MHS Set 2 Round 2

Buzzer test + Ice breaker question: What is your second favorite science subject?

TOSS-UP

1) Physics – *Short Answer* An object initially at rest has a moment of inertia of 5 kilogram meters squared. If a constant torque of 30 newton meters is applied to it for 10 seconds, what is its final angular velocity in radians per second?

ANSWER: 60

BONUS

1) Physics – *Short Answer* A capacitor of 5 farads is attached in series with a resistor and a battery. If the emf of the battery is 6 volts and the voltage drop across the resistor is 3 volts, what is the charge on the capacitor?

ANSWER: 15 COULOMBS

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TOSS-UP

2) Earth and Space - *Short Answer* Located 7000 light years from us, the Eagle Nebula, like most other nebulae, is composed primarily of what diatomic gas?

ANSWER: HYDROGEN

BONUS

2) Earth and Space - *Multiple Choice* Evaporating Gaseous Globules, also known as, EGGs (E-G-Gs) are protrusions on nebulae that can form which of the following:

W) Protostars
X) Protoplanetary Disks
Y) Accretion Rings
Z) Quasar Jets

ANSWER: W) PROTOSTARS
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TOSS-UP

3) Chemistry – *Short Answer* For the compound, Hydrogen Peroxide, what is the oxidation state respectively for hydrogen and oxygen?

ANSWER: +1, -1

BONUS

3) Chemistry – *Multiple Choice* An electron starts from an energy state and releases energy by going down quantized energy levels, which of the following will release the most energy?

W) n = 5 to n = 3
X) n = 5 to n = 2
Y) n = 4 to n = 2
Z) n = 3 to n = 2

ANSWER: X) N = 5 TO N = 2

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TOSS-UP

4) Biology – *Short Answer* What metal replaces iron when comparing hemoglobin to hemocyanin?

ANSWER: COPPER

BONUS

4) Biology – *Short Answer* In what specific phase of meiosis does crossing over take place?

ANSWER: PROPHASE I
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TOSS-UP

5) Math – *Short Answer* Which of the following is true of the graphs of x squared and e to the power of x?

W) They intersect at one point
X) They are both even functions
Y) They are both odd functions
Z) Their derivatives are always positive

ANSWER: W) THEY INTERSECT AT ONE POINT

BONUS

5) Math–*Short Answer* The sum of the roots of a quadratic equation is 10. If the product of the roots is 24, find the quadratic equation with x squared coefficient of 1.

ANSWER: X^2-10X+24

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TOSS-UP

6) Physics – *Short Answer* The amount of work done on a system is zero for what type of thermodynamic process?

W) Isothermal
X) Isobaric
Y) Adiabatic
Z) Isochoric

ANSWER: Z) ISOCHORIC

BONUS

6) Physics – *Short Answer* A balloon expands from an initial volume of 1 liter to a final volume of 3 liters. If the pressure on the balloon was halved during this process, and the initial temperature of the balloon was 300 Kelvin, what is the final temperature of the balloon in Kelvin?

ANSWER: 200 Kelvin
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TOSS-UP

7) Earth and Space - *Short Answer* Pitchblende is the most common ore of what mineral?

ANSWER: URANIUM DIOXIDE (ACCEPT: URANINITE DO NOT ACCEPT: URANIUM, URANIUM OXIDE)

BONUS

7) Earth and Space - *Short Answer* Order the following 4 sedimentary rocks from least to greatest clast size: 1) Quartz Sandstone; 2) Conglomerate; 3) Shale; 4) Siltstone

ANSWER: 3, 4, 1, 2

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TOSS-UP

8) Energy – *Short Answer* Researchers at Ames National Lab are studying Dynamic Nuclear Polarization Nuclear Magnetic Resonance to increase the intensity of standard nuclear magnetic resonance. Nuclear magnetic resonance only works on nuclei with a nonzero value of what quantity?

ANSWER: SPIN

BONUS

8) Energy – *Multiple Choice* Researchers at Argonne National Lab are studying the effects of platinum on electrocatalysts. Platinum is able to perform its catalytic roles primarily due to its electrons in what class of orbitals?

W) 5s
X) 4d
Y) 5d
Z) 6p

ANSWER: Y) 5d
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TOSS-UP

9) Biology – *Short Answer* Identify all of the following 3 quantities that, when increased, would increase the solute potential: 1) Temperature; 2) Concentration; 3) Ionization Constant.

ANSWER: NONE

BONUS

9) Biology – *Short Answer* What medical procedure is used to remove heavy metals in the body by using namesake agents?

ANSWER: CHELATION

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TOSS-UP

10) Math – *Short Answer* How many ways are there to seat 6 people around a round table if Yuchen and Rohan must sit together?

ANSWER: 48

BONUS

10) Math – *Short Answer* A triangle has sides of 13, 14, and 15. What is its inradius?

ANSWER: 4
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TOSS-UP

11) Physics–*Short Answer* What nucleon was discovered by James Chadwick in 1932 and is composed of 1 up quark and 2 down quarks?

ANSWER: NEUTRON

BONUS

11) Physics–*Short Answer* What quantity is always perpendicular to the electric field lines?

W) Electric Force
X) Electric Flux
Y) Magnetic Force
Z) Equipotential Lines

ANSWER: Z) EQUIPOTENTIAL LINES

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TOSS-UP

12) Earth and Space — *Multiple Choice* Which of the following natural phenomena might trigger an earthquake within a tectonic plate, as opposed to in tectonic boundaries?

W) Collision Zone
X) Induced Seismicity
Y) Continental Rift
Z) Rift Zone

ANSWER: Y) CONTINENTAL RIFT

BONUS

12) Earth and Space — *Short Answer* What earthquake magnitude scale, an alternative to the Richter Scale, has a maximum rating of 12?

ANSWER: MODIFIED MERCALLI SCALE
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TOSS-UP

13) Energy – *Short Answer* Researchers at Ames national lab are using hydrogenolysis to break down polyethylene into liquid hydrocarbons. What is the ratio of the number of carbon atoms, to the number of hydrogen atoms in polyethylene?

ANSWER: 1:2 (ACCEPT: ½)

BONUS

13) Energy – *Short Answer* Researchers at Lawrence Livermore national lab are measuring the electrical properties of methane hydrates. Methane hydrates are an example of what class of compounds, in which a lattice traps certain molecules?

ANSWER: CLATHRATES

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TOSS-UP

14) Chemistry – *Multiple Choice* Which of the following functions is considered a state function?

W) Heat
X) Arc Length
Y) Volume
Z) Work

ANSWER: Y) VOLUME

BONUS

14) Chemistry – *Short Answer* Order all of the following 3 ionic compounds from lowest to highest lattice energy: 1) MgO; 2) SrO; 3) NaCl.

ANSWER: 3, 2, 1
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TOSS-UP

15) Math – *Short Answer* In a particular game, you can only score either 5 or 12 points at a time. What is the greatest amount of points you cannot score in this game?

ANSWER: 43

BONUS

15) Math – *Short Answer* A theater has n^3 seats in the nth row. If the number of rows is 10, what is the total number of seats in the theater?

ANSWER: 3025

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TOSS-UP

16) Physics – *Short Answer* A spring with a spring constant of 5 Newtons per Meter and another spring with a spring constant of 3 Newtons per Meter are attached in parallel. What is the effective spring constant of the system?

ANSWER: 8 Newtons

BONUS

16) Physics–*Short Answer* What is the name of the process by which waves spread out in result of passing through a narrow aperture or across an edge, usually characterized by interference?

ANSWER: DIFFRACTION
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TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following pH values will be closest to the equivalence point in the titration of acetic acid with sodium hydroxide?

W) 2.3
X) 6.4
Y) 9.6
Z) 13.8

ANSWER: Y) 9.6

BONUS

17) Chemistry – *Short Answer* A metal M has an oxidation state of +4 when it reacts with sulfate, what will the empirical formula most likely be for the salt formed based on this information?

ANSWER: $M(SO_4)_2$

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TOSS-UP

18) Biology – *Short Answer* What type of mimicry is observed when a non-toxic animal mimics another animal who is toxic.

ANSWER: BATESIAN

BONUS

18) Biology–*Multiple Choice* Which of the following amino acids has a side group that only contains both carbon and hydrogen?

W) Glycine
X) Valine
Y) Methionine
Z) Histidine

ANSWER: X) VALINE
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TOSS-UP

19) Earth and Space - *Multiple Choice* Meant to reduce beach erosion, which of the following man-made structures runs perpendicular to the beachfront?

W) Jetty
X) Seawall
Y) Breakwater
Z) Groin

ANSWER: Z) GROIN

BONUS

19) Earth and Space — *Short Answer* Since they are a junction between inland freshwater and oceanic seawater, estuaries are commonly composed of what form of water?

ANSWER: BRACKISH

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TOSS-UP

20) Math – *Short Answer* You have unlimited water and bottles of two types: 350 ml and 500 ml. Which of the following four amounts of water can you create? 1) 50 ml; 2) 100 ml; 3) 150 ml; 4) 200 ml.

ANSWER: ALL

BONUS

20) Math – *Short Answer* What is the definite integral from 0 to 10 of the quantity $3x^2$-10x+3, dx?

ANSWER: 530
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TOSS-UP

21) Biology – *Multiple Choice* Which of the following most accurately describes the S phase in the cell cycle of a normal human cell?

W) Excretory waste is expelled
X) DNA is replicated
Y) The cell splits into two.
Z) The cell elongates

ANSWER: X) DNA IS REPLICATED

BONUS

21) Biology – *Short Answer* What type of selection is favored towards species that have high reproduction rates, and have low rates of survival?

ANSWER: R-SELECTED

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TOSS-UP

22) Chemistry – *Multiple Choice* Which of the following compounds is considered a network covalent compound?

W) Ice
X) Copper Oxide
Y) Silicon Dioxide
Z) Acetone

ANSWER: Y) SILICON DIOXIDE

BONUS

22) Chemistry – *Short Answer* Identify all of the following 3 choices that are considered a type of colloid: 1) Emulsion; 2)Aerosol; 3) Ligand

ANSWER: 1 AND 2
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TOSS-UP

23) Energy – *Short Answer* Researchers at Lawrence Berkeley National Laboratory are investigating capacitors with capacitances of the order of farads, which have important uses in transportation technology and consumer electronics. What are these devices called?

ANSWER: SUPERCAPACITORS (ACCEPT: ULTRACAPACITORS)

BONUS

23) Energy – *Short Answer* Researchers at Argonne national lab are studying the conductive properties of graphene. The conducting electrons of graphene primarily reside in what orbital of carbon?

ANSWER: 2p