2019 Science Bowl Summer Discord Tournament - Semifinal 2 Packet - dan.k.memes

Suggested ice-breaker question: Who do you think will winnats?

TOSS-UP

1) Chemistry - *Short Answer* By name or number, identify all of the following compounds that adopt a crown conformation: 1) cyclo-octasulfur, 2) cyclooctatetraene ***[cyclo-octa-tetra-een]***, 3) cyclohexane, 4) cyclooctane

ANSWER: 1 and 4 (in either order) [accept cyclo-octasulfur and cyclooctane (in either order)]

BONUS

1) Chemistry - *Multiple Choice* Which of the following is NOT true of the twist-boat in cyclohexane's ring flip mechanism?

W) It is more stable than the boat conformation
X) It is more stable than the half-chair conformation
Y) The twist-boat and half-chair transition are chiral molecules
Z) The twist-boat is a meso compound

ANSWER: Z) The twist-boat is a meso compound

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TOSS-UP

2) Earth and Space - *Short Answer* By name or number, order the following events from oldest to most recent: 1) Paleozoic ice age, 2) Snowball Earth, 3) Pleistocene glaciation, 4) Eocene-Oligocene transition.

ANSWER: 2, 1, 4, 3 [accept Snowball Earth, Paleozoic ice age, Eocene-Oligocene transition, Pleistocene glaciation]

BONUS

2) Earth and Space - *Multiple Choice* The Milankovitch cycles describe how fluctuations in the Earth's movement affect climate over the course of tens of thousands of years. Which of the following cycles has the shortest period?

W) Apsidal precession
X) Axial precession
Y) Orbital inclination
Z) Orbital shape

ANSWER: X) Axial precession
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TOSS-UP

3) Math - *Short Answer* What is the sum of the roots of the cubic equation (read slowly):
$3x^3 + 7x^2 + x - 2$ ***[three-x-cubed plus seven-x-squared plus x minus two]***.

ANSWER: -7/3

BONUS

3) Math - *Short Answer* Express $6e^{2\pi i/3}$ ***[6 times e to the quantity two-pi-i-over-three]*** in simplest a+bi form.

ANSWER: $-3 + 3\sqrt{3}i$ ***[negative-three plus three-root-three i]***

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TOSS-UP

4) Biology - *Short Answer* Although the UGA or "opal" codon is normally a stop codon, in the presence of a namesake "insertion sequence," it can also code for what nonstandard amino acid, often abbreviated as U?

ANSWER: Selenocysteine [accept Sec or Se-Cys; accept U before mention]
Note: The "insertion sequence" is SECIS.

BONUS

4) Biology - *Multiple Choice* Which of the following is NOT true of glycine?

W) It functions as an effective buffer at the pH of blood
X) It is a non-essential amino acid
Y) It is the only achiral proteinogenic amino acid
Z) Its isoelectric point is equal to the arithmetic mean of its pK_{a1} ***[p-K-a-one]*** and pK_{a2} ***[p-K-a-two]***

ANSWER: W) It functions as an effective buffer at the pH of blood
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TOSS-UP

5) Physics - *Short Answer* What quantity is positive for paramagnetic materials and negative for diamagnetic materials, and is defined as the dimensionless ratio between magnetization and magnetic field strength?

ANSWER: magnetic susceptibility [accept chi; prompt on susceptibility; do not accept or prompt on electric susceptibility]

BONUS

5) Physics - *Short Answer* Given the radius of Earth as $6.4*10^6$ meters and the permittivity of free space as $8.9*10^{-12}$ farads per meter, find the capacitance of the Earth to one significant figure. Express your answer in farads using scientific notation.

ANSWER: $7*10^{-4}$

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TOSS-UP

6) Math - *Multiple Choice* Let A be a square n-by-n matrix. Which of the following is NOT equivalent to the statement: A is an invertible matrix?

W) A has n pivot positions
X) The transpose of A is an invertible matrix
Y) There is an n-by-n matrix C such that CA = I
Z) The rows of A form a linearly independent set

ANSWER: Z) The rows of A form a linearly independent set

BONUS

6) Math - *Short Answer* In terms of theta, give the determinant of the two-by-two transformation matrix for a counter-clockwise rotation of angle theta about the origin.

ANSWER: 1
Note: By definition, rotation matrices are orthogonal matrices with determinant 1. If you write it out, you find the determinant is equivalent to the Pythagorean trigonometric identity.
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TOSS-UP

7) Physics - *Short Answer* By name or number, order the following four substances in order from least to greatest refractive index: 1) Air, 2) Ice, 3) Vacuum, 4) Diamond

ANSWER: 3, 1, 2, 4 [accept vacuum, air, ice, diamond]

BONUS

7) Physics - *Multiple Choice* Which of the following materials is incorrectly matched with the type of reflection it would primarily exhibit when illuminated?

W) Nail polish, specular and diffuse
X) Polished metal, diffuse
Y) White marble, diffuse
Z) Mirror, specular

ANSWER: X) Polished metal, diffuse

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TOSS-UP

8) Biology - *Multiple Choice* Which of the following is NOT true of gibberellins?

W) They are diterpenoid compounds
X) They are involved in breaking seed dormancy
Y) They induce degradation of growth-inhibiting DELLA ***[dell-uh]*** proteins
Z) Underproduction of gibberellic acid can lead to "foolish seedling" disease

ANSWER: Z) Underproduction of gibberellic acid can lead to "foolish seedling" disease

BONUS

8) Biology - *Multiple Choice* Which of the following anticoagulants does NOT function by binding calcium ions?

W) Heparin
X) EDTA
Y) Citrate
Z) Oxalate

ANSWER: W) Heparin
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TOSS-UP

9) Earth and Space - *Multiple Choice* Which of the following best explains why ice in glaciers has a distinctive blue tint?

W) Refraction due to the stratified layers of glacial ice
X) Rayleigh scattering due to microscopic bubbles in the ice
Y) Absorption of red light due to an overtone of the infrared OH stretching mode of water
Z) Glacial ice is not actually blue, it simply reflects the blue light from the sky

ANSWER: Y) Absorption of red light due to an overtone of the infrared OH stretching mode of water

BONUS

9) Earth and Space - *Multiple Choice* Which of the following relative dating principles is NOT correctly matched with its description?

W) Superposition: Layers at the top are younger than layers at the bottom
X) Lateral continuity: Sediment forms in layers unless it thins to nothing or terminates
Y) Inclusion: If a rock contains fragments of another rock than the rock that includes the fragments is older than the included fragments
Z) Faunal Succession: Comparing fossils in rocks, for example, if two layers have the same fossils the layers must be of the same age

ANSWER: Y) Inclusion: If a rock contains fragments of another rock than the rock that includes the fragments is older than the included fragments

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TOSS-UP

10) Chemistry - *Short Answer* By name or number, order the following three isomers of xylene, also known as dimethylbenzene, in order of decreasing melting point: 1) ortho-xylene, 2) meta-xylene, 3) para-xylene.

ANSWER: 3, 1, 2 [accept para-xylene, ortho-xylene, meta-xylene]

BONUS

10) Chemistry - *Short Answer* By name or number, order the three products of the nitration of methylbenzene from least to greatest yield: 1) ortho-nitrotoluene, 2) meta-nitrotoluene, 3) para-nitrotoluene

ANSWER: 2, 3, 1 [accept meta-nitrotoluene, para-nitrotoluene, ortho-nitrotoluene; also accept meta-, para-, ortho-]
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TOSS-UP

11) Physics - *Short Answer* Loop a wire around an ice block and attach weights to the ends of the wire. This setup allows for the demonstration of what phenomenon, the pressure-induced melting of ice and rapid subsequent refreezing as soon as the pressure is relieved?

ANSWER: regelation

BONUS

11) Physics - *Short Answer* Another demonstration you might've seen in your physics class is putting your hand on one of these devices, which can cause your hair to stand up. They typically consist of a hollow metal sphere that accumulates charge as a belt moves through it.

ANSWER: Van de Graaff generator

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TOSS-UP

12) Math - *Multiple Choice* According to De Morgan's laws, which of the following is logically equivalent to the statement: not open parenthesis A or B close parenthesis?

W) not A and not B
X) not A or not B
Y) A and B
Z) not A or B

ANSWER: W) not A and not B

BONUS

12) Math - *Short Answer* Giving your answer as an integer in base 10, what is the output of the bitwise operation: 5 or 9?

ANSWER: 13
Note: Yay! Computer science!
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TOSS-UP

13) Chemistry - *Multiple Choice* Which of the following precipitates is NOT yellow in color?

W) Silver(I) iodide
X) Lead(II) iodide
Y) Silver(I) chromate
Z) Lead(II) chromate

ANSWER: Y) Silver(I) chromate

BONUS

13) Chemistry - *Short Answer* The red color of silver(I) chromate indicates the endpoint in what argentometric titration method, used to determine the chloride concentration in a sample?

ANSWER: Mohr method

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TOSS-UP

14) Earth and Space - *Short Answer* By name or number, identify all of the following three astrophysical limits that are mass limits: 1) Tolman-Oppenheimer-Volkoff limit, 2) Eddington limit, 3) Chandrasekhar limit.

ANSWER: 1 and 3

BONUS

14) Earth and Space - *Multiple Choice* In astrodynamics, the vis-viva equation is used to model astronomical orbits. The vis-viva equation is a direct result of which of the following physical principles?

W) Conservation of mass
X) Conservation of mechanical energy
Y) Conservation of linear momentum
Z) Conservation of angular momentum

ANSWER: X) Conservation of mechanical energy
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TOSS-UP

15) Biology - *Short Answer* The deadly Texas coral snake has the same coloration pattern as the harmless Mexican milk snake. This unusual relationship, in which a dangerous species mimics a less dangerous one, is an example of what type of mimicry?

ANSWER: Emsleyan/Mertensian mimicry [accept either answer]

BONUS

15) Biology - *Multiple Choice* Which of the following is NOT true of the "waggle dance," which is used to convey information about food sources between bees?

W) The bee moves in a straight line back and forth between two points while "waggling" during the dance
X) The direction of the straight stretch indicates the direction of the food source
Y) The angle of the straight stretch relative to the vertical is equal to the angle which the direction of flight has to the sun
Z) The speed of the dance is inversely related to the distance of the food source

ANSWER: W) The bee moves in a straight line back and forth between two points while "waggling" during the dance

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TOSS-UP

16) Math - *Multiple Choice* Which of the following is NOT true of hyperbolic paraboloids?

W) They are doubly ruled surfaces
X) They each contain two families of mutually skew lines
Y) The Gaussian curvature at any point on a hyperbolic paraboloid is negative
Z) They are projectively equivalent to a sphere

ANSWER: Z) They are projectively equivalent to a sphere

BONUS

16) Math - *Short Answer* Evaluate $\int_0^1 \log x \, dx$ ***[the definite integral from zero to one of log x dx]***.

ANSWER: -1
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TOSS-UP

17) Earth and Space - *Short Answer* The calcite compensation depth, or CCD, is the depth at which all calcite has dissolved in a water column. This is analogous to the aragonite compensation depth, or ACD. By name or number, identify all of the following four statements that are true: 1) Calcite is more soluble than aragonite, 2) Calcite is less soluble than aragonite, 3) The CCD is deeper than the ACD, 4) The CCD is shallower than the ACD.

ANSWER: 2 and 3

BONUS

17) Earth and Space - *Multiple Choice* Not to be confused with the carbonate compensation depth or aragonite compensation depth is the compensation point. Which of the following statements about the compensation point in marine ecology is NOT true?

W) The location of the compensation point does not vary significantly with time of day
X) No net primary production occurs below the compensation point
Y) The light level at the compensation point is typically 1% of what it is at the surface
Z) At the compensation point, the net carbon dioxide assimilation is zero

ANSWER: W) The location of the light compensation point does not vary significantly with time of day

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TOSS-UP

18) Physics - *Multiple Choice* Which of the following relationships MUST be true of a projectile fired off a cliff from a height above where it lands such that its range is maximized?

W) The angle of launch is 45 degrees
X) The angle of impact is 45 degrees
Y) The angle of impact is horizontal
Z) The angle of launch and angle of impact are complementary

ANSWER: Z) The angle of launch and angle of impact are complementary

BONUS

18) Physics - *Short Answer* There exists a time-energy uncertainty relation which states that the product of the uncertainties of energy and time must be greater than or equal to Planck's constant. Particles that exist long enough to satisfy the time-energy uncertainty relation are called real particles, while those that do not are called virtual particles. Given that the mass of a charged pion is $2.5*10^{-28}$ kilograms, what is the minimum lifetime in seconds for the pion to be considered a real particle? Express your answer in scientific notation to one significant figure.

ANSWER: $3*10^{-23}$
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TOSS-UP

19) Biology - *Short Answer* Calculate the mean arterial pressure, in mmHg to the nearest integer, in a patient whose systolic and diastolic blood pressure is 120 and 60, respectively.

ANSWER: 80 mmHg

BONUS

19) Biology - *Short Answer* By number, identify all of the following five components of the heart conduction system that are NOT correctly matched with its location in the heart: 1) SA node: right atrium, 2) AV node: interatrial septum, 3) Bachmann's bundle: left atrium, 4) Bundle of his: right ventricle, 5) Purkinje fibers: inner ventricular walls.

ANSWER: 4 only [accept Bundle of his: right ventricle]

TOSS-UP

20) Chemistry - *Multiple Choice* Which of the following best describes the relationship between hapticity and denticity?

W) Hapticity only applies to polydentate ligands
X) Hapticity only applies to ligands in which the coordinating atoms are continuous
Y) Hapticity is denoted using kappa notation, while denticity is denoted using eta notation
Z) Hapticity is an archaic term for denticity--they refer to the same thing

ANSWER: X) Hapticity only applies to ligands in which the coordinating atoms are continuous

BONUS

20) Chemistry - *Short Answer* By name or number, order the following four ligands from weakest to strongest: 1) H_2O, 2) CN^-, 3) Cl^-, 4) Br^-

ANSWER: 4, 3, 1, 2 [accept Br^-, Cl^-, H_2O, CN^-]

REJECTED QUESTIONS
(For novelty purposes only)

TOSS-UP

Biology - *Multiple Choice* Which of the following is NOT true of the four primary mammalian isoforms of hexokinase?

W) Hexokinases I, II, and III have a lower affinity for glucose than hexokinase IV
X) Hexokinases I, II, and III are referred to as “low-Km” isozymes
Y) Hexokinases I, II, and III are strongly inhibited by glucose-6-phosphate
Z) Hexokinase is a canonical example of the induced-fit model

ANSWER: W) Hexokinases I, II, and III have a lower affinity for glucose than hexokinase IV

BONUS

Biology - *Short Answer* By number, identify all of the following symptoms that are consistent with a potassium deficiency in plants: 1) Browning and curling of leaf tips, 2) Chlorosis between leaf veins, 3) Purple spots on the underside of leaves, 4) Necrosis of leaf margins is most severe on the youngest leaves

ANSWER: 1, 2, 3 [accept all but 4]

~~**TOSS-UP**~~

~~Chemistry - *Short Answer* Which two elements are named after France?~~

~~ANSWER: Francium and Gallium [in either order]~~

BONUS

Chemistry - *Multiple Choice* Did you know that polonium is named after poland? uwu! Which of the following is NOT true of polonium?

W) At STP, it is the only element that adopts a simple cubic crystal structure
X) It radioactively decays directly into lead
Y) It is highly insoluble in most acids
Z) It is most commonly found in +2 and +4 oxidation states
ANSWER: Y) It is highly insoluble in most acids

TOSS-UP

Chemistry - *Multiple Choice* Which of the following is a valid pathway for the synthesis of PETE monomers?

W) Esterification between phthalic ***[tha-lic]*** acid and ethylene glycol

X) Esterification between dimethylterephthalate ***[di-methyl-tera-tha-late]*** and ethylene glycol
Y) Transesterification between phthalic ***[tha-lic]*** acid and ethylene glycol
Z) Transesterification between dimethylterephthalate ***[di-methyl-tera-tha-late]*** and ethylene glycol

ANSWER: Z) Transesterification between dimethylterephthalate and ethylene glycol

BONUS

Chemistry - *Multiple Choice* PETE can also be synthesized by esterification between terephthalic ***[tera-tha-lic]*** acid and ethylene glycol. What byproduct is released by this reaction?

ANSWER: Water [accept H2O]

TOSS-UP

Chemistry - *Short Answer* What is the hapticity of the ethylene ligand in Zeise's salt?

ANSWER: 2

BONUS

Chemistry - *Short Answer* What is the term for the specific type of conformational isomerism that arises due to hindered rotation about a single bond, allowing for the isolation of individual conformers?

ANSWER: atropisomerism [accept word forms]

TOSS-UP

Physics - *Short Answer* What experiment, later improved on by the Frisch-Smith experiment, was conducted at Echo Lake in 1940 and measured the decay of muons traveling through the atmosphere at relativistic speeds?

ANSWER: Rossi-Hall experiment

BONUS

Physics - *Multiple Choice* Which of the following is closest to the mean proper lifetime Rossi and Hall calculated for the moving muons in their experiment?

W) 2.4 milliseconds
X) 2.4 microseconds
Y) 2.4 nanoseconds
Z) 2.4 picoseconds

ANSWER: X) 2.4 microseconds

TOSS-UP

Earth and Space - *Short Answer* What astronomical phenomenon, closely related to the diamond ring effect, was first observed by Edmund Halley, who described it as an “exceedingly fine filament of light” during a solar eclipse in 1715?

ANSWER: Baily’s Beads

BONUS

Earth and Space - *Multiple Choice* During which phase of a solar eclipse are Baily's Beads and the diamond ring effect observed?

W) First Contact
X) Second Contact
Y) Totality
Z) Third Contact

ANSWER: X) Second Contact