LOST ROUND 6

TOSS-UP

1) Biology – *Multiple Choice* What cofactor is necessary for prolyl hydroxylase, a necessary enzyme in the production of collagen, to function?

W) Iron
X) Magnesium
Y) Biotin
Z) Ascorbic acid

ANSWER: Z) ASCORBIC ACID

BONUS

1) Biology – *Short Answer* You transfect animal cells in culture with a gene that is the dominant knockout of the guanylyl cyclase enzyme. Identify all of the following three statements that are likely to be true of this mouse: 1) cGMP phosphodiesterase would be overactive; 2) GTP concentration would be elevated; 3) DAG concentration would be elevated.

ANSWER: 2 ONLY

TOSS-UP

2) Earth and Space – *Short Answer* Pre Main sequence stars that are twice as massive as the Sun such as T-tauri stars gravitationally contract to form a radiative zone. On the HR diagram, this leads to a decrease in luminosity but retaining the temperature and follows which track in the evolution to become a main sequence star?

ANSWER: HAYASHI TRACK

BONUS

2) Earth and Space – *Short Answer* Order the following three periods of Mars in chronological order: 1) Hesperian period; 2) Noachian period; 3) Amazonian period.

ANSWER: 2, 1, 3

TOSS-UP

3) Energy – *Short Answer* Scientists at Lawrence Livermore National Lab are researching the forbidden energy transitions in coronal clouds in the interstellar medium. Due to the low density of the medium, atoms carrying atoms in unstable energy levels often do not transition due to the scarcity of atoms to transfer the energy to. What is this state known as?

ANSWER: METASTABILITY

BONUS

3) Energy – *Short Answer* Scientists at Oak Ridge National Laboratory have been studying the use of 1,3 butadiene in electrophilic addition reactions for the purpose of softening polymers. Identify all of the following three statements that are true concerning the electrophilic addition of HBr across a π bond in 1,3 butadiene: 1) The 1,2 adduct is favored at lower temperature; 2) The 1,2 adduct is higher in energy than the 1,4 adduct; 3) The 1,4 adduct is rapidly formed due to the proximity effect.

ANSWER: 1 AND 2

TOSS-UP

4) Chemistry – *Short Answer* Order the following three saturated ring sizes in increasing rate of formation in organic chemistry: 1) Four membered; 2) Five membered; 3) Six membered.

ANSWER: 1, 3, 2

BONUS

4) Chemistry – *Short Answer* Iodine and starch form a deep blue solution when mixed, allowing starch to be used as an indicator during iodometric titrations. What type of electronic transition is responsible for the vibrant coloring of the iodine-starch solution?

ANSWER: CHARGE TRANSFER

TOSS-UP

5) Math – *Short Answer* When Sean walks up an escalator, he climbs a total of 12 steps. When he walks down the same escalator, he climbs a total of 16 steps. What is the ratio of his speed to the escalator's speed?

ANSWER: 1:7 (ACCEPT: 1/7)

BONUS

5) Math – *Short Answer* Compute the magnitude of the gradient of the function $f(x,y) = x/y$ at the point (1, 1, 1).

ANSWER: $\sqrt{2}$

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TOSS-UP

6) Physics – *Multiple Choice* An object is placed 30 centimeters to the left of a concave mirror which radius of curvature 80cm, and produces a virtual, magnified and upright image. Which of the following actions would produce an image that is magnified, upright and real?

W) Moving the object to a distance of 80 cm to the left of the mirror
X) Replacing the concave mirror with a convex mirror with radius of curvature 60cm
Y) Moving the object to a distance of 30 cm to the right of the mirror
Z) Replacing the concave mirror with a concave mirror with radius of curvature 40cm

ANSWER: Z) REPLACING THE CONCAVE MIRROR WITH A CONCAVE MIRROR WITH RADIUS OF CURVATURE 40CM

BONUS

6) Physics – *Short Answer* Two large circular parallel plate capacitors hold equal and opposite charges. A thin wire is placed in between the plates on their axis and a current flows. Identify all of the following that are true of the energy flux at the surface of the wire just as the two plates are connected: 1) It is directed out of the wire; 2) It is proportional of the resistivity of the wire; 3) It is independent of the initial charge stored on the capacitor plates.

ANSWER: NONE
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TOSS-UP

7) Biology – *Short Answer* In the host life cycle of schistosomiasis, to what phylum does the intermediate host belong?

ANSWER: MOLLUSCA

BONUS

7) Biology – *Short Answer* Identify all of the following three scenarios that would increase the glomerular filtration rate: 1) Dilating the efferent arteriole; 2) Dilating the afferent arteriole; 3) Kwashiorkor.

ANSWER: 2 AND 3

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TOSS-UP

8) Earth and Space – *Short Answer* A star located 10 parsecs away has an apparent magnitude of 4.5. To two significant figures, what is the absolute magnitude of the star?

ANSWER: 4.5

BONUS

8) Earth and Space – *Short Answer* Identify all of the following three planets that have a magnetic field stronger than that of Earth's: 1) Jupiter; 2) Uranus; 3) Saturn.

ANSWER: 1 AND 3
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TOSS-UP

9) Energy – *Short Answer* DOE Researchers at Oak Ridge National Lab have been using nanobiology technology to study caspase enzymes. Caspases are proteases involved in what cellular process?

ANSWER: APOPTOSIS

BONUS

9) Energy – *Short Answer* Scientists at Pacific Northwest National Labs have been studying selective serum treatments that are able transform animal cells into malignant tumors. Identify all of the following three actions that the serum may exert: 1) Telomerase expression; 2) p53 double knockout; 3) Constitutive Ras Gs subunit.

ANSWER: ALL

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TOSS-UP

10) Chemistry – *Multiple Choice* How many axial and equatorial bonds, respectively, does chlorine trifluoride have in its lowest energy conformation?

W) 0 axial, 3 equatorial
X) 1 axial, 2 equatorial
Y) 2 axial, 1 equatorial
Z) 3 axial, 0 equatorial

ANSWER: Y) 2 AXIAL, 1 EQUATORIAL

BONUS

10) Chemistry – *Short Answer* Order the following three steps in their potential use for the formation of nylon 6,6 starting from 1,4 dibromo butane: 1) Lithium aluminum hydride in ether; 2) Condensation with adipic acid; 3) Reflux with potassium cyanide in aqueous ethanol.

ANSWER: 3, 1, 2
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TOSS-UP

11) Math – *Multiple Choice* Which of the following is equivalent to tan(15°)?

W) $\frac{1+cos(30^\circ)}{sin(30^\circ)}$ ***[the fraction with numerator 1 plus cosine of 30 degrees and denominator sine of 30 degrees]***
X) $\frac{sin(30^\circ)}{1-cos(30)}$ ***[the fraction with numerator sin of 30 degrees and denominator 1 minus cosine of 30 degrees]***
Y) $\frac{sec(30^\circ)-1}{tan(30^\circ)}$ ***[the fraction with numerator secant of 30 degrees minus 1 and denominator tan of 30 degrees]***
Z) $cot(30^\circ) + csc(30^\circ)$ ***[cotangent of 30 degrees plus cosecant 30 degrees]***

ANSWER: Y) $\frac{sec(30^\circ)-1}{tan(30^\circ)}$

BONUS

11) Math – *Short Answer* If $ln(x^2y^3) = 1$ and $ln(x^3y^2) = 2$, determine the ratio x/y.

ANSWER: e

TOSS-UP

12) Physics – *Short Answer* While the molar heat capacities of monoatomic gases can be approximated using the equipartition theorem to be equivalent at room temperature, the molar heat capacities of elemental solids can be approximated as constant using what law?

ANSWER: DULONG-PETIT

BONUS

12) Physics – *Short Answer* In terms of SI base units, what are the units of Curie's constant?

ANSWER: KELVIN (ACCEPT: K)

TOSS-UP

13) Biology – *Short Answer*   What enzyme is responsible for the cleaving of double stranded RNA into miRNAs?

ANSWER: DICER

BONUS

13) Biology – *Short Answer*   A dominant mutation leads to a constitutive MAO enzyme. Identify all of the following three neurotransmitters that are directly affected: 1) Dopamine; 2) Serotonin; 3) Glycine.

ANSWER: 1 ONLY

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TOSS-UP

14) Earth and Space – *Multiple Choice*   The Eddington Limit describes the maximum value for a mass such that it obtains balance between which of the following two forces?

W) Radiation pressure and gravity
X) Radiation pressure and degenerate pressure
Y) Degenerate pressure and gravity
Z) Quintessence pressure and radiation pressure

ANSWER: W) RADIATION PRESSURE AND GRAVITY

BONUS

14) Earth and Space – *Short Answer*   While Vega is projected to be the successor North Star to Polaris, which star, designated alpha draconis, was the predecessor to Polaris?

ANSWER: THUBAN
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TOSS-UP

15) Energy – *Short Answer* Researchers at Argonne National Lab are studying the photochemical reactions of organic compounds, such as those by acyclic conjugated trienes. What set of rules can be used to predict the class of electrocyclic rearrangement preferred in the photoisomerization of an acyclic conjugated triene?

ANSWER: WOODWARD-HOFFMAN

BONUS

15) Energy – *Short Answer* Researchers at Idaho National Lab have discovered magnetism in the honeycomb layers of $Na_2Ni_2TeO_6$, with chiral layers of Sodium. This material exhibits what effect in quantum mechanics when its spin states are disturbed to temporarily create an unequal electric potential?

ANSWER: QUANTUM HALL EFFECT

TOSS-UP

16) Chemistry – *Short Answer* In the fluorine-19 NMR spectrum of the solid-state structure of phosphorus pentafluoride, what is the ratio of the integrations of the two distinct peaks?

ANSWER: 2:3 OR 3:2 (ACCEPT EQUIVALENTS)

BONUS

16) Chemistry – *Short Answer* Identify all of the following three statements that are true about the carbon-carbon double bond in ethylene: 1) It acts as a nucleophile in acid-catalyzed hydration; 2) The stretching mode is IR active; 3) The highest occupied molecular orbital is antibonding.

ANSWER: 1 ONLY

TOSS-UP

17) Math – *Multiple Choice* Point A and B are located in the cartesian plane. What conic section is formed by the locus of points that are three times as far from point A as from point B?

W) Circle
X) Ellipse
Y) Parabola
Z) Hyperbola

ANSWER: W) CIRCLE

BONUS

17) Math – *Short Answer* What is the remainder when 15^{1526} is divided by 26?

ANSWER: 17

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TOSS-UP

18) Physics – *Short Answer* A pentaquark is a hadron containing three quarks and two antiquarks. What is its baryon number?

ANSWER: 1

BONUS

18) Physics – *Short Answer* A 10 kilogram ladder is leaning against a frictionless wall with one end resting on the frictionless floor at a 45 degree angle. A horizontal force is applied to the base of the ladder at the floor to prevent it from slipping. To the nearest newton, what is the applied force?

ANSWER: 49
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TOSS-UP

23) Math – *Short Answer* The range, median, mean, and mode of a set of 6 integers is equal to 6. What is the maximum possible value for the largest number in this set?

ANSWER: 10

BONUS

23) Math – *Short Answer* What is the greatest possible area of an ellipse formed from a cross section of a cylinder with base radius 6 and height 16?

ANSWER: 60π

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TOSS-UP

24) Physics – *Short Answer* Identify all of the following three quantities that are non-zero for a neutron: 1) Electric charge; 2) Magnetic dipole moment; 3) Spin.

ANSWER: 2 AND 3

BONUS

24) Physics – *Short Answer* A portion of an electrical circuit consists of four nodes with wires positioned such that any two nodes are connected by a wire with a resistance of 1 Ω ***[ohm]***. What is the equivalent resistance between any two nodes?

ANSWER: 0.5 Ω

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TOSS-UP

25) Biology – *Short Answer* The first step of translation in *E. coli* begins with the binding of the 16S subunit to the mRNA. To what consensus sequence upstream of the start codon does the small ribosomal subunit recognize and bind to?

ANSWER: SHINE-DALGARNO

BONUS

25) Biology – *Short Answer* Which specific ions are found seated in the gates of NMDA receptors such that they block influx of calcium ions despite binding of glutamate?

ANSWER: MAGNESIUM TWO PLUS (ACCEPT: ZN^{2+})