MHS Round 4

Buzzer test + Ice breaker question: Who's your least favorite person on your team?

TOSS-UP

1) Physics – *Short Answer* What type of scattering is characterized by particles similar to or larger than the wavelength of the incident light?

ANSWER: MIE SCATTERING

BONUS

1) Physics – *Short Answer* By what factor does the volume flow-rate of a cylindrical pipe change by, if the radius of the pipe is multiplied by 2, given that no other factors change?

ANSWER: 16

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TOSS-UP

2) Earth and Space – *Multiple Choice* There is an unusually high concentration of which of the following elements in the KT Boundary.

W) Rhenium
X) Iridium
Y) Strontium
Z) Germanium

ANSWER: X) IRIDIUM

BONUS

2) Earth and Space – *Short Answer* Scientists have discovered microscopic fissures in ancient crystals. These fissures, caused by decaying atoms, can be used to date the crystal and are known as what?

ANSWER: FISSION TRACKS
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TOSS-UP

3) Chemistry – *Multiple Choice* What term describes an alkyl halide that has 2 halogens bonded to the same carbon atom?

W) Ortho
X) Terminal
Y) Vicinal
Z) Geminal

ANSWER: Z) GEMINAL

BONUS

3) Chemistry – *Short Answer* Rank the following 4 orbitals from least to greatest in terms of total nodes: 1) 5f; 2) 4f; 3) 7p; 4) 6d.

ANSWER: 2, 1, 4, 3

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TOSS-UP

4) Biology – *Short Answer* Identify all of the following 4 mechanisms that humans go through in response to low body temperature: 1) Vasodilation; 2) Vasoconstriction; 3) Shivering; 4) Sweating

ANSWER: 2, 3

BONUS

4) Biology – *Short Answer* Rank the following 3 optical structures in order of increasing cone cell density: 1) Fovea; 2) Peripheral Retina; 3) Optic Disk.

ANSWER: 3, 2, 1
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TOSS-UP

5) Math – *Multiple Choice* The radical axis of two circles is the locus of points that have the same:

W) Length
X) Power
Y) Geometric Inverse
Z) Length squared

ANSWER: X) POWER

BONUS

5) Math – *Short Answer* What is the sum of values n, such that n is between 0 and 2020 inclusive and n over 2020 simplifies to 1/m for some positive integer m?

ANSWER: 4284

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TOSS-UP

6) Physics – *Short Answer* Assuming g to be ten meters per second squared, what is the angular frequency in radians per second of a pendulum with a length of ten meters?

ANSWER: ONE

BONUS

6) Physics – *Short Answer* A cyclotron has a radius of 5 meters, and is made for an electron. If a new cyclotron is made for an electron moving with twice the speed, what must be the radius in meters of this cyclotron, if the magnetic field is kept constant?

ANSWER: 10m
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TOSS-UP

7) Earth and Space – *Short Answer* The Van Allen Radiation Belts are created by the interaction of solar wind and which of the following:

W) Magnetic Solar Phenomena
X) Chromosphere
Y) Aurorae
Z) Magnetosphere

ANSWER: Z) Magnetosphere

BONUS

7) Earth and Space – *Short Answer* Gas Hydrates are an unconventional form of hydrocarbon deposits. They are made up of water ice enclosing molecules of what hydrocarbon?

ANSWER: METHANE (ACCEPT: CH_4)

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TOSS-UP

8) Chemistry – *Short Answer* Identify all of the following 3 catalysts that would result in a cis alkene after the hydrogenation of an alkyne: 1) Lindlar's Catalyst; 2) P-2 Catalyst; 3) Platinum Catalyst.

ANSWER: 1 AND 2

BONUS

8) Chemistry – *Multiple Choice* Which of the following statements regarding argentometry is NOT true:

W) It is a titration involving the nitrate ion.
X) It is used to calculate the standard reduction potential of a silver electrode.
Y) The Mohr method uses potassium chromate as an indicator.
Z) Volhard's method uses back titration to titrate.

ANSWER: X) IT IS USED TO CALCULATE THE STANDARD REDUCTION POTENTIAL OF A SILVER ELECTRODE.
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TOSS-UP

9) Biology – *Short Answer* In the development of a protostome, what opening becomes the mouth, while in the development of a deuterostome, the same opening becomes the anus.

ANSWER: BLASTOPORE

BONUS

9) Biology – *Short Answer* Identify all of the following 4 plant divisions in which the sporophyte is less well developed than the gametophyte: 1) Mosses 2) Ferns 3) Liverworts 4) Hornworts

ANSWER: 1, 3, 4

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TOSS-UP

10) Math – *Short Answer* How many non-empty subsets are there for the set of positive integers less than 10?

ANSWER: 511

BONUS

10) Math – *Multiple Choice* How many ways are there to triangulate a convex seven-sided polygon?

W) 14
X) 28
Y) 42
Z) 56

ANSWER: Y) 42
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TOSS-UP

11) Physics – *Short Answer* What is the magnetic flux in webers emanating from a circular surface with radius one meter, and magnetic field of one tesla, if the magnetic field makes an angle of 60 degrees with the normal?

ANSWER: pi/2

BONUS

11) Physics – *Short Answer* A beam of light enters a series of 4 polarizers, each rotated 45 degrees from the previous polarizer. What fraction of the initial intensity of light remains after leaving the 4th polarizer?

ANSWER: 1/16

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TOSS-UP

12) Earth and Space – *Multiple Choice* Conventional hydrocarbon reserves have been mined for oil, gas, etc since the 1800s. As those dry up, companies turn to unconventional hydrocarbons such as which of the following:

W) Oil Trap
X) Oil Seep
Y) Oil Sands
Z) Hydrofracturing

ANSWER: Y) Oil Sands

BONUS

12) Earth and Space – *Multiple Choice* Which of the following is NOT a form of submarine mass movement:

W) Turbidity Current
X) Submarine Slump
Y) Submarine Debris Flow
Z) Submarine Groin

ANSWER: Z) SUBMARINE GROIN
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TOSS-UP

13) Biology – *Short Answer* What prokaryotic factor is responsible for the initiation of transcription?

ANSWER: SIGMA (ACCEPT: SPECIFICITY)

BONUS

13) Biology – *Short Answer* In a differential centrifugation experiment, multiple speeds are used to separate out cellular components. Order the following 3 cellular components in order of lowest to the highest speed required to separate it out: 1) Nuclei; 2) Ribosomes; 3) Lysosomes.

ANSWER: 1, 3, 2

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TOSS-UP

14) Chemistry – *Short Answer* How many electrons are in the pi system for a molecule of Ozone?

ANSWER: 4

BONUS

14) Chemistry – *Multiple Choice* Which of the following statements is NOT true regarding the epoxidation of alkenes:

W) The reaction can use a peroxy acid.
X) It is an electrophilic addition of oxygen to the double bond.
Y) A product can only be formed from a cis alkene.
Z) The addition can happen on either face.

ANSWER: Y) A PRODUCT CAN ONLY BE FORMED FROM A CIS ALKENE.
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TOSS-UP

15) Math – *Short Answer* Find the determinant of a matrix with first row 1, 2, and second row, 3, 4.

ANSWER: -2

BONUS

15) Math – *Short Answer* Solve the following system of equations for A, B, C, D, and E.
$2A + B + C + D + E = 10$
$A + 2B + C + D + E = 11$
$A + B + 2C + D + E = 12$
$A + B + C + 2D + E = 13$
$A + B + C + D + 2E = 14$

ANSWER) A= 0, B=1, C= 2, D=3, E=4

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TOSS-UP

16) Physics – *Multiple Choice* A cylindrical resistor has a resistance of 5 Ohms. A new resistor is made such that its length is double the original resistor, and its diameter is twice that of the original resistor. What is the resistance of the new resistor in ohms?

W) 2.5
X) 5
Y) 10
Z) 20

ANSWER: W) 2.5

BONUS

16) Physics – *Short Answer* A rocket moves at a speed 0.8c to the right and fires a bullet at 0.6c to the left. In terms of c, to the nearest tenth, what speed does an observer on earth measure the bullet to be traveling at in terms of c?

ANSWER: 0.4c
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TOSS-UP

17) Chemistry – *Short Answer* In the crown ether 18-crown-6, how many carbon and hydrogen atoms are there respectively?

ANSWER: 12, 24

BONUS

17) Chemistry – *Multiple Choice* Which of the following compounds is considered a meso compound?

W) (2R,2S)-2,3-dibromobutane
X) (1R, 4R)-1,4-dinitrocyclohexane
Y) 2,4,6-trinitrotoluene
Z) (1R, 2S, 3S)-1,2,3-triethylheptane

ANSWER: W) (2R,2S)-2,3-DIBROMOBUTANE

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TOSS-UP

18) Biology – *Multiple Choice* What organic product is given after the nucleotide, adenine is deaminated?

W) Inosine
X) Hypoxanthine
Y) Uracil
Z) Guanine

ANSWER: X) HYPOXANTHINE

BONUS

18) Biology – *Multiple Choice* Dan was found after wandering a hot desert for several hours with no water. Which of the following solutions given intravenously would best return Dan's intracellular volume toward normal?

W) Hypertonic Saline
X) Plasma
Y) Isotonic Saline
Z) Dextran in isotonic saline.

ANSWER: Y) ISOTONIC SALINE
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TOSS-UP

19) Earth and Space – *Short Answer* Metamorphic Rocks that appear banded are classified as what?

ANSWER: FOLIATED

BONUS

19) Earth and Space – *Multiple Choice* Of the following, which technique uses stellar parallax as its primary measurement:

W) Occultation
X) Triangulation
Y) Aperture synthesis
Z) Entanglement Distillation

ANSWER: X) TRIANGULATION

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TOSS-UP

20) Math – *Short Answer* What is the definite integral from 0 to pi of the expression 1 plus cosine of x dx?

ANSWER: pi

BONUS

20) Math – *Short Answer* A triangle has three altitudes of 5, 6 and 7. What is the radius of the circle inscribed in this triangle?

ANSWER: 210/107
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TOSS-UP

21) Biology – *Multiple Choice* Which of the following plant tissues is present in eudicots but not in monocots?

W) Pith
X) Endodermis
Y) Cortex
Z) Epidermis

ANSWER: W) PITH

BONUS

21) Biology – *Short Answer* What genetic disease is characterized by excess copper buildup in several essential organs, which causes jaundice in certain cases.

ANSWER: Wilson's Disease

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TOSS-UP

22) Chemistry – *Short Answer* Identify all of the following 3 materials that can be considered metastable: 1) Graphene; 2) Graphene oxide; 3) Diamond

ANSWER: 2 AND 3

BONUS

22) Chemistry – *Short Answer* Order the following 3 molecules based on melting points: 1) S8; 2) C60; 3) C6H6.

ANSWER: 3, 1, 2
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TOSS-UP

23) Math – *Multiple Choice* For a continuous and differentiable function f of x, if f of 1 equals 10 and f of 9 equals 10, which of the following must exist on the open interval from 1 to 9?

W) A local minimum or maximum
X) A point of inflection
Y) A vertical asymptote
Z) A horizontal asymptote

ANSWER: W) A LOCAL MINIMUM OR MAXIMUM

BONUS

23) Math – *Short Answer* When the five-digit number AB0AB is divided by the two-digit number AB the result is A00B. What is the value of A+B?

ANSWER: 2