LOST ROUND 2

TOSS-UP

1) Earth and Space – *Short Answer* The large impact hypothesis describes the collision of which planetesimal into the Earth to form the moon?

ANSWER: THEIA

BONUS

1) Earth and Space – *Multiple Choice* Hubble's constant is empirical, but is not accurate for many extraterrestrial objects such as quasars. What phenomenon was not accounted for which creates this error?

W) Time dilation
X) Gravitational lensing
Y) Interstellar reddening
Z) Length contraction

ANSWER: W) TIME DILATION

TOSS-UP

2) Physics – *Short Answer* Tanmay emits electromagnetic radiation from a point source in a wide field. If the intensity of the radiation 5 meters from the point source is 12 watts per square meter, what is the intensity 10 meters from the point source?

ANSWER: 3

BONUS

2) Physics – *Multiple Choice* Einstein was inspired to create his theory of special relativity after observing that which of the following laws was invariant not under Galilean transformations, but under Lorentz transformations?

W) Newton's law of gravitation
X) Newton's laws of motion
Y) Schrödinger's equation
Z) Maxwell's equations

ANSWER: Z) MAXWELL'S EQUATIONS

TOSS-UP

3) Math – *Short Answer* What is the remainder when the polynomial $x^3 + 1$ is divided by the polynomial $x^2 - 1$?

ANSWER: $x + 1$

BONUS

3) Math – *Short Answer* The centers of the six faces of a cube are connected to form an octahedron. What is the ratio of the volume of the octahedron to the volume of the cube?

ANSWER: 1/6

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TOSS-UP

4) Energy – *Short Answer* Researchers at Los Alamos National Lab used the Hubble Space Telescope to measure the albedos of solar system objects. Due to anisotropic backscattering, what object in the solar system is observed to have an albedo greater than one?

ANSWER: ENCELADUS

BONUS

4) Energy – *Short Answer* Scientists at Lawrence Berkeley National Labs used fluorescence *in situ* hybridization or FISH to determine the genetic composition of sperms exposed to mutagen. Identify all of the following three statements that are true about FISH: 1) It can be used to detect differential gene expression in organisms; 2) It can be used to determine where enhancers are; 3) Fluorescent probes are attached to the nucleic acid probe.

ANSWER: 1 AND 3
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TOSS-UP

5) Biology – *Short Answer* Parthenogenesis in animals is analogous to what process in plants whereby an unfertilized seed develops into a new flower?

ANSWER: APOMIXIS

BONUS

5) Biology - *Short Answer* Order the following 4 layers of a secondary growth tree from innermost to outermost 1) Secondary Phloem ***[flow-em]***; 2) Secondary Xylem ***[zylem];*** 3) Cork Cambium; 4) Phelloderm

ANSWER: 2, 1 , 4 , 3

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TOSS-UP

6) Chemistry – *Short Answer* Identify all of the following three ionic compounds that have a greater lattice energy than magnesium oxide: 1) Aluminum chloride; 2) Magnesium sulfide; 3) Beryllium oxide.

ANSWER: 3 ONLY

BONUS

6) Chemistry – *Short Answer* Formaldehyde trimerizes in aqueous solution with a yield of 90%, with the remaining formaldehyde dimerizing with a yield of 50%. What is the Van't Hoff factor of formaldehyde in aqueous solution?

ANSWER: 3/8
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TOSS-UP

7) Earth and Space – *Short Answer* Early RNA formation may have been catalyzed by what soft type of clay which significantly expands when absorbing water?

ANSWER: MONTMORILLONITE

BONUS

7) Earth and Space – *Short Answer* Identify all of the following 3 statements that are true concerning clays. 1) Clays are all sheet silicates; 2) Clays can act as aquitards; 3) Clays have high porosities.

ANSWER: ALL

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TOSS-UP

8) Physics – *Short Answer* A sphere is spinning along an axis through its diameter with a constant angular velocity. Upon significant heating, the diameter of the sphere expands by 50% while conserving its mass. By what factor is the rotational kinetic energy of the spinning sphere changed along the same axis?

ANSWER: 4/9

BONUS

8) Physics – *Short Answer* A particle with mass 3 kilograms is located at the point (3,6). A second particle with mass 6 kilograms creates a two-particle system with the first particle with a center of mass at the point (-1,4). What are the coordinates of the second particle?

ANSWER: (-3,3)
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TOSS-UP

9) Math – *Multiple Choice* The cube of an integer is divided by 7, and the remainder is taken. Which of the following could be the value of this remainder?

W) 3
X) 4
Y) 5
Z) 6

ANSWER: Z) 6

BONUS

9) Math – *Short Answer* Five members of a Science Bowl team are sitting around a table. Each flips a fair coin. What is the probability that three consecutive members flip heads?

ANSWER: 11/32

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TOSS-UP

10) Energy – *Short Answer* Scientists at Lawrence Livermore National Lab measured the electrical conductivity of clathrates ***[clahth-rate]*** on the seafloor to improve geophysical mapping. The scientists focused on studying clathrates containing what hydrocarbon trapped within a crystalline ice structure?

ANSWER: METHANE

BONUS

10) Energy – *Short Answer* Scientists at SLAC National Accelerator Laboratory used the Linac Coherent Light Source to image conformation changes in electron carrier proteins after being reduced or oxidized in photosynthesis. In noncyclic electron flow, what pair of chlorophyll molecules is responsible for oxidizing plastocyanin and is found in Photosystem I?

ANSWER: P700
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TOSS-UP

11) Biology – *Short Answer* What is the name of the valve that regulates the flow of pancreatic and liver fluids into the small intestine?

ANSWER: SPHINCTER OF ODDI

BONUS

11) Biology – *Short Answer* In the proximal convoluted tubule, the reabsorption of glucose and amino acids are coupled with the transport of what ion?

ANSWER: SODIUM

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TOSS-UP

12) Chemistry – *Short Answer* Order the following three molecules in increasing oxygen oxygen bond length: 1) Dioxygen; 2) Ozone; 3) Hydrogen peroxide.

ANSWER: 1, 2, 3

BONUS

12) Chemistry – *Short Answer* When a metal bipyridine ***[bi-pure-idine]*** complex is oxidized from its neutral form to its 2^+ form, a 1.6-volt source is required. To oxidize the 2^+ complex to its 3^+ form, a 2.2-volt source is required. In volts, what voltage is required to oxidize the neutral complex directly to its 3^+ form?

ANSWER: 1.8
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TOSS-UP

13) Earth and Space – *Multiple Choice* Which of the following best explains the primary way how X ray binaries produce x rays?

W) Infalling matter decreases gravitational potential energy
X) Neutron star spallation creates X rays
Y) Fusion in the Proton-proton chain
Z) Fusion in the CNO cycle

ANSWER: W) INFALLING MATTER DECREASES GRAVITATIONAL POTENTIAL ENERGY

BONUS

13) Earth and Space – *Short Answer* Identify all of the following three statements that are TRUE concerning granules: 1) The darker parts of granules are hotter than the lighter parts; 2) Granules are formed by convection cells in the sun; 3) The center of a granule is hotter than the edges.

ANSWER: 2 AND 3

TOSS-UP

14) Physics – *Short Answer* The energy states of quasiparticles, neutrinos, and all other particles with half-integer integer spins follow what type of distribution?

ANSWER: FERMI-DIRAC

BONUS

14) Physics – *Short Answer* The potential energy V and displacement r of a particle in 1D motion can be represented by the two parametric equations$V(t) = t2 - 4t + 6$ and $r(t) = 2t + 8$. What is the magnitude of the force acting on the particle when t equals 3?

ANSWER: 1

TOSS-UP

15) Math – *Short Answer* Determine the product of the complex numbers $4 + 8i$ and $4 - 8i$.

ANSWER: 80

BONUS

15) Math – *Short Answer* For what value b are the two vectors $3\mathbf{i} + \mathbf{j}$ and $b\mathbf{j} + 3\mathbf{k}$ orthogonal?

ANSWER: 0

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TOSS-UP

16) Energy – *Multiple Choice* Scientists at Ames National Lab are using Dynamic Nuclear Polarization NMR spectroscopy to study radical species by exciting their unpaired electrons and transferring the resulting high spin polarization to atomic nuclei to be observed. The spectroscopic analysis of which of the following species would benefit the most from this technique?

W) O_2
X) BF_3
Y) O_3
Z) CO

ANSWER: W) O_2

BONUS

16) Energy – *Short Answer* Scientists at Pacific Northwest National Lab created a highly conductive copper-graphene composite material to use in electrical motors. Identify all of the following three terms that correctly describe graphene along the axis of its plane: 1) Ductile; 2) Malleable; 3) Thermally conductive.

ANSWER: ALL
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TOSS-UP

17) Biology - *Multiple Choice* Which of the following best explains why the human genome can be smaller than the genome of simpler animals, such as the water flea?

W) Exon Shuffling allows humans to generate multiple unique proteins per individual
X) Methylation allows one gene to be expressed in multiple different ways
Y) Alternative Splicing allows humans to generate a large variety of proteins based on one sequence
Z) Transposons allow for rapid modification of protein coding sequences

ANSWER: Y) ALTERNATIVE SPLICING ALLOWS HUMANS TO GENERATE A LARGE VARIETY OF PROTEINS BASED ON ONE SEQUENCE

BONUS

17) Biology – *Short Answer* Identify all of the following three situations in which the individual would likely be exhibiting beta waves: 1) A science bowler listening attentively to a question; 2) Someone in the middle of REM sleep; 3) A relaxed person closing their eyes trying to sleep.

ANSWER: 1 AND 2

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TOSS-UP

18) Chemistry – *Short Answer* Identify all of the following three quantities that must increase during a spontaneous reaction at constant temperature and pressure: 1) Entropy of the universe; 2) Entropy of the system; 3) Gibbs free energy of the system.

ANSWER: 1 ONLY

BONUS

18) Chemistry – *Short Answer* Identify all of the following three statements that are true about the unit cell structure of diamond: 1) Each carbon atom is octahedrally coordinated; 2) The underlying structure is face centered cubic; 3) Diamond has a higher band gap than silicon.

ANSWER: 2 AND 3
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TOSS-UP

19) Earth and Space – *Short Answer* Order the following 3 rocks in order of increasing density: 1) Gabbro; 2) Sandstone; 3) Granite.

ANSWER: 2, 3, 1

BONUS

19) Earth and Space – *Short Answer* Identify all of the following 3 minerals which are correctly paired with their respective silicate structure: 1) Plagioclase feldspar - tectosilicate ; 2) Pyroxene - cyclosilicate; 3) Quartz - Sorosilicate.

ANSWER: 1 ONLY

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TOSS-UP

20) Physics – *Short Answer* A barrel has a height H. What is the ratio of the speed of water between a spigot ***[spih-got]*** at the bottom and a spigot located at a height of $\frac{H}{2}$ ***[H over two]***?

ANSWER: $\sqrt{2}$ (ACCEPT: $1 : \frac{\sqrt{2}}{2}$)

BONUS

20) Physics – *Short Answer* Identify all of the following three statements that are true of convex mirrors: 1) All images produced are virtual; 2) All images produced are diminished; 3) All images produced are inverted.

ANSWER: 1 AND 2
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TOSS-UP

21) Math – *Short Answer* Kira is rolling a 12-sided die labeled with the integers from 1 to 12 until she rolls a prime number. What is the expected number of times she will roll the die?

ANSWER: 2.4 (ACCEPT: 12/5)

BONUS

21) Math – *Short Answer* Compute the indefinite integral of $3x\sqrt{x^2 - 1}\,dx$.

ANSWER: $(x^2 - 1)^{3/2} + C$

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TOSS-UP

22) Energy – *Multiple Choice* Scientists at Brookhaven National Laboratory have been using positron emission tomography, or PET scans, to image to track brain responses to light and electrical stimulation. For PET scans, researchers used Fluorodeoxyglucose, glucose modified with radioactive fluorine-18. What type of radioactive decay do PET scans take advantage of for imaging?

W) Alpha
X) Beta minus
Y) Beta plus
Z) Gamma

ANSWER: Y) BETA PLUS

BONUS

22) Energy – *Short Answer* Scientists from SLAC National Accelerator Lab working in the Linac Coherent Light Source used ultrashort X-ray pulses from a free-electron laser to monitor processes occurring on the femto timescale. Identify all of the following three processes that occur on the femto timescale: 1) Rearrangement of sigma electrons during cleavage of single bond; 2) Emission of an Auger electron during X-ray bombardment; 3) Duration of a calcium-based action potential between neurons.

ANSWER: 1 AND 2
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TOSS-UP

23) Biology - *Short Answer* AQP2 is the major response protein for what renal hormone that plays a primary role in maintaining the water potential of the extracellular fluid by adjusting the permeability of the collecting duct?

ANSWER: VASOPRESSIN (ACCEPT: ANTIDIURETIC HORMONE, ADH)

BONUS

23) Biology – *Short Answer* Identify all of the following three substances that are able to pass through the glomerulus: 1) Testosterone; 2) Cysteine; 3) Vitamin A.

ANSWER: 2 ONLY

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TOSS-UP

24) Chemistry – *Short Answer* The reaction between hydrogen and iodine to produce hydrogen iodide increases in its initial rate by a factor of 8 when the initial concentrations of hydrogen and iodine are each quadrupled. What is the overall order of the rate law for this reaction?

ANSWER: 3/2

BONUS

24) Chemistry – *Short Answer* How many ^{13}C ***[C-Thirteen]*** signals are observed in the NMR spectrum of 1,2,4,5-tetrapropyl benzene ***[read name slowly]***?

ANSWER: 5

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TOSS-UP

25) Earth and Space – *Short Answer* Arroyos and washes are classified as what type of stream which can only form when there is significant precipitation in an endorheic basin?

ANSWER: EPHEMERAL STREAM

BONUS

25) Earth and Space – *Multiple Choice* Which of the following statements is false about desert environments?

W) Star dunes often form in coastal deserts
X) Saltation is the movement by bouncing along the ground
Y) Desert pavement inhibits erosion
Z) Longitudinal dunes are parallel to the wind direction

ANSWER: W) STAR DUNES OFTEN FORM IN COASTAL DESERTS