SSBT Playoff Round 7

TOSS-UP

1) Biology - *Multiple Choice* Which of the following situations would shift the oxygen-hemoglobin dissociation curve right?

W) Replacing adult hemoglobin with fetal hemoglobin

X) Decreasing 2,3-BPG

Y) Increasing pH

Z) Increasing Temperature

ANSWER: Z) Increasing Temperature

BONUS

1) Biology - *Short Answer* Identify all of the following three structures that are considered vestigial structures to the creature: 1) Nictitating Membrane for crocodiles, 2) Pelvic Spur for snakes, 3) Flowers for dandelions.

ANSWER: 2 AND 3

TOSS-UP

2) Math – *Short Answer* A triangle has a perimeter of 54. If the triangle's sides are scaled by the same factor so that it has a perimeter of 81, by what factor does the area increase?

ANSWER: 9/4 (ACCEPT: 2.25)

BONUS

2) Math – *Short Answer* There exists positive integers a and b such that log base a of b squared equals $(\log_a b)^2 - 3$ **[open parentheses log base a of b close parentheses squared minus 3]** What is the sum of the possible values of log base a of b?

ANSWER: 2

TOSS-UP

3) Physics – *Short Answer* Through what 2 particles are most of the energy from a star like our sun released?

ANSWER: PHOTON, NEUTRINO (IN ANY ORDER)

BONUS

3) Physics – *Short Answer* A object attached to a spring is moving linearly in simple harmonic motion on a frictionless surface. If the maximum displacement from equilibrium is 5m and the maximum velocity reached by the object is 8 m/s, what is the speed of the object 3m from the equilibrium?

ANSWER: 32/5 m/s (ill give anyone a solid $13 if anyone gets this q in 20 sec -medha)

TOSS-UP

4) Energy - *Multiple Choice* Researchers at the National Energy Technology Lab are monitoring gas hydrates on the ocean floor in order to potentially convert their stored energy to electricity. What greenhouse gas do these hydrates contain?

W) Carbon dioxide

X) Methane

Y) Nitrous oxide

Z) Ozone

ANSWER: X) METHANE

BONUS

4) Energy – *Short Answer* Researchers at the Max Planck Institute are studying the interactions between the magnetosphere of Jupiter and its moons. What is the name of the charged structure connecting Jupiter and Io that is formed by the rapidly rotating magnetic field of Jupiter?

ANSWER: IO FLUX TUBE (ACCEPT: FLUX TUBE)

TOSS-UP

5) Earth and Space – *Short Answer* What is the name of the phenomenon that occurs when a nearer celestial body is observed to pass in front of a larger celestial body but only covers a small portion of the larger body?

ANSWER: TRANSIT

BONUS

5) Earth and Space – *Multiple Choice* Which of the following conditions for a hypothetical star would produce the broadest spectral lines if its mass stays the same?

W) Large radius, high temperature

X) Large radius, low temperature

Y) Small radius, high temperature

Z) Small radius, low temperature

ANSWER: Y) SMALL RADIUS, HIGH TEMPERATURE

TOSS-UP

6) Chemistry - *Multiple Choice* Which of the following functional groups present in toluene allows it to undergo nitration at a rate 25x greater than benzene?

W) Methyl

X) Ethyl

Y) Propyl

Z) Thiol

ANSWER: W) Methyl

BONUS

6) Chemistry - *Short Answer* What set of reactions, involves an acyl chloride and a Lewis acid, to produce an acylium ion, which can then be reduced by benzene to form an aryl chloride?

ANSWER: Friedel-Crafts Acylation

TOSS-UP

7) Biology - *Short Answer* What type of selection occurs when the fitness of a trait is based on how prevalent the trait is in a population?

ANSWER: FREQUENCY-DEPENDENT SELECTION

BONUS

7) Biology - *Multiple Choice* The relationship between bees and flowering plants is an example of what type of mutualism?

W) Obligate Mutualism

X) Facultative Mutualism

Y) Trophic Mutualism

Z) Defensive Mutualism

ANSWER: X) Facultative Mutualism

TOSS-UP

8) Math – *Short Answer* A polynomial of degree 3 has roots at 0, 1, and 2 and passes through the point (6, 9). What is the value of its leading coefficient?

ANSWER: 3/40

BONUS

8) Math – *Short Answer* A triangle has side lengths 13, 14, and 18. What is the length of the shortest altitude of the triangle in simplest form?

ANSWER: 4sqrt465

TOSS-UP

9) Physics – *Short Answer* Two current carrying wires running antiparallel to each other are a perpendicular distance d from one another. If the current in one of the wires switches direction, and the distance between them triples, by what factor does the force due to one wire on another get multiplied by?

ANSWER: -1/3

BONUS

9) Physics – *Short Answer* A beam of light enters a magical substance with index of refraction 2 form the air. Assuming it enters at an angle of 30 degrees from the normal, what is the cosine of the angle the beam will leave at compared to the perpendicular?

ANSWER: (sqrt 15)/4

TOSS-UP

10) Energy – *Short Answer* Photoprotection is a natural process that enables plants to cope with damaging excess absorbed light energy in full sunlight. What mechanism best describes when plants in full sunlight dissipate potentially damaging excess absorbed light energy as heat?

ANSWER: Nonphotochemical Quenching (NPQ)

BONUS

10) Energy – *Short Answer* An international research team led by the University of Göttingen has, for the first time, observed the build-up of a physical phenomenon that plays a role in the conversion of sunlight into electrical energy in 2D materials. The scientists succeeded in making Dark Moiré (mwah-ray) interlayer excitons visible and also in explaining their formation using quantum mechanics. What two particles compose an exciton?

ANSWER: Electron and Electron Hole (DO NOT ACCEPT ANYTHING ELSE)

TOSS-UP

11) Earth and Space – *Short Answer* Cutoffs in meandering streams are an example of what general process that occurs in rivers where a new river channel is formed and the old one is abandoned?

ANSWER: AVULSION

BONUS

11) Earth and Space – *Short Answer* Identify all of the following 4 parts of the electromagnetic spectrum that generally can easily pass through the Earth's atmosphere: 1) Visible; 2) Infrared; 3) Radio; 4) Ultraviolet

ANSWER: 1 AND 3

TOSS-UP

12) Chemistry - *Short Answer* Order the following monoprotic acids by increasing acidity.

I) Chlorous acid

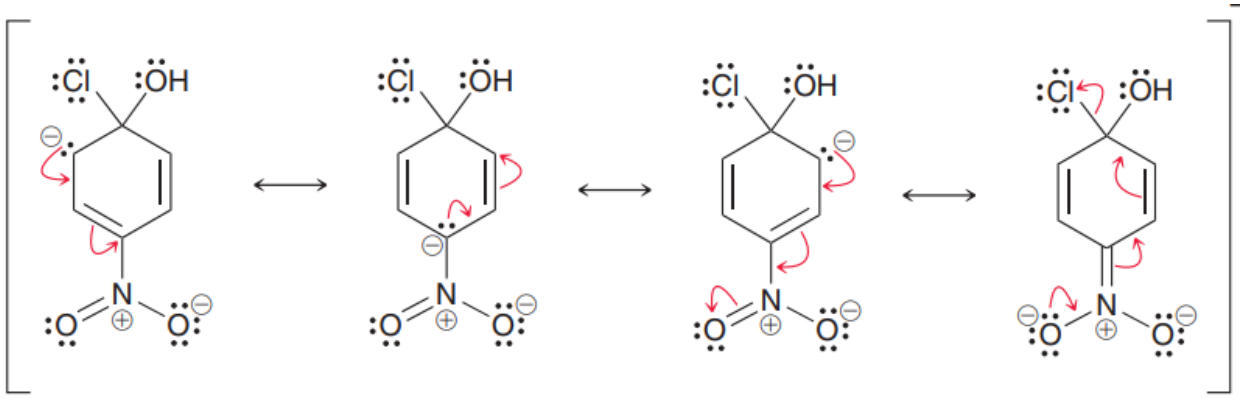
II) Acetic Acid

III) Hydrofluoric Acid

ANSWER: II, III, I

Visual BONUS

12) Chemistry - *Short Answer* Identify the following complex, a resonance-stabilized intermediate commonly found during a nucleophilic attack on an aromatic compound.



ANSWER: Meisenheimer Complex

TOSS-UP

13) Biology - *Short Answer* In which group of specialized cells do plants shed their aerial organs?

ANSWER: Abscission zones

BONUS

13) Biology - *Short Answer* X-linked adrenoleukodystrophy, also known as XALD is the inability to oxidize 26:0 fatty acids because of the failure of what cellular organelle?

ANSWER: Peroxisomes

TOSS-UP

14) Math – *Short Answer* What is the equation of the line defined by y = 3x/5 + 5 reflected over y=x in standard form?

ANSWER: 5x-3y=25

BONUS

14) Math – *Short Answer* Bananas come in bunches of either 7 or 8. If 45 bunches of 7 bananas and 46 bunches of 8 bananas make a total of 683 bananas, how many combinations of 7 and 8 bunches exist such that the total sum of bananas is 683?

ANSWER: 14

TOSS-UP

15) Physics – *Short Answer* Neutrino observatories observed flavor oscillations which implied neutrino has nonzero value of what quantity?

W) charge

X) mass

Y) spin

Z) taste

ANSWER: X) MASS

BONUS

15) Physics - *Multiple Choice* Which of the following is true of an ideal LC circuit?

W) Energy is lost when current goes from the capacitor to the inductor

X) Resonance occurs when capacitive reactance is greater than inductive reactance

Y) Impedance is 0 when the inductor and capacitor are in parallel

Z) Alternating current is least effective with the inductor and capacitor in parallel

ANSWER: Z) Alternating current is least effective with the inductor and capacitor in parallel

TOSS-UP

16) Energy – *Multiple Choice* Scientists at the University of Michigan are investigating traumatic head injuries and the likelihood that they cause death. Specifically, they are investigating two different proteins, one of which is Glial Fibrillary Acidic Protein, a type of

structural protein in the cell. Which of the following types of intracellular structures does this protein likely comprise?

W) Microtubules

X) Microfilaments

Y) Intermediate Filaments

Z) Myosin

ANSWER: Y) INTERMEDIATE FILAMENTS

BONUS

16) Energy - *Short Answer* Scientists at Rockefeller University are studying neuronal formation and its role in the reversal of Alzheimer's Disease in mice. Identify all of the following three statements that are true of their research: 1) The scientists were producing dopaminergic neurons; 2) The scientists were looking to boost long-term memory retention by increasing neuronal differentiation in the thalamus; 3) The scientists were injecting fully differentiated neurons into the brain

ANSWER: 1 ONLY

TOSS-UP

17) Earth and Space – *Short Answer* What is the name of the type of telescope lens that uses two different glass lenses to reduce the effects of chromatic abberation?

ANSWER: ACHROMATIC LENS

BONUS

17) Earth and Space – *Short Answer* An unknown star has an absolute magnitude of -5 but is observed to have an apparent magnitude of 25. What is the distance of the star from the observation planet in parsecs?

ANSWER: 10^7

TOSS-UP

18) Chemistry - *Short Answer* What type of hybridization is present between the carbon atoms in benzene?

ANSWER: sp^2

BONUS

18) Chemistry - *Multiple Choice* Which of the following is incorrect regarding the Hofmann Elimination and formation of alkenes?

W) Amines can be converted into alkenes via Hofmann Elimination

X) Silver oxides can be utilized to catalyze conversion into alkenes

Y) Both amines and alcohols can undergo elimination reactions to form alkenes

Z) An E1 reaction usually occurs between a hydroxide ion and the quaternary ammonium

ANSWER: Z) An E1 reaction usually occurs between a hydroxide ion and quaternary ammonium salt

TOSS-UP

19) Biology – *Multiple Choice* Which of the following phylums exhibit radial symmetry?

W) Chordata

X) Porifera

Y) Cnidaria

Z) Annelia

ANSWER: Y) Cnidaria

BONUS

19) Biology – *Short Answer* What type of cell in cnidarians contains the stinging organelle that can be used to envenomate both predators and prey alike?

ANSWER: Cnidocyte (or Nematocyte, Do not accept: Nematocyst, Cnidocyst)

TOSS-UP

20) Math – *Multiple Choice* Which of the following best describes the relationship between the mean and median in a distribution which is skewed left?

W) The mean is less than the median

X) The mean is greater than the median

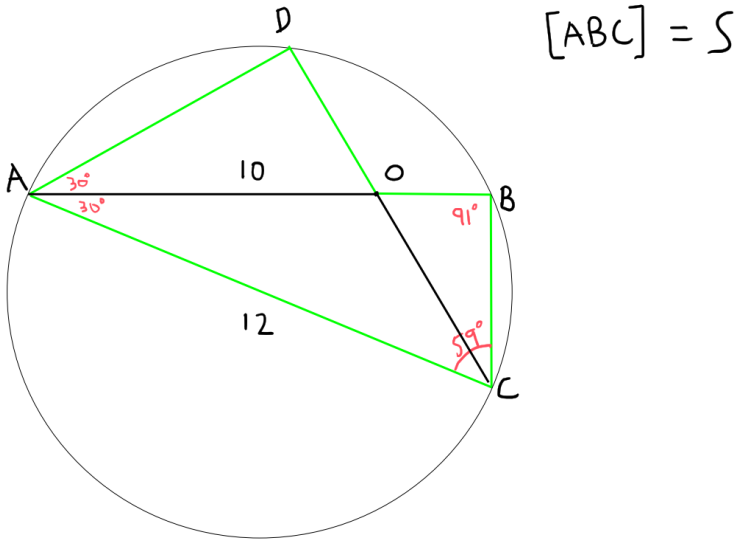
Y) The mean is equal to the median

Z) The mean and median both lie on the tail

ANSWER: W) THE MEAN IS LESS THAN THE MEDIAN

VISUAL BONUS

20) Math – *Short Answer* If the area of triangle ABC is S, what is the area of the figure outlined in green in terms of S?



ANSWER: 61/25 S

TOSS-UP

21) Physics – *Multiple Choice* A particle with charge q moves perpendicular to a magnetic field, and is deflected such that the path it travels has a radius R. If the mass, charge, speed, and magnetic field strength were all doubled, which of the following would be the new radius the electron travels?

W) ½ R

X) R

Y) 3/2 R

Z) 2R

ANSWER: X) R

BONUS

21) Physics – *Short Answer* What is the speed of a particle that has a Lorentz factor of 5.0, in terms of c, the speed of light?

ANSWER: (2sqrt6)/5 c

TOSS-UP

22) Earth and Space – *Short Answer* Both Voyager 1 and 2 have been able to pass what boundary that separates the Sun's solar wind from the remainder of interstellar space?

ANSWER: HELIOPAUSE

BONUS

22) Earth and Space – *Short Answer* Janus and Epimetheus are two small moons of Saturn that exchange orbits every 4 years due to gravitational attractions. What is the name of pairs of moons that exhibit this behavior?

ANSWER: CO-ORBITAL MOONS

TOSS-UP

23) Chemistry - *Short Answer* Identify all of the following three processes which are industrial processes that produce a primary amine:

I) Gabriel Synthesis

II) Azide Synthesis

III) Reductive Amination

ANSWER: ALL

BONUS

23) Chemistry - *Short Answer* Identify all of the following reactions that CANNOT produce an alcohol: 1) Acid-catalyzed hydration; 2) Hydroboration-Oxidation; 3) Oxymercuration Demercuration

ANSWER: NONE