MHS Set 2 Round 6 EDER

Buzzer test + Ice breaker question: What is one thing that people are impressed by, but isn't that impressive?

TOSS-UP

1) Physics – *Multiple Choice* Which of the following is the direction of the acceleration on an electron with a velocity in the positive *x* direction and a magnetic field acting on the electron in the positive *y* direction?

W) Positive *x*
X) Positive *z*
Y) Negative *x*
Z) Negative *z*

ANSWER: Z) NEGATIVE *Z*

BONUS

1) Physics – *Short Answer* Luke, currently learning about the Cobb angle, is listening to a video 1 meter away from the speaker, and perceives a sound with intensity of 80 decibels. If he were to move 0.5 meters closer to the speaker, what sound intensity would he perceive, to the nearest decibel?

ANSWER: 86

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TOSS-UP

2) Earth and Space - *Short Answer* Sunspots, prominences, and other solar phenomena are caused by what part of the sun being twisted around, which is in turn due to the sun's differential rotation?

ANSWER: MAGNETIC FIELD

BONUS

2)Earth and Space - *Multiple Choice* - If a star is 132 parsecs away and has an apparent magnitude of 2.5, what is its absolute magnitude?

W) 4.3
X) 2.1
Y) -1.6
Z) -3.1

ANSWER: Z) -3.1
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TOSS-UP

3) Chemistry – *Short Answer* What equation in chemistry finds the frequency of a one electron system given the final and initial energy levels and a namesake constant?

ANSWER: RYDBERG'S EQUATION

BONUS

3) Chemistry – *Short Answer* Identify all of the following 3 addition reactions of alkenes that result in a racemic mixture: 1) Hydroboration oxidation; 2) Bromination; 3) Acid-Catalyzed Addition.

ANSWER: 3 ONLY

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TOSS-UP

4) Biology – *Short Answer* In the channel protein, Aquaporin, two hydrophobic loops contain the amino acids asparagine, proline, and alanine creating what structural motif?

ANSWER: NPA MOTIF

BONUS

4) Biology – *Short Answer* What transposable element is transcribed into RNA before it moves into the genome?

ANSWER: RETROTRANSPOSONS
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TOSS-UP

5) Math – *Short Answer* What is the distance between the points (7, 11) and (12, 17)?

ANSWER: $\sqrt{61}$

BONUS

5) Math – *Short Answer* An arithmetic sequence has first term 7 and fourth term 22. What is the sum of the first 20 terms?

ANSWER: 1090

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TOSS-UP

6) Physics – *Short Answer* An object with a density of 3 grams per cubic centimeter and a volume of 1 cubic meter is submerged underwater. What is the magnitude, in newtons, of the buoyant force on the object?

ANSWER: 9800

BONUS

6) Physics – *Short Answer* A container with an initial volume of 5 liters expands to a volume of 10 liters against a pressure of 1 bar. How much work, in joules, did the container perform on the surroundings?

ANSWER: 500
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TOSS-UP

7) Earth and Space - *Short Answer* Because of its lack of any appreciable topsoil or humus, desert soil lacks which soil horizon?

ANSWER: O HORIZON

BONUS

7) Earth and Space - *Multiple Choice* - If a mineral has a reading on Moh's Hardness Scale between Quartz and Corundum, what could its actual hardness be?

W) 8
X) 6
Y) 5
Z) 3

ANSWER: W) 8

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TOSS-UP

8) Energy – *Short Answer* Researchers at Argonne national lab are studying the electronic structure of strontium titanate, or $SrTiO_3$. What is the oxidation state of titanium in strontium titanate?

ANSWER: +4

BONUS

8) Energy – *Multiple Choice* Researchers at Ames national lab are studying the cleaving of carbon-oxygen bonds via hydroboration. Which of the following molecules has the strongest carbon-oxygen bonds?

W) Methanol
X) Acetic Acid
Y) Carbon Dioxide
Z) Carbon Monoxide

ANSWER: Z) CARBON MONOXIDE
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TOSS-UP

9) Biology – *Short Answer* What term is used to describe when two allopatrically separated species are reunited.

ANSWER: SECONDARY CONTACT

BONUS

9) Biology – *Short Answer* Identify all of the following 3 liquids that would inhibit ADH function: 1) Water; 2) Alcohol; 3) Coffee.

ANSWER: 2 AND 3

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TOSS-UP

10) Math – *Short Answer* What is the sum of the infinite geometric series with first term 1/6 and second term 1/36?

ANSWER: 1/5

BONUS

10) Math – *Multiple Choice* Which of the following pairs of vectors are orthogonal?

W) 2i + 3j and 4i - 2j
X) 3j + 2k and i - k
Y) 4i + j - k and 2j + 2k
Z) 3i + k and 2i - 6j

ANSWER: Y) 4i + j - k AND 2j + 2k
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TOSS-UP

11) Physics – *Short Answer* What law states that the entropy of a perfect crystal at absolute zero is equivalent to 0?

ANSWER: THIRD LAW OF THERMODYNAMICS

BONUS

11) Physics – *Short Answer* By what factor is the schwarzschild radius of a black hole multiplied by if its mass is doubled?

ANSWER: 2

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TOSS-UP

12) Earth and Space - *Multiple Choice* It is believed that dogs can detect earthquakes before humans due to their heightened sense of hearing, and can sense the scraping and grinding of rocks underground before the wave arrives. Which of the following parts of the earthquake are they hearing?

W) Rayleigh Wave
X) Foreshock
Y) Aftershock
Z) Love Wave

ANSWER: X) FORESHOCK

BONUS

12)Earth and Space - *Multiple Choice* Compared to the faster Primary waves, S-waves move at approximately what percent the speed of P-waves?

W) 20%
X) 40%
Y) 60%
Z) 80%

ANSWER: Y) 60%
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TOSS-UP

13) Energy – *Short Answer* Researchers at Argonne national lab are studying distortions in gallium arsenide quantum dots. The highest energy electrons for both gallium and arsenic reside in what orbital?

ANSWER: 4p

BONUS

13) Energy – *Short Answer* Researchers at Ames national lab are studying perovskite nanocuboids for uses as a catalyst. These perovskites are composed of strontium, three oxygen atoms, and what other period 4 transition metal element?

ANSWER: TITANIUM

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TOSS-UP

14) Chemistry – *Multiple Choice* Which of the following most accurately describes an optically active mixture?

W) It is a racemic mixture
X) One chiral species dominates.
Y) Geometric isomers are in equal amounts.
Z) It follows Beer's Laws

ANSWER: X) ONE CHIRAL SPECIES DOMINATES

BONUS

14) Chemistry – *Short Answer* A transition metal ion has how many valence atomic orbitals?

ANSWER: 9
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TOSS-UP

15) Math – *Short Answer* What is the remainder when the polynomial $4x^4 - 3x^2 + 12x + 16$ is divided by $x + 1$?

ANSWER: 5

BONUS

15) Math – *Short Answer* What is the volume of a hexagonal pyramid with a regular hexagonal base with sides of length 6, and a height of 10?

ANSWER: $180\sqrt{3}$

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TOSS-UP

16) Physics – *Multiple Choice* Which of the following particles has a spin of 1?

W) Neutron
X) Neutrino
Y) Higgs Boson
Z) Photon

ANSWER: Z) PHOTON

BONUS

16) Physics – *Short Answer* In terms of the permittivity of free space, ϵ_0(*read as: "epsilon naught"*), what is the electric flux through a sphere with radius 100 meters entirely encompassing an insulating sphere of radius 3, with uniform charge density 3 coulumbs per cubic meter?

ANSWER: $108\pi/\epsilon_0$
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TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following most accurately describes the difference between a carbon carbon double bond and a silicon silicon double bond?

W) The carbon double bond will have lower bond energy and longer bond length than the silicon double bond
X) The carbon double bond will have lower bond energy and shorter bond length than the silicon double bond
Y) The carbon double bond will have higher bond energy and longer bond length than the silicon double bond
Z) The carbon double bond will have higher bond energy and shorter bond length than the silicon double bond

ANSWER: Z) THE CARBON DOUBLE BOND WILL HAVE HIGHER BOND ENERGY AND SHORTER BOND LENGTH THAN THE SILICON DOUBLE BOND

BONUS

17) Chemistry – *Multiple Choice* According to the collision theory of chemical kinetics and the Arrhenius equation, which of the following will NOT necessarily increase the reaction rate?

W) Increase in temperature
X) Decrease in activation energy
Y) Increase in frequency factor
Z) Increase in concentration of reactant

ANSWER: Z) INCREASE IN CONCENTRATION OF REACTANT

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TOSS-UP

18) Biology – *Short Answer* Identify all of the following 3 choices that hemoglobin molecules act as, when binding to excess H+ ions from the blood plasma: 1) Lewis Acids; 2) Bronsted Lowry Bases; 3) Buffers.

ANSWER: 2 AND 3

BONUS

18) Biology – *Short Answer* Identify all of the following 4 choices that are considered exocrine products: 1) Estrogen; 2) Mucous; 3) ADH; 4) Retinol.

ANSWER: 2 ONLY
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TOSS-UP

19) Earth and Space - *Short Answer* Black Lung is an affliction contracted by miners of what important energy source?

ANSWER: COAL

BONUS

19) Earth and Space - *Short Answer* Identify all of the following 4 minerals that are correctly matched with their correct ore: 1) Lead, Galena; 2) Copper, Chalcopyrite; 3) Ilmenite, Niobium; 4) Coltan, Tantalum.

ANSWER: 1, 2, 4

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TOSS-UP

20) Math – *Short Answer* What is the maximum value of the function $f(x) = -3x^2 + 12x + 17$ over its entire domain?

ANSWER: 29

BONUS

20) Math – *Short Answer* What is the area enclosed by the graphs $y = -x^2 + 3x + 2$ and $y = x + 2$?

ANSWER: 4/3
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TOSS-UP

21) Biology – *Short Answer* What equation in enzyme kinetics is derived from the steady-state approximation using the reaction mechanism for an enzyme-substrate reaction?

ANSWER: MICHAELIS MENTEN EQUATION

BONUS

21) Biology – *Short Answer* What cranial nerve is primarily responsible for the sense of smell?

ANSWER: CRANIAL NERVE 1 (ACCEPT: OLFACTORY)

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TOSS-UP

22) Chemistry – *Short Answer* Order the following 3 carbocations based on stability: 1) Primary; 2) Secondary; 3) Tertiary.

ANSWER: 3, 2, 1

BONUS

22) Chemistry – *Short Answer* Order the following 3 ions from least to greatest in charge: 1) Sulfate; 2) Nitrate; 3) Ammonia.

ANSWER: 1, 2, 3
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TOSS-UP

23) Energy – *Short Answer* Researchers at Argonne national lab are using density functional theory to study iron porphyrin complexes. What element in porphyrin is used to coordinate with the central iron atom?

ANSWER: NITROGEN

BONUS

23) Energy – *Multiple Choice* Researchers at Argonne national lab are studying high spin and low spin iron complexes in the general form of $[Fe(X)_6]^{2+}$, where X is the coordinating ligand. Which of the following ligands would most likely lead to a low spin iron complex?

W) O^{2-}
X) Oxalate anion
Y) I^-
Z) CN^-

ANSWER: Z) CN^-