SSBT Playoffs Round 6

TOSS-UP

1) Biology - *Short Answer* Peter finds that he is not evil, but his identical twin happens to be a supervillain. His doctor explains that difference falls under what field of genetics, which describes how the environment affects the human phenotype?

ANSWER: EPIGENETICS

BONUS

1) Biology - *Short Answer* What is the name of the conducting-system fibers located within the interventricular septum and propagates action potentials from the AV node to the Purkinje fibers?

ANSWER: BUNDLE OF HIS

TOSS-UP

2) Earth and Space - *Short Answer* Rocks from the Cretaceous-Paleogene boundary can be easily identified because they contain relatively high amounts of what element, which is common in asteroids but not on Earth?

ANSWER: IRIDIUM

BONUS

2) Earth and Space - *Multiple Choice* Which of the following conditions would most directly hinder a sea breeze?

W) Coastal urban sprawl

X) Cold ocean waters

Y) High pressure above land

Z) Conditional instability

ANSWER: Y) HIGH PRESSURE ABOVE LAND

TOSS-UP

3) Math – *Short Answer* What fraction can be written in decimal form as 0.36 repeating?

ANSWER: 4/11

BONUS

3) Math – *Short Answer* How many ways are there to write 8 as the sum of positive integers if order matters?

ANSWER: 127

TOSS-UP

4) Physics – *Short Answer* Identify all of the following four quarks that have a positive charge: 1) Up; 2) Strange; 3) Charm; 4) Bottom.

ANSWER: 1 AND 3

BONUS

4) Physics – *Short Answer* An object is thrown vertically upward with an initial velocity of 30 meters per second from the top of a building with a height of 135 meters. Assuming acceleration due to gravity equals 10 meters per second squared, in how many seconds from the time the ball is thrown will the object hit the ground?

ANSWER: 9

TOSS-UP

5) Energy - *Multiple Choice* Researchers at Pacific Northwest National Lab recently discovered that rainfall mitigates the impact cyclones have on the ocean. Cyclonic winds typically lead to which of the following processes in the ocean?

W) Ekman suction

X) Ekman pumping

Y) Cold-core eddy formation

Z) Warm-core eddy formation

ANSWER: W) EKMAN SUCTION

BONUS

5) Energy - *Short Answer* Researchers at Lawrence Berkeley National Lab are studying the origins of geologic carbon dioxide in order to understand the processes that create fossil fuel reservoirs. Identify all of the following three groups of marine organisms that could create source material for carbon dioxide: 1) Diatoms; 2) Foraminifera; 3) Radiolarians.

ANSWER: 2 ONLY

TOSS-UP

6) Chemistry - *Short Answer* What rule defines that an unsymmetrical alkene, when treated with a hydrogen halide, will bear the halide at the vinylic position containing the greater number of alkyl groups?

ANSWER: MARKOVNIKOV RULE (ACCEPT: MARKOVNIKOV ADDITION)

BONUS

6) Chemistry - *Short Answer* Identify all of the following three statements which are correct regarding hydrohalogenation of an alkene: 1) The rate of acid-catalyzed hydration of an alkene increases with the number of alkyl groups; 2) The anti-Markovnikov addition, where the halide is present at the less substituted position of a vinyl group, was a result of the presence of alkyl peroxides; 3) The nucleophilic attack of an unsymmetrical halide is the rate-limiting step of hydrohalogenation.

ANSWER: 1 AND 2

TOSSUP

7) Biology - *Multiple Choice* Which of the following nutrients are mycorrhizae most important for absorption?

W) Nitrogen

X) Phosphorus

Y) Carbon

Z) Potassium

ANSWER: X) PHOSPHORUS

BONUS

7) Biology - *Short Answer* What is the name of the Sudoriferous Gland that is numerous, found all around the body, produces sweat, and is part of the body's heat regulating system?

ANSWER: ECCRINE GLAND

TOSS-UP

8) Earth and Space - *Multiple Choice* Which of the following types of sediment is most common in the deepest regions of the ocean?

W) Terrigenous sediment

X) Siliceous ooze

Y) Calcareous ooze

Z) Abyssal clay

ANSWER: Z) ABYSSAL CLAY

BONUS

8) Earth and Space - *Multiple Choice* Which of the following rocks forms from the highest degree of metamorphism?

W) Marble

X) Migmatite

Y) Hornfels

Z) Schist

ANSWER: X) MIGMATITE

TOSS-UP

9) Math – *Short Answer* On the complex plane, what is the distance from the solutions of $z^3 = 8 - 6i$ and the origin?

ANSWER: CUBE ROOT OF 10

BONUS

9) Math – *Short Answer* A parallelogram has vertices at the coordinates (2, 5), (-1, 3), and (7, 2). What is the sum of the possible x-coordinates of its last vertex?

ANSWER: 8

TOSS-UP

10) Physics – *Short Answer* A capacitor with capacitance 6 uF ***[microfarads]*** is connected to a 5V battery. In microjoules, what is the energy stored in the capacitor?

ANSWER: 75

BONUS

10) Physics – *Short Answer* How many kilojoules of thermal energy are lost from a 200-gram block of Teflon with a specific heat of 1 kJ/kg°C, to lower the block's temperature from 84º C to 58º C?

ANSWER: 5.2 kJ

TOSS-UP

11) Energy - *Short Answer* Researchers are currently studying the Cul2-APPBP2 which catalyzes the breakdown of the PRDM16 protein, a key enzyme in metabolic regulation. These enzymes catalyze the biogenesis of what tissue, known to regulate hunger and body temperature?

ANSWER: BROWN ADIPOSE TISSUE

BONUS

11) Energy - *Short Answer* Researchers at the University of Berlin are discovering the expansion of the genetic code and the use of special tRNAs to incorporate non-canonical amino acids. What special amino acid are these researchers studying, characterized by the encoding of a UGA stop codon facilitated by a hairpin loop known as the SECIS-element?

ANSWER: SELENOCYSTEINE (ACCEPT: U, SEC)

TOSS-UP

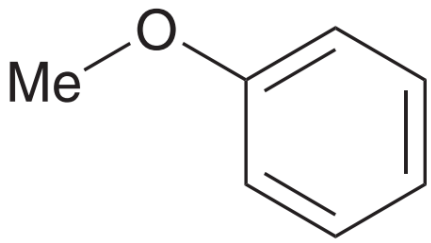
12) Chemistry – *Short Answer* Identify all of the following statements which are true regarding the hydrogen atom: 1) Its electron subshells are degenerate; 2) When in a negatively charged

state, its orbital wave function cannot be solved; 3) When neutral, its single electron occupies the 1s orbital, in which it has no angular momentum

ANSWER: ALL

VISUAL BONUS

12) Using standard IUPAC nomenclature, correctly name the following compound.



ANSWER: METHOXYBENZENE (ACCEPT: 1-METHOXYBENZENE)

TOSSUP

13) Biology - *Short Answer* What is the name of the condition which involves an enlarged thyroid gland due to causes such as greater concentrations of thyroid stimulating hormones?

ANSWER: GOITER

BONUS

13) Biology - *Multiple Choice* According to Poiseuille's law, which of the following IS NOT a factor which directly impacts resistance inside of a blood vessel?

W) Fluid viscosity

X) Length of the vessel

Y) Fluid volume

Z) Radius of the vessel

ANSWER: Y) FLUID VOLUME

TOSS-UP

14) Earth and Space – *Short Answer* What phenomena describes when a natural satellite has the same orbital and rotational period?

ANSWER: TIDAL LOCKING (ACCEPT: TIDAL COUPLING)

BONUS

14) Earth and Space – *Multiple Choice* Which of the following statements are not true of Seyfert galaxies?

W) Type I Seyfert galaxies have stronger x-ray emission than Type II Seyfert galaxies

X) Seyfert galaxies have highly luminous nuclei

Y) Seyfert galaxies are closer than quasar galaxies

Z) Seyfert galaxies have strong, narrow emission lines

ANSWER: Z) SEYFERT GALAXIES HAVE STRONG, NARROW EMISSION LINES

TOSS-UP

15) Math – *Short Answer* A binary operator called star is defined such that for any a and b, a star b equals ab/(a-b) **[a b divided by the quantity a minus b]**. What is the value of 5 star (4 star 3) as a fraction?

ANSWER: -60/7

BONUS

15) Math – *Short Answer* A fair 10-sided die with faces numbered from 4 to 13 is rolled to determine the outcome of this match. If the sum of the 9 faces not touching the ground is congruent to 0 mod 3, no one wins; if it's congruent to 1 mod 3, team A wins; and if it's congruent to 2 mod 3, team B wins. How many times more likely is team B to win than team A?

ANSWER: 1

TOSS-UP

16) Physics – *Multiple Choice* To convert a galvanometer to a voltmeter, you should add which of the following?

W) high resistance in series

X) high resistance in parallel

Y) low resistance in series

Z) low resistance in parallel

ANSWER: W) HIGH RESISTANCE IN SERIES

BONUS

16) Physics – *Short Answer* How many joules of energy are used by an electrical appliance operating on 12 amps of current flowing through a 5-ohm resistance circuit for 5 minutes?

ANSWER: 216000

TOSS-UP

17) Energy - *Short Answer* Researchers at Harvard University are studying the effects of climate change on the rates of evolution in reptiles prior to the end-Permian extinction, where which of the following events occurred?

W) Volcanic eruption

X) Ocean anoxia

Y) Asteroid impact

Z) Gamma ray burst

ANSWER: W) VOLCANIC ERUPTION

BONUS

17) Energy - *Short Answer* Scientists are currently studying the unusual olfactory system of mosquitoes, whose olfactory neurons contain multiple different signal receptors. This phenomenon is caused by what recently discovered process?

ANSWER: GENETIC CO-EXPRESSION

TOSS-UP

18) Chemistry - *Short Answer* Identify all of the following components that could be present in a SN2 reaction, regarding the substrate and reagent properties, respectively: 1) Primary substrate, strong base, weak nucleophile; 2) Tertiary substrate, weak base, strong nucleophile; 3) Tertiary substrate, strong base, strong nucleophile

ANSWER: NONE

BONUS

18) Chemistry - *Multiple Choice* Which of the following is incorrect regarding addition reactions of an alkene?

W) Halogenation of a cyclic alkene by molecular bromine leads to a formation of a positively-charged bridged bromonium ion

X) Anti-dihydroxylation of a cyclic alkene involves the formation of an epoxide

Y) Hydrogenation of an alkene can be facilitated via the use of Wilkinson's Catalyst

Z) In hydrogenation, metals are used to coordinate anti-addition of hydrogen across a double bond

ANSWER: Z) Metals, such as nickel, are utilized in hydrogenation to catalyze anti addition of hydrogen on opposite sides of a double bond

TOSS-UP

19) Biology – *Multiple Choice* Which of the following is true about skeletal muscles?

W) Units are connected by gap junctions

X) They contain dense bodies to help with contraction

Y) Units consistently undergo cell division

Z) When muscles contract, the H zone shrinks

ANSWER: Z) WHEN MUSCLES CONTRACT, THE H ZONE SHRINKS

BONUS

19) Biology - *Short Answer* What is the equilibrium potential of sodium ions across a neuron, if the extracellular concentration of sodium ions is 150 mM and the intracellular concentration is about 15 mM?

ANSWER: 62 mV (ACCEPT: 61 mV)

TOSS-UP

20) Earth and Space – *Short Answer* Identify all of the following statements that are true about the Pluto and Charon binary system. 1) Their barycenter is located outside Pluto; 2) They are mutually tidally locked; 3) Charon perturbs Pluto's orbit significantly.

ANSWER: ALL

BONUS

20) Earth and Space – *Short Answer* Identify all of the following 3 statements that are true of Uranus: 1) Its belt-zone circulation is in the the opposite direction of the planet's rotation; 2) Its magnetic field is derived from convection in its core; 3) Its auroras are only located directly above its geographical poles.

ANSWER: NONE

TOSS-UP

21) Math – *Short Answer* What is the slope of the slant asymptote of the rational function $(5x^3 - 3)/(x^2+4x+3)$

ANSWER: 5

BONUS

21) Math – *Short Answer* A set S contains the numbers 0, 1, 2, 3, and 4. How many subsets of S exist such that there are an odd number of even numbers and an even number of odd numbers?

ANSWER: 8

TOSS-UP

22) Physics – *Short Answer* What fundamental force mediates the decay of a neutron into a proton, an electron, and a neutrino??

ANSWER: WEAK FORCE

BONUS

22) Physics – *Multiple Choice* Which of the following electrical components is generally used to limit the current flow to one direction?

W) Inductor

X) Transformer

Y) Capacitor

Z) Diode

ANSWER: Z) DIODE

TOSS-UP

23) Chemistry - *Short Answer* Order the following 3 organic compounds in terms of increasing boiling point: 1) Propane; 2) Dipropyl ether; 3) Dimethyl ether.

ANSWER: 1, 3, 2

BONUS

23) Chemistry - *Multiple Choice* Which of the following statements is INCORRECT regarding ethers?

W) Benzene can be utilized as a reagent to solvate a cation inside a crown ether

X) The Williamson ether synthesis involves an SN2 nucleophilic attack

Y) Acidic cleavage of an ether in the presence of a strong acid produces two alcohols

Z) A ring opening reaction of an epoxide occurs in the presence of a strong nucleophile

ANSWER: Y) ACIDIC CLEAVAGE OF AN ETHER IN THE PRESENCE OF A STRONG ACID PRODUCES TWO ALCOHOLS