# MHS Set 2 Round 8

Buzzer test + Ice breaker question: This isn't a question, I've written too much and I want to die.

**TOSS-UP**

1) Physics – *Short Answer* The force exerted on an object is plotted against time. What quantity is represented by the area under the curve?

ANSWER: IMPULSE

**BONUS**

1) Physics – *Short Answer* What is the resonant frequency, in hertz, of an LC circuit composed of an inductor with an inductance of 5 millihenrys and a capacitor with capacitance of 50 microfarads?

ANSWER: 2000

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**TOSS-UP**

2) Earth and Space — *Short Answer* Cassini's division divides which two of Saturn's rings?

ANSWER: A AND B RINGS

**BONUS**

2) Earth and Space — *Multiple Choice* The presence of Uranus' rings was discovered because of which of the following phenomena, where a shadow from the rings is cast upon the planet?

W) Hydrostatic Equilibrium
X) Forward Scattering
Y) Occultation
Z) Cold Dark Matter

ANSWER: Y) OCCULTATION
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**TOSS-UP**

3) Chemistry – *Short Answer* According to VSEPR theory, what two molecular geometries is shared between the two electron pair geometries: Trigonal Bipyramidal and Octahedral?

ANSWER: T-SHAPED AND LINEAR

**BONUS**

3) Chemistry – *Multiple Choice* Which of the following wavenumber ranges, in inverse centimeters, would you expect an alcohol functional group to have?

W) 2000-2400
X) 2400-2800
Y) 2800-3200
Z) 3200-3600

ANSWER: Z) 3200-3600

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**TOSS-UP**

4) Biology – *Short Answer* What type of speciation is described as a small subpopulation speciating in the periphery, however, isolated from the original population

ANSWER: PERIPATRIC SPECIATION

**BONUS**

4) Biology – *Short Answer* A base substitution mutation in a gene sometimes has no effect on the protein the gene codes for. Identify all of the following 3 factors that could account for this: 1) Rarity of mutations; 2) Amino acids have more than one codon; 3) Correcting mechanism that is part of the mRNA molecule.

ANSWER: 2 ONLY
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**TOSS-UP**

5) Math – *Multiple Choice* Which of the following is not a possible root of the polynomial $15x^6 - 27x^3 + 24x - 36$ by the rational root theorem?

W) 12
X) 9
Y) 8
Z) 4

ANSWER: Y) 8

**BONUS**

5) Math – *Short Answer* What is the distance from the point (2,5,1) to the plane defined by the equation $3x + 4y + 12z = 14$?

ANSWER: 24/13

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**TOSS-UP**

6) Physics – *Short Answer* Identify all of the following three interactions whose strength depends on the inverse square of distance: 1) Gravitational potential energy; 2) Ion-Dipole potential energy; 3) Dipole electric field strength.

ANSWER: 2 ONLY

**BONUS**

6) Physics – *Short Answer* A tube open at one end has a fundamental frequency of 100 hertz. What is the frequency, in hertz, of its fourth harmonic?

ANSWER: 700
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**TOSS-UP**

7) Earth and Space — *Short Answer* By name or number, identify which of the following that are NOT glassy igneous rocks: 1) Obsidian; 2) Scoria; 3) Tachylite; 4) Pumice.

ANSWER: NONE

**BONUS**

7) Earth and Space — *Multiple Choice* Victim to various forms of weathering like frost wedging and erosion, cliffsides will often crumble. Which of the following describes the blocks of stone that tumble off the sides of rock outcroppings?

W) Tombolo
X) Thalweg
Y) Laterite
Z) Talus

ANSWER: Z) TALUS

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**TOSS-UP**

8) Energy – *Short Answer* Researchers at Lawrence Berkeley national lab have developed a metal organic framework that can filter out sulfur dioxide from other atmospheric gases. Sulfur dioxide reacts with water and oxygen in the atmosphere to form what acid?

ANSWER: SULFURIC ACID

**BONUS**

8) Energy – *Multiple Choice* Researchers at Lawrence Berkeley national lab are studying the semiconducting capabilities of nitride materials. Which of the following elements would form the most stable nitrides?

W) Lithium
X) Sodium
Y) Potassium
Z) Rubidium

ANSWER: W) LITHIUM
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**TOSS-UP**

9) Biology – *Short Answer* Identify all of the following 3 choices that are characteristic of fungi but not plants: 1) Immobile; 2) Heterotrophic; 3) Fixes $CO_2$.

ANSWER: 2 ONLY

**BONUS**

9) Biology – *Short Answer* In the RNA World Hypothesis, it is theorized that one of the first enzymes ever was a catalytic RNA molecule, what name is given to these catalytic RNA molecules?

ANSWER: RIBOZYMES

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**TOSS-UP**

10) Math – *Short Answer* What is the integral of $x\,dx$ from 0 to 10?

ANSWER: 50

**BONUS**

10) Math – *Short Answer* A wallet contains two coins, one that is fair and another that flips heads ⅔ of the time. One coin is chosen out of the wallet randomly and is flipped, and it lands on heads. What is the probability that the coin is a fair coin?

ANSWER: 3/7
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**TOSS-UP**

11) Physics – *Short Answer* An object is moving at a speed of 0.6c with respect to an observer. If it's rest length is 120 meters, what is the length, in meters, measured by the observer?

ANSWER: 96

**BONUS**

11) Physics – *Short Answer* A person walks up a 30 degree slope for a total distance of 100 meters. Given that their mass is 50 kilograms, what is the magnitude of the work done, to the nearest joule, by gravity on the person?

ANSWER: 24500

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**TOSS-UP**

12) Earth and Space — *Multiple Choice* There are multiple types of solar prominences, but some erupt and subside comparatively slowly, making them visible for months. Which of the following correctly identifies these prominences?

W) Quiescent
X) Eruptive
Y) Filament
Z) Coronal Hole

ANSWER: W) QUIESCENT

**BONUS**

12) Earth and Space — *Multiple Choice* If a star has an apparent magnitude of 12, and an absolute magnitude of 2, which of the following is its distance from Earth, to the nearest parsec?

W) 400 parsecs
X) 600 parsecs
Y) 800 parsecs
Z) 1000 parsecs

ANSWER: Z) 1000 PARSECS
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**TOSS-UP**

13) Energy – *Short Answer* Researchers at Lawrence Berkeley national lab have discovered a protein found in bullfrogs that can inhibit saxitoxin, a neurotoxin generated from harmful algal blooms. What group of organisms are responsible for blue-green algal blooms?

ANSWER: CYANOBACTERIA

**BONUS**

13) Energy – *Short Answer* Researchers at Lawrence Berkeley national lab are using cubic catalysts to facilitate artificial photosynthesis. These compounds take on the shape of the cubane hydrocarbon, which has a carbon atom at each vertex of a cube. What is the degree of unsaturation of cubane?

ANSWER: 5

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**TOSS-UP**

14) Chemistry – *Short Answer* Order the following 3 species from lowest solubility in water to highest solubility in water: 1) AgI; 2) AgBr; 3) AgCl

ANSWER: 1, 2, 3

**BONUS**

14) Chemistry – *Multiple Choice* Which of the following statements regarding lewis acids is NOT correct?

W) They can be used to catalyze electrophilic aromatic substitution reactions.
X) They accept electron pairs
Y) They are considered electrophiles
Z) They are all Bronsted Lowry acids

ANSWER: Z) THEY ARE ALL BRONSTED LOWRY ACIDS
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**TOSS-UP**

15) Math – *Short Answer* What is the lateral surface area of a cone with radius 6 and height 8?

ANSWER: 60$\pi$

**BONUS**

15) Math – *Short Answer* What is the eccentricity of an ellipse with foci at the points (2,3) and (8,13) and a vertex at (0.5, 0.5)?

ANSWER: 2/3

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**TOSS-UP**

16) Physics – *Multiple Choice* Which of the following processes, when done on a system, would lead to the smallest change in entropy?

W) Reversible isobaric expansion
X) Isochoric heating
Y) Reversible adiabatic expansion
Z) Reversible isothermal expansion

ANSWER: Y) REVERSIBLE ADIABATIC EXPANSION

**BONUS**

16) Physics – *Short Answer* A galaxy is travelling at a speed that is 50% the speed of light. To the nearest tenth, what is its redshift?

ANSWER: 0.7
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**TOSS-UP**

17) Chemistry – *Short Answer* Order the following 3 molecules from lowest to highest strength due to London Dispersion Force: 1) Isooctane; 2) n-octane; 3) n-hexane.

ANSWER: 3, 1, 2

**BONUS**

17) Chemistry – *Short Answer* Which of the following statements is NOT true regarding electrolytic cells?

W) Electrolytic cells provide energy for reactions with positive Gibbs free energy to occur.
X) The Down's process allows us to plate out sodium with an electrolytic cell.
Y) All electrolytic cells have a salt bridge to maintain constant concentrations of salts.
Z) An external electricity source is required to drive a current.

ANSWER: Y) ALL ELECTROLYTIC CELLS HAVE A SALT BRIDGE TO MAINTAIN CONSTANT CONCENTRATIONS OF SALTS.

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**TOSS-UP**

18) Biology – *Short Answer* What common type of arthritis occurs when urate crystals accumulate in joints and cause inflammation, when either your body produces too much uric acid or your kidneys do a bad job at excreting uric acid?

ANSWER: GOUT

**BONUS**

18) Biology – *Multiple Choice* Which of the following is NOT true regarding retinol?

W) Transthyretin moves retinol in the body.
X) Retinol is fat-soluble.
Y) A deficiency of retinol prevents the reformation of rhodopsin.
Z) Retinol is used in the synthesis of Acetyl CoA

ANSWER: Z) RETINOL IS USED IN THE SYNTHESIS OF ACETYL COA
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## TOSS-UP

19) Earth and Space — *Short Answer* In 1914, it was discovered that Primary Earthquake waves do not register at seismometers between 103° and 143° from the epicenter, due to refraction of waves through Earth's core. What is this area known as?

ANSWER: P-WAVE SHADOW ZONE

## BONUS

19) Earth and Space — *Short Answer* While researching mantle plumes, researchers have discovered that the innermost layer of Earth spins at a slightly faster rate than the rest of the Earth, going around once more than than the Earth every 20-25 years. This is called what?

ANSWER: CORE SUPERROTATION

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## TOSS-UP

20) Math – *Short Answer* The product of two prime numbers is 143. What is their sum?

ANSWER: 24

## BONUS

20) Math – *Short Answer* As a result of negging too much in middle school, Sanjay has damaged his myelin sheath, leading to him having a 2 second total reaction time. A heavy object is coming towards him starting at time $t = 0$ with a velocity that follows the function $v(t) = 5t^3 + 3t^2 + 4t + 4$. What is the minimum distance at which Sanjay must notice the object in order to avoid being hit?

ANSWER: 44
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**TOSS-UP**

21) Biology – *Short Answer* In comparison to the blood of vertebrates, what fluid in invertebrates occupies similar roles as blood?

ANSWER: HEMOLYMPH

**BONUS**

21) Biology – *Multiple Choice* Which of the following would NOT be true of a virulent phage?

W) They reproduce through the lytic cycle.
X) Glutathione functions to limit its effectiveness.
Y) They are considered prophages.
Z) They can be converted into temperate phages.

ANSWER: Y) THEY ARE CONSIDERED PROPHAGES

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**TOSS-UP**

22) Chemistry – *Short Answer* What metal was used in the Davisson Germer experiment that showed that electrons were able to diffract?

ANSWER: NICKEL

**BONUS**

22) Chemistry – *Short Answer* Identify all of the following 3 species that are paramagnetic: 1) $O_2$; 2) $O_2^-$; 3) $O_2^{2-}$

ANSWER: 1 AND 2
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## TOSS-UP

23) Energy – *Multiple Choice* Researchers at Lawrence Berkeley national lab are studying the electromagnetic radiation emitted by heated bodies. What law gives the spectral density of the radiation emitted by a blackbody?

W) Rayleigh Jeans Law
X) Stefan-Boltzmann Law
Y) Planck's Law
Z) Wien's Law

ANSWER: Y) PLANCK'S LAW

## BONUS

23) Energy – *Short Answer* Researchers at Lawrence Berkeley national lab are using silver catalysts to reduce carbon dioxide to carbon monoxide. What is the positive difference between the formal charges present on the carbon atoms in carbon dioxide and carbon monoxide?

ANSWER: 1