MHS Round 12

Buzzer test + Ice breaker question:

TOSS-UP

1) Physics – *Short Answer* What is the name for materials that have different indices of refraction for different polarizations of incoming light?

ANSWER: BIREFRINGENT

BONUS

1) Physics – *Short Answer* A particle with a mass of 3 moves with a position function $x(t) = 4t^3 - 8t^2 + 42t$. What is the force acting on the particle at time $t = 4$?

ANSWER: 240

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TOSS-UP

2) Earth and Space – *Multiple Choice* Which of the following statements is correct about volcanic eruptions?

W) Vulcanian eruptions produce low-viscosity lava flows
X) Sheets of tuff form ignimbrite
Y) Shield volcanoes produce more pyroclastic debris than stratovolcanoes
Z) Hawaiian eruptions are primarily composed of lapilli

ANSWER: X) SHEETS OF TUFF FORM IGNIMBRITE

BONUS

2) Earth and Space – *Short Answer* What type of sand dune is formed along coasts with abundant sand, containing some vegetative cover?

ANSWER: PARABOLIC
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TOSS-UP

3) Chemistry – *Short Answer* In FT-NMR, magnetic field strength is held constant while the sample is irradiated with a short pulse that covers the entire range of the relevant rF frequencies. This data is read as an FID which is converted into a spectrum via what mathematical technique?

ANSWER: FOURIER TRANSFORMS

BONUS

3) Chemistry – *Short Answer* Order the following 3 substituents on a benzene ring from increasing order of promoting an SNAR reaction rate. 1) Nitro; 2) Methoxy; 3) Chloro.

ANSWER: 2, 3, 1

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TOSS-UP

4) Biology – *Short Answer* Which of the following molecules is involved in both the synthesis of glycerophospholipids and triacylglycerols:

W) Arachidonate (Arch a dough nate)
X) Phosphoenol pyruvate
Y) Eicosanoide (I co sin oids)
Z) Phosphatidate

ANSWER: Z) PHOSPHATIDATE

BONUS

4) Biology – *Short Answer* Order the following 3 stages from earliest to latest in the embryonic development of a frog: 1) Blastula; 2) Zygote; 3) Gastrula.

ANSWER: 2, 1, 3
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TOSS-UP

5) Math – *Short Answer* An isosceles triangle has a vertex angle of 40 degrees. What is the degree measure of an exterior angle to a base angle of the triangle?

ANSWER: 110

BONUS

5) Math – *Short Answer* Will is trying to figure out Sanjay's mom's 7-digit phone number, and he knows the following two facts: 1) It is divisible by 9; 2) Its last 4 digits are 6967. How many possible numbers satisfy these conditions?

ANSWER: 111

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TOSS-UP

6) Physics – *Short Answer* What is the focal length, in centimeters, of a spherical mirror with a radius of curvature of 70 centimeters?

ANSWER: 35

BONUS

6) Physics – *Multiple Choice* Which of the following types of scattering is both elastic, and due to a result of collisions with charged particles?

W) Thomson Scattering
X) Raman Scattering
Y) Compton Scattering
Z) Mie Scattering

ANSWER: W) THOMSON SCATTERING
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TOSS-UP

7) Earth and Space – *Short Answer* Identify all of the following igneous intrusions that are concordant: 1) Dike; 2) Batholith; 3) Stock

ANSWER: NONE

BONUS

7) Earth and Space – *Multiple Choice* The Great Oxygenation Event occurred during which of the following eons?

W) Hadean
X) Archean
Y) Proterozoic
Z) Phanerozoic

ANSWER: Y) PROTEROZOIC

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TOSS-UP

8) Energy – *Short Answer* Researchers at the Joint Genome Institute have recently found a seed dispersal gene in the Green Millet plant. The Green Millet plant undergoes carbon fixation through what pathway, which derives carbon dioxide from malate in the mesophyll cells of the plant?

ANSWER: C4

BONUS

8) Energy – *Short Answer* Researchers at Brookhaven national lab are studying the use of desaturase enzymes for green chemistry. Desaturase enzymes work in reverse of what process, in which an alkene is turned into an alkane?

ANSWER: HYDROGENATION
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TOSS-UP

9) Biology – *Short Answer* What type of study is used in animal science that tests nature versus nurture by separating the youngs of species and allowing them to develop with another species?

ANSWER: CROSS FOSTERING STUDY

BONUS

9) Biology – *Multiple Choice* Which of the following best describes the difference between an osmoconformer and an osmoregulator?

W) Osmoconformers have had adaptive radiation to live in different environments, osmoregulators are a paralog of osmoconformers.
X) Osmoconformers have a swim bladder, and osmoregulators do not.
Y) Osmoconformers are hyperosmotic with their surroundings, osmoregulators are isosmotic with their environments.
Z) Osmoconformers are isosmotic with their surroundings, osmoregulators allow inhabitance in multiple environments.

ANSWER: Z) OSMOCONFORMERS ARE ISOSMOTIC WITH THEIR SURROUNDINGS, OSMOREGULATORS ALLOW INHABITANCE IN MULTIPLE ENVIRONMENTS.

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TOSS-UP

10) Math – *Short Answer* What is the coefficient of the x^2y^3 term in the binomial expansion of $(3x - 2y)^5$?

ANSWER: -720

BONUS

10) Math – *Short Answer* What is the distance between the two points with polar coordinates $(2, \frac{\pi}{3})$ and $(5, \frac{2\pi}{3})$?

ANSWER: $\sqrt{19}$
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TOSS-UP

11) Physics – *Short Answer* Given that a tube open at one end has a length of 3 meters, what is the wavelength of the second harmonic?

ANSWER: 4

BONUS

11) Physics – *Short Answer* What is the magnetic flux, to the nearest weber, of a circle with a radius of 2, with a 2 tesla uniform magnetic field going through it at an angle of 60 degrees with respect to the normal?

ANSWER: 13

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TOSS-UP

12) Earth and Space – *Short Answer* What is the term for the feature of an aquifer that forms when groundwater is pumped from a well, showing most prominence in heavy pumping?

ANSWER: CONE OF DEPRESSION

BONUS

12) Earth and Space – *Short Answer* What is the term for points on the Earth's surface that have a tidal range of 0?

ANSWER: AMPHIDROMIC POINTS
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TOSS-UP

13) Energy – *Multiple Choice* Researchers at Brookhaven national lab are studying enzymes that can convert fatty acids into diols. These enzymes work by adding molecules of dioxygen to the double bond of the fatty acid. Which of the following statements is false about dioxygen?

W) Each oxygen atom has an oxidation state of 0
X) It is isoelectronic to the cyanide ion
Y) It is paramagnetic
Z) It can act as a biradical

ANSWER: X) IT IS ISOELECTRONIC TO THE CYANIDE ION

BONUS

13) Energy – *Short Answer* Researchers at Brookhaven national lab are studying the production of oils in plants. They have found that a large portion of the oils are produced by what process, the natural, regulated recycling of cellular components?

ANSWER: AUTOPHAGY (ACCEPT: AUTOPHAGOCYTOSIS)

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TOSS-UP

14) Chemistry – *Multiple Choice* Which of the following indicators would be the best for a titration that changes from 7 to 8 pH.

W) Methyl Orange
X) Methyl Red
Y) Phenolphthalein
Z) Phenol Red

ANSWER: Z) PHENOL RED

BONUS

14) Chemistry – *Multiple Choice* Which of the following cannot be concluded from de Broglie's proposition of the electron as a standing wave?

W) An electron has a specific probability of being found in an orbital
X) An electron has discrete energies when inside of an atom
Y) An electron can have wavelike behavior
Z) An electron's wavelength can be related to its velocity

ANSWER: W) AN ELECTRON HAS A SPECIFIC PROBABILITY OF BEING FOUND IN AN ORBITAL.
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TOSS-UP

15) Math – *Short Answer* The integral from 0 to 8 of $f(x)\,dx$ has a value of 32. What is the value of the integral from 0 to 4 of $f(2x) + 3\,dx$?

ANSWER: 28

BONUS

15) Math – *Short Answer* What is the area enclosed by the figure formed from the locus of all points that are a distance of 3 from an equilateral triangle with side length 4?

ANSWER: $9\pi + 36 + 4\sqrt{3}$

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TOSS-UP

16) Physics – *Short Answer* What is the reduced mass, in kilograms, of a system containing a 6 kilogram object and an 8 kilogram object?

ANSWER: 24/7

BONUS

16) Physics – *Short Answer* To the nearest second, what is the period of a physical pendulum with a mass of 3 kilograms, a moment of inertia of 60 kilogram meters squared, and a center of gravity that is a distance of 2 meters from the pivot?

ANSWER: 6
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TOSS-UP

17) Chemistry – *Multiple Choice* In lab, you placed a hot piece of metal into cool water to measure the specific heat capacity of the metal. Which of the following would be considered the system, and describes the reaction.

W) The piece of metal is the system and the process is endothermic.
X) The piece of metal is the system and the process is exothermic.
Y) The water is the system and the process is endothermic.
Z) The water is the system and the process is exothermic.

ANSWER: X) THE PIECE OF METAL IS THE SYSTEM AND THE PROCESS IS EXOTHERMIC

BONUS

17) Chemistry – *Short Answer* In the molecule N_2, how many valence electrons are in antibonding orbitals?

ANSWER: 2

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TOSS-UP

18) Biology – *Short Answer* The lysosomal storage disease I-Cell disease results from a defective version of the protein phosphotransferase. What organelle other than the lysosome is most likely to be affected by this?

ANSWER: GOLGI BODY

BONUS

18) Biology – *Short Answer* Restriction enzymes can generate DNA overhangs, what is the term for these DNA overhangs?

ANSWER: STICKY ENDS
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TOSS-UP

19) Earth and Space – *Multiple Choice* Which of the following planets has the smallest eccentricity?

W) Mercury
X) Venus
Y) Jupiter
Z) Saturn

ANSWER: X) VENUS

BONUS

19) Earth and Space – *Short Answer* The transit and microlensing methods are both used to detect what astronomical objects?

ANSWER: EXOPLANETS

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TOSS-UP

20) Math – *Short Answer* What is the value of the fourth derivative at $x = 0$ of e^{3x}?

ANSWER: 81

BONUS

20) Math – *Short Answer* What is the sum of the first 11 terms of the geometric series with first 2 terms, 3 and 6?

ANSWER: 6141
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TOSS-UP

21) Biology – *Multiple Choice* Which of the following biological molecules acts as the strongest antioxidant.

W) Alanine
X) Glutathione
Y) Amylase
Z) Glutamate

ANSWER: X) GLUTATHIONE

BONUS

21) Biology – *Multiple Choice* Which of the following is an example of a fixed-interval reinforcement schedule?

W) Getting a candy for good test scores occasionally
X) When a dog gets a treat for sitting on command
Y) Winning money on a slot machine
Z) Getting paid on the second Friday of every month.

ANSWER: Z) GETTING PAID ON THE SECOND FRIDAY OF EVERY MONTH.

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TOSS-UP

22) Chemistry – *Short Answer* What dimensionless quantity is used to represent the non-ideal interactions between two components in a liquid solution.

ANSWER: ACTIVITY COEFFICIENT

BONUS

22) Chemistry – *Multiple Choice* Which of the following percentages best represents the probability of finding an electron in an orbital:

W) 50%
X) 75%
Y) 90%
Z) 100%

ANSWER: Y) 90%
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TOSS-UP

23) Energy – *Short Answer* Researchers at Brookhaven national lab in PROSPECT are studying the electron antineutrinos produced in beta decay. They have hypothesized that these antineutrinos are capable of turning into what class of leptons, that are only able to interact with particles through gravity?

ANSWER: STERILE NEUTRINOS

BONUS

23) Energy – *Multiple Choice* Researchers at Brookhaven national lab are studying the components of high temperature superconductors that contribute to the conductance. They have found that one class of particles in the superconductor LBCO that contributes to the superconductivity is the electron hole. Which element in LBCO is responsible for the generation of electron holes?

W) Lanthanum
X) Barium
Y) Copper
Z) Oxygen

ANSWER: X) BARIUM