MHS Round 5

Buzzer test + Ice-breaker question: What is your favorite Ram Ranch song?

TOSS-UP

1) Physics *Multiple Choice* Approximately how many times greater is the electric field due to a Helium atom with charge +1 than a Hydrogen atom with charge +1?

W) 2
X) 4
Y) 8
Z) 16

ANSWER: Y) 8

BONUS

1) Physics – *Short Answer* What is the maximal angle of an incline, in degrees, such that a box on the incline doesn't slip given that the coefficient of static friction is sqrt3/3?

ANSWER: 30

~~~~~~

TOSS-UP

2) Earth and Space – *Short Answer*- Name all of the following three rocks that would form an effective aquitard: 1) Shale; 2) Breccia; 3) Pumice.

ANSWER: 1 AND 2

BONUS

2) Earth and Space – *Multiple Choice*- White Asbestos, a naturally occurring crystal also known as chrysolite, is known as a cancer inducing agent, especially when inhaled. This is due to it having which of the following structure?

W) Tetrahedral
X) Needle-like
Y) Triclinic
Z) Granular

ANSWER: X) NEEDLE-LIKE
~~~~~~

TOSS-UP

3) Chemistry – *Multiple Choice* Which of the following options would oxidize 1-butanol into butanoic acid the quickest.

W) Pyrimidine Chlorochromate
X) Chromic acid
Y) Tosylate
Z) Sodium Borohydride

ANSWER: X) CHROMIC ACID

BONUS

3) Chemistry – *Short Answer* Identify all of the following 3 statements that are true regarding Grignard reagents: 1) They are nucleophilic; 2) They can cleave carbon-oxygen bonds in an ester; 3) They react with nitro groups to form Amides.

ANSWER: 1 AND 2

~~~~~~

TOSS-UP

4) Biology – *Multiple Choice* Which of the following depiction of protein structure shows secondary structure the best?

W) Ribbon
X) Backbone
Y) Wire
Z) Space-filling

ANSWER: W) RIBBON

BONUS

4) Biology – *Short Answer* Identify all of the following 3 hormones that are cholesterol derivatives: 1) Glucocorticoid; 2) Calcitonin; 3) Insulin.

ANSWER: 1 ONLY
~~~~~~

TOSS-UP

5) Math – *Short Answer* The positive difference between two consecutive perfect squares is 35. What is the value of the larger square?

ANSWER: 324

BONUS

5) Math – *Short Answer* If the hands of a working clock move continuously, how many times per day are the hour and minute hands perpendicular to each other?

Answer: 44

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

6) Physics – *Short Answer* What is the resonant angular frequency, in radians per second of an LC circuit with a capacitance of 5 millifarads, and an inductance of 20 millihenrys?

ANSWER: 100

BONUS

6) Physics – *Short Answer* How many times greater is the electric field close to a conductor than a sheet of charge, given they have the same surface charge density?

ANSWER: 2
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

7) Earth and Space -- *Multiple Choice* Yardangs, a form of ventifact, are formed via erosion by which process:

W) Abrasion
X) Water
Y) Solifluction
Z) Wind

ANSWER: Z) Wind

BONUS

7) Earth and Space – *Short Answer* List the following 3 types of coal that correspond to the correct location that they can be readily found. 1) Anthracite in Central Germany; 2) Anthracite in the Rocky Mountains; 3) Peat coal in the Australian Outback.

ANSWER: 2

~~~~~~

TOSS-UP

8) Chemistry – *Short Answer* Rank the following 3 species in order of increasing standard reduction potential: 1) F2; 2) 2H+; 3) Cl2

ANSWER: 2,3,1

BONUS

8) Chemistry – *Short Answer* Identify all of the following 3 compounds that are considered internal alkynes: 1) Methylacetylene; 2) Diisopropyl Acetylene; 3) Phenylpropyl Acetylene.

ANSWER: 2 AND 3
~~~~~~

TOSS-UP

9) Biology – *Multiple Choice* Which of the following statements of the protein family, serine proteases, is NOT correct?

W) They all enzymatically cleave the same protein.
X) They all contain similar three-dimensional conformations.
Y) They all have very similar primary structures.
Z) They are all catalytic enzymes.

ANSWER: W) THEY ALL ENZYMATICALLY CLEAVE THE SAME PROTEIN.

BONUS

9) Biology – *Multiple Choice* List the following four structures from the most lateral to the most medial in a woody eudicot stem: 1) Primary Xylem 2) Primary Phloem 3) Secondary Xylem 4) Secondary Phloem

Answer: 4, 2, 3, 1 (ACCEPT: Secondary Phloem, Primary Phloem, Secondary Xylem, Primary Xylem)

~~~~~~

TOSS-UP

10) Math – *Multiple Choice* Which of the following statements about triangles is not correct?

W) The sum of the exterior angles is twice the sum of the interior angles of the triangles
X) The circumradius must be greater than or equal to twice the inradius
Y) Drawing the medians of each side of a triangle splits the triangle into 6 equal areas
Z) The area of a triangle is equal to the inradius times the perimeter of the triangle

ANSWER: Z) The area of a triangle is equal to the inradius times the perimeter of the triangle

BONUS

10) Math – *Short Answer* Find the infinite sum of 1 over 1 factorial minus 2 over 2 factorial plus 4 over 3 factorial, minus 8 over 4 factorial, etc, where the numerators are integer powers of two.

ANSWER: E TO THE MINUS 2 (ACCEPT ONE OVER E SQUARED)
~~~~~~

TOSS-UP

11) Physics – *Multiple Choice* Quantum Chromodynamics exhibits two properties. Name both of them.

ANSWER: COLOR CONFINEMENT AND ASYMPTOTIC FREEDOM

BONUS

11) Physics – *Short Answer* In extremely small spherical objects such as raindrops, an approximation for the force of air resistance is proportional to velocity to what power?

ANSWER: 1

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

12) Earth and Space – *Multiple Choice* Glaciers can form all of the following except:

W) Chatter Marks
X) Rock Flour
Y) Tombolo
Z) Arête (pronounced ah- ret)

ANSWER: Y) Tombolo

BONUS

12) Earth and Space – *Short Answer* What track is followed by protostars as they follow the HR Diagram and relates temperature and luminosity.

ANSWER: HAYASHI TRACK
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

13) Biology – *Multiple Choice* What evolutionary factor is primarily responsible for producing adaptive evolutionary changes?

W) Random Mutation
X) Natural Selection
Y) Emigration
Z) Genetic drift

ANSWER: X) NATURAL SELECTION

BONUS

13) Biology – *Multiple Choice* In an isometric contraction of a skeletal muscle, the force of contraction cannot be altered by:

W) Changing the resting length of the muscle.
X) Increasing stimulation frequency.
Y) Increasing the number of sarcomeres in parallel in the muscle
Z) Increasing the number of sarcomeres in series in the muscle.

ANSWER: Z) INCREASING THE NUMBER OF SARCOMERES IN SERIES IN THE MUSCLE

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

14) Chemistry – *Short Answer* Identify all of the following 3 solvents that would be favored in an SN2 reaction pathway: 1) DMSO; 2) EtSH; 3) THF

ANSWER: 1, 3

BONUS

14) Chemistry – *Short Answer* What is the overall order of the reaction with elementary reactions: A plus B yields C slowly, and C+B is in equilibrium with D quickly.

ANSWER: 2
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

15) Math – *Multiple Choice* What is the remainder when 19 to the tenth power is divided by 11?

W) 1
X) 5
Y) 8
Z) 10

ANSWER: W) 1

BONUS

15) Math – *Short Answer* You have 2 types of coins, 7-cent coins, and 11-cent coins. You go to a store that sells pencils and you realize that you cannot buy a pencil without the cashier having to give you change. What is the number of possible positive-integer values that could represent the cost of a pencil?

ANSWER: 30

~~~~~~

TOSS-UP

16) Physics – *Short Answer* What theorem in Physics states that no particle can be in stable equilibrium under the action of electrostatic forces alone?

ANSWER: Earnshaw's Theorem

BONUS

16) Physics – *Multiple Choice* How much torque is experienced by an electric dipole with a positive charge and negative charge of magnitude 10 coulombs each, separated by 1 meter, given that the uniform electric field of 10 newtons per coulomb is pointing 30 degrees counterclockwise from the dipole?

W) -5sqrt3
X) -5
Y) 5
Z) 5sqrt3

ANSWER: Y) 5
~~~~~~

TOSS-UP

17) Chemistry – *Short Answer* What process is defined as the transformation of a substance that turns into a glass..

ANSWER: VITRIFICATION

BONUS

17) Chemistry – *Multiple Choice* Which of the following statements regarding the reaction of an alkene with osmium tetroxide and sodium hydrogen sulfite is NOT true.

W) It is a syn addition
X) It is a dihydroxylation reaction
Y) Sodium hydrogen sulfite breaks down cyclic osmium compounds
Z) It has an osmonium ion intermediate.

ANSWER: Z) IT HAS AN OSMONIUM ION INTERMEDIATE

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

18) Biology – *Multiple Choice* Which of the following is NOT a means of endocytosis?

W) Pinocytosis
X) Potocytosis
Y) Macrocytosis
Z) Phagocytosis

ANSWER: Y) MACROCYTOSIS

BONUS

18) Biology – *Short Answer* Identify all of the following 3 mechanisms that are methods of transport in plants: 1) Cohesion-Tension Mechanism 2) Concentration-Reduction Mechanism 3) Recurrent Osmosis Mechanism.

ANSWER: 1 ONLY
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

19) Earth and Space – *Multiple Choice* Which of the following defines the space between stars and other celestial bodies:

W) Interstellar Medium
X) Vacuum
Y) Stardust
Z) Molecular Cloud

ANSWER: W) Interstellar Medium

BONUS

19) Earth and Space – *Multiple Choice* - A playa lake can be found at which regularity:

W) Year- Round
X) None of the year
Y) Part of the year
Z) Whenever there's snowfall

ANSWER: Y) PART OF THE YEAR

~~~~~~

TOSS-UP

20) Math – *Short Answer* What type of Diophantine Equation is x squared minus d y squared equals 1?

Answer: PELL'S EQUATIONS

BONUS

20) Math – *Short Answer* On a given day, the probability that it snows given that school is canceled is 1/2. The probability that it snows is 1/4 and the probability that school is canceled is 1/3 given that it snows that day. What is the probability that on that day, school is canceled?

ANSWER: 1/6
~~~~~~

TOSS-UP

21) Biology – *Multiple Choice* Which of the following statements is not true regarding the diseases diabetes insipidus and type 1 Diabetes Mellitus:

W) Both diseases are caused by the malfunction of the islets of langerhans.
X) Both diseases increase the amount of urine secretion of the human.
Y) Both diseases can lead to the degradation of vision.
Z) Type 1 diabetes mellitus is tested by blood glucose levels, while insipidus is tested by blood sodium levels.

ANSWER: W) BOTH DISEASES ARE CAUSED BY THE MALFUNCTION OF THE PANCREATIC ISLETS.

BONUS

21) Biology – *Short Answer* Given the data points of arterial blood, which of the following statements are true about the patient: pH=7.31, Pressure of CO2=35 milimeters of Mercury, and Bicarbonate concentration = 17 miliequivalent per liter:

W) Uncompensated respiratory alkalosis
X) Uncompensated metabolic acidiosis;
Y) Partially compensated respiratory alkalosis;
Z) Partially compensated metabolic acidiosis

ANSWER: Z) PARTIALLY COMPENSATED METABOLIC ACIDOSIS.

~~~~~~

TOSS-UP

22) Chemistry – *Short Answer* Identify all of the following statements that are true about reversible processes: 1) dG must be zero; 2) Cleavage reactions are generally reversible; 3) Reversible reactions proceed towards equilibrium.

ANSWER: 1 and 3

BONUS

22) Chemistry – *Multiple Choice* Rank the following 3 molecules from least to greatest in terms of degree of unsaturation: 1) Cubane; 2) Acetonitrile; 3) Cyclohexane

ANSWER: 3, 2, 1
~~~~~~

TOSS-UP

23) Math – *Short Answer* For the set of numbers {5,10,15,20,25} rank the following 4 means from least to greatest: 1) Arithmetic; 2) Geometric; 3) Harmonic; 4) Quadratic.

ANSWER: 3, 2, 1, 4

BONUS

23) Math – *Short Answer* How many 2 digit numbers have a sum of digits of a perfect square?

ANSWER: 17

~~~~~~
~~~~~~