ROUND 8

TOSS-UP

1) Biology – *Multiple Choice* Which of the following is true regarding exergonic redox reactions in the mitochondria?

W) They are the energy source driving prokaryotic ATP synthesis
X) They provide energy, establishing the H+ gradient
Y) They reduce carbon atoms to CO2
Z) They are coupled via phosphorylated intermediates to endergonic processes

ANSWER: X) THEY PROVIDE ENERGY, ESTABLISHING THE H+ GRADIENT

BONUS

1) Biology – *Short Answer* Which of the following four structures may be present in archaeans?

1) Peptidoglycan cell wall
2) Methionine as an initiator amino acid
3) Ester linkage between glycerol and side chain in phospholipids
4) 70S ribosome

ANSWER: 2 AND 4

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TOSS-UP

2) Physics – *Multiple Choice* In an experiment performed in 1785 by Charles Augustine Coulomb, he used a metal torsion balance to demonstrate which of the following?

W) Charge can be induced in one body by another
X) Electric force follows an inverse square relationship
Y) The Earth is a charged conductor
Z) Bodies tend to states of least electric potential

Answer: X) Electric force follows an inverse square relationship
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BONUS

2) Physics – *Short Answer* Assume the gravitational acceleration of the Earth is 10 meters per second squared. A system consists of an ideal string over a frictionless pulley, with two masses of 4kg and 12 kg on opposite ends of the string, what is the tension in the string?

ANSWER: 5, 5 N

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TOSS-UP

3) Chemistry – *Short Answer* Identify all of the following four leaving groups that are better than an OTs group 1) Hydroxide 2) Bromide 3) Chloride 4) Thiolate

Answer: 2 & 3 Only

BONUS

3) Chemistry -- *Short Answer* For a barrierless reaction, Arrhenius theory predicts the rate constant is equal to what parameter indicating the frequency of collisions?

ANSWER: PRE-EXPONENTIAL FACTOR (ACCEPT: A, FREQUENCY FACTOR)

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TOSS-UP

4) Earth and Space – *Multiple Choice* In which of the following locations would you most likely find Andisols?

W) Volcanic Islands
X) Desert
Y) Peat Bogs
Z) Boreal Forest

ANSWER: W) VOLCANIC ISLANDS [SP]

BONUS

4) Earth and Space – *Short Answer* What type of stars have no hydrogen absorption lines?

ANSWER: WHITE DWARFS [SP]

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TOSS-UP

5) Math – *Short Answer* In computer science and Boolean algebra, the "exclusive or," shortened to the XOR [zor] operator returns true if the two operands are different and false otherwise. What is 4 XOR 6?

ANSWER: 2

BONUS

5) Math – *Short Answer* Find the ratio of the side length of a regular octahedron to the radius of its circumscribed sphere.

ANSWER: sqrt2

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TOSS-UP

6) Physics – *Short Answer* The wave equation has many applications throughout physics. It can concisely be written as ***[read slowly]*** the operator A applied to the wave's displacement function is equal to 0. What specific operator is operator A?

ANSWER: D'ALEMBERTIAN OPERATOR

BONUS

6) Physics – *Short Answer* The jerk of a particle is defined the third derivative of the position of the particle with respect to time. The acceleration of a particle is described by a of x equals 3 times x squared plus 4 times x and its velocity at x equals 1 is 4 meters per second. What is the jerk the particle experiences at x equals 1, in SI units?

ANSWER: 40, 40 m/s^3

TOSS-UP

7) Math – *Short Answer* What is the maximum value of the function f of x equals 4 times sine of x plus 5 times cosine of x as *x* varies over all possible reals?

ANSWER: sqrt(41)

BONUS

7) Math – *Short Answer* The binary operation "pound" for integers *a* and *b* is defined as the reciprocal of the sum of the reciprocals of *a* and *b*. Let f of n equal n pound f of n minus 1 for n greater than 0 and f of 1 equal 1. If f of 10 is expressed in simplest form, what is its numerator?

ANSWER: 2,520

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TOSS-UP

8) Chemistry – *Short Answer* According to ligand field theory, identify all of the following statements that are true 1) pi donor ligands decrease delta nought 2) pi acceptor ligands do not affect delta nought 3) the inner d orbitals of the central atom are affected by the presence of ligands

Answer: 1 & 3 Only

BONUS

8) Chemistry – *Short Answer* [] For the reaction A yields B, at high temperatures the ratio of B to A approaches 20. To two significant figures and in J/mol K, what is the change in entropy for this reaction?

ANSWER: 25 [VN]

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TOSS-UP

9) Earth and Space – *Multiple Choice* Which of the following best explains the existence of the asteroid belt between Mars and Jupiter?

W) It is the remnant of failed planet formation

X) Asteroids in this region are constantly pulled in by the strong gravity of Mars and Jupiter
Y) The low density of particles in this region prevent larger objects from forming
Z) The high concentration of icy materials in this region prevents large rocky objects from forming

ANSWER: W) IT IS THE REMNANT OF FAILED PLANET FORMATION [SP]

BONUS

9) Earth and Space – *Short Answer* Identify all of the following that are characteristic of Population II stars: 1) Contain high amounts of Hydrogen and Helium; 2) Located in the flattened disk of the galaxy; 3) Older and Metal-poor stars

ANSWER: 1 & 3 ONLY [SP]

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TOSS-UP

10) Biology – *Short Answer* Which of the following four are not true of cancer cells?

1) They are capable of chemotaxis
2) They exhibit anchorage dependence
3) They have undergone a process known as "transformation"
4) They exhibit density-dependent inhibition

ANSWER: 2 AND 4

BONUS

10) Biology – *Short Answer* What type of microscopy involves rapidly freezing specimens of tissue or aqueous solutions of proteins below -160°C, locking the molecules into a rigid state and passing a beam of electrons through the sample to see molecules?

ANSWER: CRYO-ELECTRON MICROSCOPY

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TOSS-UP

11) Chemistry – *Short Answer* If the effusion velocity of Hydrogen gas is 300 m/s, what is the effusion velocity of Oxygen gas under the same conditions, in meters per second?

Answer: 75

BONUS

11) Chemistry – *Multiple Choice* In the Van Der Waals equation, which constant accounts for the gas molecules having attraction to each other?

W) Constant a
X) Constant b
Y) Constant c
Z) Ideal gas constant

Answer: W) Constant a

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TOSS-UP

12) Math – *Short Answer* In Boolean algebra, a conjunction is a logical operator representing "and" whereas a disjunction is a logical operator representing "or". What set of laws in Boolean algebra relate conjunctions and disjunctions by negation?

ANSWER: De Morgan's Laws (ACCEPT: De Morgan's Theorems and WORD FORMS)

BONUS

12) Math – *Short Answer* How many ways can a boy climb a flight of 10 stairs starting from the bottom if he can only climb one or two stairs at a time?

ANSWER: 89

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TOSS-UP

13) Physics – *Multiple Choice* Two spherical bodies of mass rotating around each other in space will never collide due to what principle?

W) Conservation of Momentum
X) Conservation of Energy
Y) Conservation of Angular Momentum
Z) Conservation of Mass

ANSWER: Y) Conservation of Angular Momentum

BONUS

13) Physics – *Multiple Choice* A spaceship orbits around a planet. What physical property of the spaceship or the orbit of the spaceship must be negative for the orbit to be closed?
W) Kinetic Energy
X) Total Energy
Y) Angular Impulse
Z) Potential Energy

ANSWER: X) Total Energy

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TOSS-UP

14) Earth and Space – *Short Answer* What limit has a star probably passed if it is blowing away its outer layers?

ANSWER: EDDINGTON LIMIT [SP]

BONUS

14) Earth and Space – *Short Answer* A main sequence star with mass M has luminosity L. If the mass of the star is multiplied by 9, what is the luminosity of the star now in terms of L?

ANSWER: 2187L [SP]

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TOSS-UP

15) Biology – *Short Answer* Which of the two main types of slime molds consists of a large cell with thousands of nuclei within a single membrane without walls, forming a syncytium

ANSWER: CELLULAR SLIME MOLDS (ACCEPT: MYXOGASTRIA)

BONUS

15) Biology – *Short Answer* Which of the following four mechanisms contributed to the evolution of larger size and greater complexity in green algae?

1) The formation of colonies of individual cells
2) The formation of true multicellular bodies by cell division and differentiation
3) Increased surface area needed gas exchange for photosynthesis
4) Sequential nuclear divisions without cytokinesis

ANSWER: 1, 2, AND 4

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TOSS-UP

16) Earth and Space – *Multiple Choice* Which of the following objects can be used as spiral tracers?

W) Type K Stars
X) Exoplanets
Y) Emission Nebulae
Z) H1 Region

ANSWER: Y) Emission Nebulae [SP]

BONUS

16) Earth and Space – *Short Answer* In what constellation is the supermassive black hole at the center of the galaxy visible?

ANSWER: SAGITARRIUS [SP]

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TOSS-UP

17) Chemistry – *Short Answer* The efficiency of a Carnot Engine changes from 40% to 60%. How much does the temperature of the source change when temperature of heat sink is 123 celsius rounded to the nearest 10 degrees

Answer: 80

BONUS

17) Chemistry – *Multiple Choice* Which of the following compounds has an exothermic dissolution in water?

W) Sulfur Dioxide
X) Sodium Nitrate
Y) Potassium Iodide
Z) Ammonium Chloride

Answer: W) Sulfur Dioxide

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TOSS-UP

18) Physics – *Short Answer* Two parallel plates of area 0.25 meters squared have a surface charge of 5 couloumbs per square meter. The two plates form a capacitor with a capacitance of 4 millifarads. What is the voltage difference between the two plates, in volts?

ANSWER: 312.5 V

BONUS

18) Physics – *Short Answer* What law commonly used in fluid mechanics describes the pressure drop across a pipe as being related to the fluid's viscosity?

ANSWER: POISEUILLE'S LAW (Accept: Hagen-Poiseuille's Equation)

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TOSSUP

19) Biology – *Short Answer* Order the following four root layers from superficial to deep?

1) Pericycle
2) Stele
3) Root cap
4) Cortex

ANSWER: ROOT CAP, CORTEX, PERICYCLE, STELE (3, 4, 1, 2)

BONUS

19) Biology – *Short Answer* If a man with DMD has a daughter without DMD who marries a man without DMD, what percent of the daughters will be carriers for DMD?

ANSWER: 50

TOSS-UP

20) Math – *Short Answer* What is the measure of the larger angle, in degrees, between the minute hand and the hour hand of a 12-hour clock at 3:58?

ANSWER: 229

BONUS

20) Math – *Short Answer* What is the measure, in degrees, of the smaller angle between the minute hand and the seconds hand 390 seconds after midnight?

ANSWER: 141

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