MHS Set 2 Round 7

Buzzer test + Ice breaker question:

TOSS-UP

1) Physics – *Short Answer* Sanjay Suresh, currently experiencing rhabdomyolysis, can only exert a maximum force of 10 newtons on any object. An object with a mass of 2 kilograms is currently 5 meters above the ground. What is the minimum amount of work, in joules, Sanjay can perform on the block as it falls?

ANSWER: -50

BONUS

1) Physics – *Multiple Choice* Given a planet with mass M and radius R, under which of the following changes would the surface gravitational force be the greatest?

W) The planet's radius doubles and its density remains the same
X) The planet's radius is halved and its density is halved
Y) The planet's density is doubled and its radius is halved
Z) The planet's radius is halved and its density remains the same

ANSWER: W) THE PLANET'S RADIUS DOUBLES AND ITS DENSITY REMAINS THE SAME

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TOSS-UP

2) Earth and Space – *Short Answer* The statement that angles between two corresponding faces of a crystal are constant is attributed to which scientist?

ANSWER: STENO

BONUS

2) Earth and Space – *Short Answer* What is the term for the type of hydrothermal vent that has water of intermediate temperature, emitting lighter colored minerals containing elements such as barium and calcium?

ANSWER: WHITE SMOKER
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TOSS-UP

3) Chemistry – *Short Answer* The Van't Hoff equation is used to calculate the equilibrium constant when what other parameter is changed?

ANSWER: TEMPERATURE

BONUS

3) Chemistry – *Multiple Choice* Which of the following expressions does not equal to the gas constant R?

W) PV/nT
X) $M(u_{rms})^2/3T$ (big M times RMS squared divided by 3T
Y) PVm/MT (P V little m divided by the quantity big M times T)
Z) PM/rhoT

ANSWER: Y) PVm/MT

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TOSS-UP

4) Biology – *Short Answer* The medulla oblongata checks the pH of what fluid as an indicator for blood CO2 concentration?

ANSWER: CEREBROSPINAL FLUID (CSF)

BONUS

4) Biology – *Short Answer* What amino acid has the highest hydrophobicity?

ANSWER: PHENYLALANINE (ACCEPT: PHE OR F)
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TOSS-UP

5) Math – *Short Answer* What is the sum of the first three prime numbers greater than 100?

ANSWER: 311

BONUS

5) Math – *Short Answer* What is the projection of the vector 2i + 3j on the vector 6i - 4j?

ANSWER: 0 (ACCEPT: 0i + 0j)

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TOSS-UP

6) Physics – *Short Answer* What is the potential energy, in joules, stored in a capacitor with a capacitance of 2 farads, that is storing 6 coulombs of charge?

ANSWER: 9

BONUS

6) Physics – *Short Answer* How many quark flavors are more massive than the up quark?

ANSWER: 5
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TOSS-UP

7) Earth and Space – *Multiple Choice* Which of the following rocks will you most likely find near a mid-ocean ridge?

W) Basalt
X) Rhyolite
Y) Granite
Z) Andesite

ANSWER: W) BASALT

BONUS

7) Earth and Space – *Multiple Choice* Which of the following igneous rocks would be expected to have cooled the fastest?

W) Basalt
X) Granite
Y) Diorite
Z) Obsidian

ANSWER: Z) OBSIDIAN

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TOSS-UP

8) Energy – *Short Answer* Researchers at Ames national lab are using Raman scattering to study gold nanoparticles. Raman scattering is a form of inelastic light scattering. Identify all of the following three types of scattering that are also inelastic: 1) Rayleigh; 2) Compton; 3) Thomson.

ANSWER: 2 ONLY

BONUS

8) Energy – *Multiple Choice* Researchers at Ames national lab are investigating the microstructure of polycyclosilanes. In these cyclosilanes, what is the molecular geometry present around each silicon atom?

W) Trigonal planar
X) Bent
Y) Trigonal Pyramidal
Z) Tetrahedral

ANSWER: Z) TETRAHEDRAL
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TOSS-UP

9) Biology – *Short Answer* Two true-breeding pea plants for pea color are crossed. Given that 100% of the offspring are yellow, which of the following must be true?

W) One of the parents had the recessive gene.
X) One of the parents had both the dominant and recessive gene.
Y) Neither parents were homozygous
Z) Gene linkage must have occurred.

ANSWER:Y) NEITHER PARENTS WERE HOMOZYGOUS

BONUS

9) Biology – *Short Answer* Identify all of the following 3 choices that are thickened by secondary walls: 1) Parenchyma; 2) Collenchyma; 3) Sclerenchyma.

ANSWER: 3 ONLY

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TOSS-UP

10) Math – *Short Answer* How many edges does a pyramid 21 vertices have?

ANSWER: 40

BONUS

10) Math – *Short Answer* What is the positive difference in area between the circumcircle and incircle of a triangle with sides of length 6, 8, and 10?

ANSWER: 21π
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TOSS-UP

11) Physics – *Multiple Choice* Which of the following best describes the image formed from an object that is in front of a convex spherical mirror?

W) Real and inverted
X) Real and upright
Y) Virtual and inverted
Z) Virtual and upright

ANSWER: Z) VIRTUAL AND UPRIGHT

BONUS

11) Physics – *Short Answer* The Debye model states that for solids at low temperatures, the specific heat is proportional to what power of temperature?

ANSWER: 3

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TOSS-UP

12) Earth and Space – *Short Answer* What is the chemical formula of aragonite?

ANSWER: $CaCO_3$

BONUS

12) Earth and Space – *Short Answer* What type of plate boundary exists between the North American plate and the Eurasian plate?

ANSWER: DIVERGENT
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TOSS-UP

13) Energy – *Multiple Choice* Researchers at Lawrence Livermore national lab are studying antibiotics that can relieve inflammation. The inflammatory response occurs as a result of the release of histamines by what cells?

W) Natural Killer Cells
X) Macrophages
Y) Mast Cells
Z) Erythrocytes

ANSWER: Y) MAST CELLS

BONUS

13) Energy – *Short Answer* Researchers at Lawrence Livermore national lab are studying the electrochemistry of ionic liquids. Identify all of the following three statements that are true of ionic liquids: 1) They have relatively low melting points for an ionic compound; 2) They are often used to dissolve organic substances; 3) They have a high vapor pressure.

ANSWER: 1 AND 2

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TOSS-UP

14) Chemistry – *Short Answer* What type of bond is formed when a single atom donates both electrons to form the bond and is a 2c2e covalent bond?

ANSWER: DATIVE (ACCEPT: COORDINATE OR DIPOLAR)

BONUS

14) Chemistry – *Multiple Choice* Which of the following compounds, when added to water, will form the most acidic solution when equal amount is added?

W) BaO
X) BaO_2
Y) SO_2
Z) SO_3

ANSWER: Z) SO_3
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TOSS-UP

15) Math – *Short Answer* What is the product of the two complex numbers 8 + 7i and 3 + i?

ANSWER: 17 + 29i

BONUS

15) Math – *Short Answer* What is the mean of the first 12 prime numbers?

ANSWER: 197/12

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TOSS-UP

16) Physics – *Multiple Choice* When a pendulum undergoes small oscillations which of the following quantities does not follow a sinusoidal pattern?

W) Magnitude of tangential acceleration
X) Angular displacement
Y) Angular velocity
Z) Magnitude of centripetal acceleration

ANSWER: Z) MAGNITUDE OF CENTRIPETAL ACCELERATION

BONUS

16) Physics – *Short Answer* To the nearest tenth, what is the total resistance of a 4 ohm resistor, connected in parallel to a 1 ohm and 2 ohm resistor connected in series?

ANSWER: 1.7
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TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following best describes the solvent for an Sn2 type reaction?

W) Nonpolar aprotic
X) Polar Aprotic
X) Nonpolar protic
Z) Polar protic

ANSWER:) POLAR APROTIC

BONUS

17) Chemistry – *Short Answer* Which of the following choices is closest to the boiling point of Br2 liquid, given that delta H = 31kJ and delta S = 93 J/K for boiling.

W) 288 Kelvin
X) 332 Kelvin
Y) 359 Kelvin
Z) 401 Kelvin

ANSWER: X) 332 KELVIN

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TOSS-UP

18) Biology – *Short Answer* It is observed that certain bacteria can lay dormant for millions of years, waiting for a more favorable environment for the bacteria. What structure is formed in order for this dormancy to occur?

ANSWER: ENDOSPORE

BONUS

18) Biology – *Short Answer* Identify all of the following 3 bacteria that are considered gram-positive: 1) Shigella; 2) Anthracis; 3) Salmonella.

ANSWER: 2 ONLY
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TOSS-UP

19) Earth and Space – *Multiple Choice* Which of the following sediments is the smallest on the Wentworth scale?

W) Pebble
X) Silt
Y) Cobble
Z) Sand

ANSWER: X) SILT

BONUS

19) Earth and Space – *Short Answer* Identify all of the following three that are sedimentary rocks: 1) Limestone; 2) Gabbro; 3) Gneiss

ANSWER: 1 ONLY

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TOSS-UP

20) Math – *Short Answer* What is the average value of $\sin(x)$ from the interval 0 to π?

ANSWER: $2/\pi$

BONUS

20) Math – *Short Answer* A coin has a property such that it has a 1/4 chance of landing on heads. If the coin is flipped three times, what is the probability that more tails are landed than heads?

ANSWER: 27/32
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TOSS-UP

21) Biology – *Short Answer* What group of enzymes is used to transfer phosphate groups from ATP molecules to other biomolecules?

ANSWER: KINASES

BONUS

21) Biology – *Short Answer* Identify all of the following 3 compounds that are considered secondary messengers: 1) K+; 2) Na+; 3) F-

ANSWER: NONE

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TOSS-UP

22) Chemistry – *Multiple Choice* Which of the following is not a Bravais Lattice?

W) Orthoclinic
X) Cubic
Y) Orthorhombic
Z) Tetragonal

ANSWER: W) ORTHOCLINIC

BONUS

22) Chemistry – *Multiple Choice* Which of the following has the highest boiling point?

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

ANSWER: X) COBALT
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TOSS-UP

23) Energy – *Short Answer* Researchers at Lawrence Berkeley national lab are studying structural changes in lithium titanate as a potential use for fast-charging batteries. In standard lithium-ion batteries, what element makes up the anode?

ANSWER: CARBON

BONUS

23) Energy – *Short Answer* Researchers at Lawrence Berkeley national lab are studying the role microorganisms play in desert soils as well as human lungs. What is the name for the collection of microorganisms present in the gastrointestinal tract?

ANSWER: GUT MICROBIOME (ACCEPT: GUT FLORA)