MHS Set 2 Round 10

Buzzer test + Ice breaker question: Why won't my physics/math person write any questions?

TOSS-UP

1) Physics – *Short Answer* According to Noether's theorem, translational symmetry corresponds to a conservation of what physical quantity?

ANSWER: LINEAR MOMENTUM

BONUS

1) Physics – *Multiple Choice* Given an axis of rotation about the point (0,0), which of the following mass distributions would yield an equivalent moment of inertia compared to a mass distribution about a uniform disk with radius 3 and mass 4 about (0,0)?

W) A mass of 1 at the point (2,3) and a mass of 3 at the point (-1,0)
X) A mass of 2 at the point (3,0) and a mass of 2 at the point (0,3)
Y) A mass of 4 at the point (3,0)
Z) A mass of 1 at the point $(2,\sqrt{2})$ and a mass of 3 at the point (0,-2)

ANSWER: Z) A MASS OF 1 AT THE POINT $(2,\sqrt{2})$ AND A MASS OF 3 AT THE POINT (0, -2)

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TOSS-UP

2) Earth and Space – *Short Answer* In pyrite, what is the oxidation state of sulfur?

ANSWER: -1

BONUS

2) Earth and Space – *Short Answer* What is the name of the primary method by which glaciers erode large pieces of bedrock?

ANSWER: PLUCKING
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TOSS-UP

3) Chemistry – *Multiple Choice* Which of the following is NOT an experimental observation of the photoelectric effect?

W) Electrons are not ejected from the metal if the frequency of the photon is not higher than the threshold energy required.
X) The intensity of the light does not impact whether electrons are ejected.
Y) Kinetic energy of the ejected electrons is linearly increased with the frequency of the incident radiation.
Z) An ejected electrons velocity can be determined solely by the work function of the metal.

ANSWER: Z) AN EJECTED ELECTRONS VELOCITY CAN BE DETERMINED SOLELY BY THE WORK FUNCTION OF THE METAL.

BONUS

3) Chemistry – *Multiple Choice* It is observed that the value for the nuclear magnetic moment is non-zero for certain nuclei. Which of the following is concluded from a nucleus that has a non-zero nuclear magnetic spin?

W) The g-factor must be zero for protons.
X) The g-factor must be -1 for neutrons.
Y) There must be an odd amount of either protons or neutrons.
Z) There must be an even amount of protons or neutrons.

ANSWER: Y) THERE MUST BE AN ODD AMOUNT OF EITHER PROTONS OR NEUTRONS

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TOSS-UP

4) Biology – *Short Answer* In the congregation of lipid molecules in water due to hydrophobic interactions, what quantity of water is favorably increased?

ANSWER: ENTROPY

BONUS

4) Biology – *Multiple Choice* Women who are pregnant require increased amounts of calories and vitamins. The dietary need for folate in a pregnant woman is especially important in that it helps reduce the risk of which of the following effects on a fetus?

W) Anencephaly
X) Cleft lip
Y) Stubbed fingers
Z) Polydactyl

ANSWER: W) ANENCEPHALY
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TOSS-UP

5) Math – *Short Answer* What is tangent of 30 degrees times sine of 60 degrees?

ANSWER: 1/2

BONUS

5) Math – *Short Answer* Identify all of the following that are true of the function sine of 1 over x: 1) It is continuous; 2) Its second derivative approaches zero as *x* approaches infinity; 3) It is positive for most of its domain

ANSWER: 2 ONLY

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TOSS-UP

6) Physics – *Multiple Choice* A block of mass 2 kilograms is travelling with a velocity of 5 meters per second. It is sliding on a surface with a coefficient of static friction of 0.4. What distance must the block travel to come to a complete stop?

W) 2.8 meters
X) 3 meters
Y) 3.2 meters
Z) 3.4 meters

ANSWER: Y) 3.2 METERS

BONUS

6) Physics – *Short Answer* Identify all of the following that are true of quarks: 1) The charm quark is a second generation quark; 2) They have a baryon number of 1/3; 3) They cannot be isolated.

ANSWER: ALL
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TOSS-UP

7) Earth and Space – *Multiple Choice* Which of the following types of moraines marks the glacier's maximum advance, appearing at the glacier's edge?

W) Terminal Moraine
X) Medial Moraine
Y) Lateral Moraine
Z) Ground Moraine

ANSWER: W) TERMINAL MORAINE

BONUS

7) Earth and Space – *Short Answer* Rank the following three minerals in order of increasing oxygen content: 1) Olivine; 2) Quartz; 3) Muscovite.

ANSWER: 2, 3, 1

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TOSS-UP

8) Energy – *Short Answer* Researchers at Lawrence Livermore national lab are working on technologies to minimize the waste heat from various energy sources. Identify all of the following three statements that are true of heat: 1) It is a path function; 2) Under constant temperature, the change in heat is equivalent to temperature multiplied by the change in entropy; 3) For an isothermal process, the heat added to the system is equivalent to the work performed by the system.

ANSWER: ALL

BONUS

8) Energy – *Short Answer* Researchers at Lawrence Livermore national lab are working on antineutrino detectors for use in nuclear nonproliferation efforts. Identify all of the following three processes that release an antineutrino: 1) Proton-proton chain; 2) Carbon-14 decaying into Nitrogen-14; 3) Potassium-40 undergoes electron capture to form Argon-40

ANSWER: 2 ONLY

9) Biology – *Multiple Choice* Which of the following most accurately describes the role of acetylcholine in calcium release?
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TOSS-UP

W) Stimulates cellular contractions by opening voltage-gated ion channels.
X) Stimulates postsynaptic ACH receptors to release intracellular calcium
Y) Binds to the sarcoplasmic reticulum, causing calcium release
Z) Binds to the T-tubules, causing calcium release.

ANSWER: W) STIMULATES CELLULAR CONTRACTIONS BY OPENING VOLTAGE-GATED ION CHANNELS.

BONUS

9) Biology – *Short Answer* Identify all of the following 3 choices that could be considered a fomite: 1) Furniture; 2) Clothing; 3) Hair.

ANSWER: ALL

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TOSS-UP

10) Math – *Short Answer* What is the cross product of the vectors $2i$ and $3j$?

ANSWER: $6k$

BONUS

10) Math – *Short Answer* What is the sum of all numbers less than 300 that are divisible by 7?

ANSWER: 6321
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TOSS-UP

11) Physics – *Short Answer* How many vibrational modes of freedom does carbon dioxide have?

ANSWER: 4

BONUS

11) Physics – *Short Answer* Given that the drag force at low velocities is equivalent to -*bv*, where *b* is a constant and *v* is velocity. What are the units of constant *b*?

ANSWER: KILOGRAMS PER SECOND

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TOSS-UP

12) Earth and Space – *Short Answer* What element is the last to fuse in a star before a supernova occurs?

ANSWER: SILICON

BONUS

12) Earth and Space – *Multiple Choice* Stars with which of the following solar masses would be most likely to leave behind a neutron star?

W) 2
X) 5
Y) 12
Z) 25

ANSWER: Y) 12
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TOSS-UP

13) Energy – *Short Answer* Researchers at Lawrence Livermore national lab are investigating the retreat of glaciers in Africa and South America as an indicator of climate change. Glaciers retreat when the rate of accumulation is less than the rate of what process?

ANWER: ABLATION

BONUS

13) Energy – *Multiple Choice* Researchers at Lawrence Livermore national lab have discovered that at the high temperatures and pressures within Earth's core argon is capable of forming an alloy with a Group 10 metal. What is the identity of this metal?

W) Iron
X) Palladium
Y) Nickel
Z) Cobalt

ANSWER: Y) NICKEL

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TOSS-UP

14) Chemistry – *Short Answer* Given that the rate constant for a reaction is 1 inverse minute, to 2 significant figures, what is the half-life in minutes?

ANSWER: 0.69

BONUS

14) Chemistry – *Short Answer* What equation, analogous to Henderson-Hasselbach, is used as a measure of acidity of acids and bases that extend beyond the normal pH scale?

ANSWER: HAMMET'S FUNCTION
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TOSS-UP

15) Math – *Short Answer* How many ways are there to 5 people around a table with six chairs, given that arrangements with rotational symmetry are considered identical?

ANSWER: 120

BONUS

15) Math – *Short Answer* For the implicitly defined function $y^3 + 2x^2 = 16$, what is the value of dy/dx at the point (2,2)?

ANSWER: -2/3

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TOSS-UP

16) Physics – *Short Answer* A Carnot engine has a cold reservoir with a temperature of 0 degrees Celsius. At what temperature, to the nearest degree celsius, must the hot reservoir be such that the efficiency is 50%?

ANSWER: 273

BONUS

16) Physics – *Multiple Choice* A door is swinging simple harmonically, where it is crossing its equilibrium position every 2 seconds. A carpet is then placed underneath it such that it undergoes numerous oscillations of decreasing amplitude before coming to a stop. Which of the following best describes the system?

W) Overdamped
X) Underdamped
Y) Critically damped
Z) Undamped

ANSWER: X) UNDERDAMPED
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TOSS-UP

17) Chemistry – *Short Answer* What term is used to describe a 3 center 2 electron bond, characterized by the molecule diborane?

ANSWER: BANANA BONDS

BONUS

17) Chemistry – *Short Answer* Identify all of the following 3 statements that are true of the Nernst equation: 1) When the concentration of the reducing agent and oxidizing agent are equal to each other E and E naught are also equal; 2) A positive reduction potential represents a positive Gibbs free energy; 3) If you increase the concentration of the products, the cell potential will decrease.

ANSWER: 1 AND 3

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TOSS-UP

18) Biology – *Short Answer* Identify all of the following 3 bases that are considered pyrimidines: 1) Guanine; 2) Uracil; 3) Thymine.

ANSWER: 2 AND 3

BONUS

18) Biology – *Multiple Choice* Which of the following is true about the depolarization phase of an action potential under normal physiological conditions?

W) The absolute magnitude of depolarization is dependent on stimulus intensity
X) The axon has reached its threshold potential based on a summation of inputs
Y) Downstream calcium efflux will result in synaptic neurotransmitter release
Z) Transient membrane potential is at least 10 mV more negative than at rest

ANSWER: X) THE AXON HAS REACHED ITS THRESHOLD POTENTIAL BASED ON A SUMMATION OF INPUTS
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TOSS-UP

19) Earth and Space – *Short Answer* What is the term for the zig-zag movement of sediment along the surf zone, caused by waves approaching the shoreline at an angle?

ANSWER: LONGSHORE DRIFT

BONUS

19) Earth and Space – *Multiple Choice* What type of drainage pattern occurs in alternating areas of weak and resistant bedrock?

W) Dendritic
X) Radial
Y) Rectangular
Z) Trellis

ANSWER: Z) TRELLIS

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TOSS-UP

20) Math – *Short Answer* Triangle *ABC* is inscribed inside circle *O* such that side *BC* contains center *O*. Given that the circle has a diameter of 10 meters, what is the maximum possible area of triangle *ABC*?

ANSWER: 25

BONUS

20) Math – *Short Answer* Solve the following equation for x from x equals 0 to 2π:
$2sin^2(x) + sin(x) = 1$.

ANSWER: $x = \pi/6, 5\pi/6, 3\pi/2$
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TOSS-UP

21) Biology – *Short Answer* What amino acid has a selenium analog?

ANSWER: CYSTEINE

BONUS

21) Biology – *Short Answer* Identify all of the following tissues that the epidermis is composed of: 1) Keratinized; 2) Stratified squamous epithelium; 3) Stratified columnar epithelium.

ANSWER: 1 AND 2

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TOSS-UP

22) Chemistry – *Short Answer* Order the following 3 carbons from lowest to highest electronegativity: 1) Acetylene carbon; 2) Ethylene carbon; 3) Ethane Carbon.

ANSWER: 3, 2, 1

BONUS

22) Chemistry – *Multiple Choice* Which of the following lewis acids can only coordinate one oxygen?

W) $TiCl_4$
X) $ZnCl_2$
Y) BF_3
Z) $MgBr_2$

ANSWER: Y) BF_3
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TOSS-UP

23) Energy – *Short Answer* Researchers at Lawrence Livermore national lab have developed a nerve agent antidote that protects the central nervous system. Previous drugs had difficulty protecting the central nervous system due to the drugs being unable to pass through what semipermeable barrier?

ANSWER: BLOOD BRAIN BARRIER

BONUS

23) Energy – *Multiple Choice* Researchers at Lawrence Livermore national lab are investigating the hypothesis that organic compounds originating from comets jump-started life on Earth. The compounds of interest are nitrogen-containing polycyclic aromatic hydrocarbons. Which of the following is a nitrogen-containing polycyclic aromatic hydrocarbon?

W) Purine
X) Pyrimidine
Y) Imidazole
Z) Pyrrole

ANSWER: W) PURINE