by after these two seconds, in degrees?

ANSWER: 30 degrees

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TOSS-UP

9) Earth and Space – *Short Answer* What type of front is indicated on a weather map by a purple line of alternating triangles and semicircles?

ANSWER: OCCLUDED [SW]

BONUS

9) Earth and Space – *Short Answer* In an occluded front, what is the name of the projection on the Earth's surface of the wedge of warm air above the Earth's surface that rides above the cold air patches?

ANSWER: TROWAL (ACCEPT: TROUGH OF WARM AIR) [SW]

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TOSS-UP

10) Biology – *Multiple Choice* Lack of which protein would cause polypeptide chains to be unable to exit specifically the membrane of the endoplasmic reticulum?

W) Helicase
X) Signal peptidase
Y) Signal recognition particle
Z) Release factor

ANSWER: X) SIGNAL PEPTIDASE

BONUS

10) Biology – *Multiple Choice* What allowed early plants to survive, even though they lacked roots?

W) All plants have had roots
X) They utilized specialized stems to facilitate gas and nutrient exchange
Y) They utilized facilitated diffusion to get nutrients from the soil
Z) They had a symbiotic relationship with mycorrhizae

ANSWER: Z) THEY HAD A SYMBIOTIC RELATIONSHIP WITH MYCORRHIZAE

TOSS-UP

11) Math – *Short Answer* How many positive integers have a base-2 representation that is four digits long and a base-3 representation that is three digits long?

ANSWER: 7

BONUS

11) Math – *Short Answer* If x and y are positive reals such that x plus y equals 4, what is the maximum value of x cubed times y?

ANSWER: 27

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TOSS-UP

12) Chemistry – *Short Answer* What are all the possible molecular geometries for a four coordinate transition metal compounds?

Answer: Tetrahedral & Square Planar

BONUS

12) Chemistry – *Multiple Choice* Using standard notation, the double vertical line in a voltaic cell represents

W) Precipitate
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X) Phase Boundary
Y) Direction of Current Flow
Z) Salt Bridge

Answer: Z) Salt Bridge

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TOSS-UP

13) Physics – *Multiple Choice* A pendulum initially has a period of 10 seconds. The mass on the end of the pendulum and the pendulum length both quadruple. What is the new period of the pendulum?

W) 5 seconds
X) 10 seconds
Y) 20 seconds
Z) 40 seconds

ANSWER: Y) 20 Seconds

BONUS

13) Physics – *Short Answer* The restoring force of a certain spring is proportional to the third power of the displacement. If the time period of the oscillations when the spring is stretched to a distance of 4 meters from equilibrium is 4 seconds, what would be the time period of oscillations, in seconds, when stretched to a distance of 1 meter from equilibrium?

ANSWER: 16 seconds

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TOSS-UP

14) Biology – *Multiple Choice* Which of the following gymnosperm phyla is mismatched with their defining features?

W) Cycadophyta - leaves that shed seasonally
X) Ginkgophyta - only contains the maidenhair tree
Y) Gnetophyta - contains various differing species
Z) Coniferophyta - cone-bearing plants

ANSWER: W) LEAVES THAT SHED SEASONALLY

BONUS

14) Biology – *Short Answer* Order the following steps used in gram staining?

1) Decolorization
2) Primary stain
3) Counterstain
4) Mordant

ANSWER: PRIMARY STAIN, MORDANT, DECOLORIZE, COUNTERSTAIN (2, 4, 1, 3)

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TOSS-UP

15) Earth and Space – *Short Answer* Funnel clouds are most frequently associated with what type of thunderstorm?

ANSWER: SUPERCELL THUNDERSTORMS (ACCEPT: SUPERCELL) [SW]

BONUS

15) Earth and Space – *Multiple Choice* Which of the following choices correctly indicates which direction a Meso Anticyclone would spin in each hemisphere?

W) Clockwise in the northern hemisphere and Counter-Clockwise in the southern hemisphere
X) Counter-Clockwise in the northern hemisphere and Clockwise in the southern hemisphere
Y) Clockwise in both the northern and southern hemisphere
Z) Counter-Clockwise in both the northern and southern hemisphere

ANSWER: W) CLOCKWISE IN THE NORTHERN HEMISPHERE AND COUNTER-CLOCKWISE IN THE SOUTHERN HEMISPHERE [SW]

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TOSS-UP

16) Earth and Space – *Short Answer* Which of the following types of streams usually occur as a result of precipitation and only flow for a short period of time?

ANSWER: EPHEMERAL [SW]

BONUS

16) Earth and Space – *Multiple Choice* Which of the following terms refers to a small body of water, which often resembles a oxbow lake?

W) Yagara
X) Billabong
Y) Waterhole
Z) Guelta

ANSWER: X) BILLABONG [SW]

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TOSS-UP

17) Physics – *Short Answer* Choose all of the following optical devices that will always form an upright and virtual image.

1) Convex Mirror
2) Concave Mirror
3) Convex Lens
4) Concave Lens

ANSWER: Convex Mirror and Concave Lens, 1 and 4

BONUS

17) Physics – *Short Answer* A light beam passes from a medium with index of refraction 2 into air. What is the minimum angle to the normal of the interface, in degrees, that the light beam hit the interface between the two media at such that total internal reflection occurs?

ANSWER: 30

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TOSS-UP

18) Chemistry – *Multiple Choice* Which part of the alkene acts as a nucleophile in an hydrohalogenation?

W) Carbon Hydrogen Sigma Bond
X) Carbon Carbon Sigma Bond
Y) The electronegative Carbon
Z) Carbon Carbon Pi - Bond

Answer: Z) Carbon Carbon Pi - Bond

BONUS

18) Chemistry – *Short Answer* What is the smallest possible value of the principal quantum number given that the angular momentum quantum number is 2

Answer: 3

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TOSS-UP

19) Math – *Short Answer* In computer science and graph theory, what matrix stores information about connected nodes within a finite graph in a two-dimensional matrix?

ANSWER: Adjacency Matrix (ACCEPT: Connection Matrix)

BONUS

19) Math – *Multiple Choice* A complete graph is a graph with every pair of vertices connected by an edge. Which of the following is NOT a property of a complete graph with more than 2 vertices?
W) Every vertex is connected to every other vertex
X) It has the maximum number of edges for a given number of vertices
Y) It can be bipartite
Z) It contains a cycle

ANSWER: Y) It can be bipartite

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TOSS-UP

20) Biology – *Multiple Choice* Shlok has ovarian cancer, which of the following proteins most likely suffered a Gain-of-function mutation in his cancer cells?

W) p53
X) Retinoblastoma (rb) protein
Y) Cyclin E
Z) p16

ANSWER: Y) Cyclin E

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BONUS

20) Biology – *Short Answer* What is the property of p53 that gave it its name?

ANSWER: ITS MASS IN DALTONS (ACCEPT: MASS)