SSBT Prelim Round 3

TOSS-UP

1) Chemistry – *Multiple Choice* Which of the following elements is the most polarizable?

W) Aluminum

X) Rubidium

Y) Cesium

Z) Iodine

ANSWER: Y) CESIUM

BONUS

1) Chemistry – *Short Answer* Identify all of the following 3 statements which are true of enantiomers: 1) Enantiomers exhibit identical optical properties; 2) Enantiomers are structural isomers; 3) Enantiomers exhibit identical physical properties.

ANSWER: 3 ONLY

TOSS-UP

2) Biology – *Short Answer* What hormone opposes the actions of the parathyroid hormone, and helps regulate the levels of calcium and phosphate in the blood?

ANSWER: CALCITONIN

BONUS

2) Biology – *Short Answer* An individual of a new species has a genotype where they are homozygous dominant for gene A, heterozygous for genes B and C, and homozygous recessive for gene D. If they mate with another individual that is heterozygous for every gene, what is the probability of getting an offspring that has genotype AabbCcdd ***[big A, little a…]***?

ANSWER: 1/16 (ACCEPT: 0.0625)

TOSS-UP

3) Earth and Space – *Short Answer* According to the Babcock Model, the Sun's magnetic poles reverse in a partial magnetic cycle of how many years?

ANSWER: 11

BONUS

3) Earth and Space – *Short Answer* Hurricanes and various weather systems are confined to the lower atmosphere by what atmospheric boundary?

ANSWER: TROPOPAUSE

TOSS-UP

4) Math – *Short Answer* How many ways can 3 distinguishable dogs and 2 distinguishable cats stand in a line such that no dog is directly adjacent to another dog?

ANSWER: 12

BONUS

4) Math – *Short Answer* If the diagonal of a rectangle has length $6\sqrt{3}$, what is the maximum area it can have?

ANSWER: 54

TOSS-UP

5) Energy – *Short Answer* Researchers at Princeton Plasma Physics Lab are testing sodium-ion batteries as a cheaper alternative to lithium-ion batteries. What is the charge of the namesake sodium ion in these batteries?

ANSWER: +1

BONUS

5) Energy – *Short Answer* Researchers at Princeton Plasma Physics Lab are investigating intense magnetic fields in order to better predict solar flares, coronal mass ejections, and the resulting geomagnetic storms. These events are driven by what process, where magnetic field lines break and reform to release huge amounts of stored potential energy?

ANSWER: MAGNETIC RECONNECTION

TOSS-UP

6) Physics – *Short Answer* The time constant of an RC circuit represents the time it takes to charge a capacitor to what percent of full capacity, rounded to the nearest integer?

ANSWER: 63%

BONUS

6) Physics – *Multiple Choice* A circuit with an open switch has a resistor and a capacitor in parallel. Which of the following is true about the current through the resistor and capacitor immediately after the switch is closed?

W) It flows only through the resistor

X) It flows only through the capacitor

Y) It flows through both equally

Z) It flows through both unequally

ANSWER: W) IT FLOWS ONLY THROUGH THE RESISTOR

TOSS UP

7) Chemistry – *Multiple Choice* Which of the following carbocations is most stable?

W) Primary

X) Secondary

Y) Tertiary

Z) Quaternary

ANSWER: Y) TERTIARY

BONUS

7) Chemistry – *Short Answer* What term describes donation of electron density into p-orbitals from neighboring sigma bonds that stabilizes carbocations?

ANSWER: HYPERCONJUGATION

TOSSUP

8) Biology – *Multiple Choice* Which of the following actions is not controlled by the sympathetic nervous system?

W) Constricting pupils

X) Accelerating heart activity

Y) Inhibition of the pancreas

Z) Release of glucose from the liver

ANSWER: W) CONSTRICTING PUPILS

BONUS

8) Biology – *Short Answer* Identify all of the following 3 structures of the electron transport chain that do NOT actively transport protons into the intermembrane space of the mitochondria: 1) Ubiquinone; 2) Cytochrome c; 3) Complex II.

ANSWER: ALL

TOSS-UP

9) Earth and Space – *Short Answer* What type of jointing occurs commonly in igneous rocks and can form long hexagonal pillars?

ANSWER: COLUMNAR JOINTING

BONUS

9) Earth and Space – *Short Answer* Order the following 3 objects in decreasing order of brightness to an observer on Earth: 1) The Full Moon; 2) Betelgeuse; 3) Sirius A.

ANSWER: 1, 3, 2

TOSS-UP

10) Math – *Multiple Choice* Which of the following equations on the x-y plane has an x-intercept of -5 and a y-intercept of 2?

W) $y = 5x + 10$

X) $y = 2x + 10$

Y) $5y = 3x - 15$

Z) $5y = 2x + 10$

ANSWER: Z) $5y = 2x + 10$

BONUS

10) Math – *Short Answer* What is the coefficient of the x^4y^9 term in the expansion of $(2x+y)^{13}$?

ANSWER: 11440

TOSS-UP

11) Energy – *Short Answer* Sandia National Lab recently established a challenge of looking for alternatives to traditional silicon-based electronics, especially in quantum and neuromorphic computing. This is because scientists believe the world is reaching the limits of what law, which accurately predicted that the number of transistors in microprocessors doubles every two years?

ANSWER: MOORE'S LAW

BONUS

11) Energy – *Short Answer* Savannah River National Lab is currently funding projects related to boosting nuclear weapons, where the introduction of extra neutrons results in increased fissility and a higher energy yield. These neutrons are typically added by injecting a gas that includes what radioactive isotope of hydrogen?

ANSWER: TRITIUM

TOSS-UP

12) Physics - *Short Answer* The speed of light in a vacuum is estimated to be about 3.0 x 10^8 m/s. If it is found that the speed of light in water is about 2.25 x 10^8 m/s, what is, rounded to the nearest whole number, the index of refraction in water?

ANSWER: 1 (DO NOT ACCEPT: 1.3)

BONUS

12) Physics - *Short Answer* The index of refraction of a liquid is 1.25. What is the index of refraction of an unknown solid if the critical angle between the solid and liquid is 30 degrees?

ANSWER: 2.5

TOSS-UP

13) Chemistry – *Short Answer* What is the pH of a solution with a pOH of 3.5?

ANSWER: 10.5

BONUS

13) Chemistry – *Short Answer* What is the classification of compounds that have chiral centers but are not chiral?

ANSWER: MESO COMPOUNDS (ACCEPT: MESO)

TOSS-UP

14) Biology – *Short Answer* What term defines the contract phase of the cardiac cycle, which involves the pumping of blood out of the ventricles and into the arteries?

ANSWER: SYSTOLE ***[SIS-tuh-lee]***

BONUS

14) Biology – *Multiple Choice* Which of the following is NOT a specialization of the vertebrate forebrain?

W) Regulation of sleep

X) Olfactory input

Y) Blood circulation

Z) Learning

ANSWER: Y) BLOOD CIRCULATION

TOSS-UP

15) Earth and Space – *Multiple Choice* Point bars are most commonly deposited in which of the following areas of a meandering stream?

W) On the outside of meanders

X) On the inside of meanders

Y) At the source of the stream

Z) At the mouth of the stream

ANSWER: X) ON THE INSIDE OF THE MEANDERS

BONUS

15) Earth and Space – *Short Answer* Identify all of the following 3 statements that are generally true of isobars: 1) Closely spaced isobars indicate strong winds; 2) Geostrophic winds blow perpendicular to isobars; 3) Surface winds generally blow parallel to isobars.

ANSWER: 1 ONLY

TOSS-UP

16) Math – *Multiple Choice* A triangle consists of three angles with measures of $4x - 2$, $3x + 5$, and $x + 1$ degrees. What is the value of x?

W) 20

X) 21

Y) 22

Z) 23

ANSWER: Y) 22

BONUS

16) Math – *Short Answer* What are the coordinates of the intersections of the equations $y = x^2 - 6$ and $y = x$?

ANSWER: (3, 3) AND (-2, -2)

TOSS-UP

17) Energy – *Short Answer* Researchers at Thomas Jefferson National Accelerator Facility are using simulations to model neutrino oscillation. In order to test their simulation, they use it to model the interactions of electrons. Neutrinos and electrons are highly similar in that they both do not undergo strong interactions, placing them in what group of particles?

ANSWER: LEPTONS

BONUS

17) Energy – *Short Answer* Researchers at Los Alamos National Lab are using heavy-ion collisions to study the extremely dense supranuclear conditions inside neutron stars. These stars are so dense because the pressure from gravity has exceeded what force that normally prevents stars from collapsing?

ANSWER: NEUTRON DEGENERACY PRESSURE

TOSS-UP

18) Physics – *Multiple Choice* Two identical balls are dropped at different times over a bottomless pit. Considering air resistance, which of the following best describes the difference in velocity between the two balls after both balls are dropped?

W) It always increases

X) It always decreases

Y) It increases, then decreases

Z) It decreases, then increases

ANSWER: X) IT ALWAYS DECREASES

BONUS

18) Physics – *Short Answer* Ignoring air resistance, a 2 kg projectile is launched vertically into the air with initial speed 5 m/s. To one significant figure and in Joules, how much kinetic energy is lost after the ball travels 0.5 meters upward?

ANSWER: 10

TOSS UP

19) Chemistry – *Short Answer* How many sigma and pi bonds respectively are there in a molecule of ethyne (eh·thine)?

ANSWER: 3 SIGMA, 2 PI (ACCEPT: 3, 2)

BONUS

19) Chemistry – *Short Answer* What is the maximum number of stereoisomers a compound with 6 chiral centers can have?

ANSWER: 64

TOSS-UP

20) Biology – *Multiple Choice* Which of the following is the starting and ending substrate of the Citric Acid Cycle which binds to acetyl Co A?

W) Citrate ***[SIH-trate]***

X) Oxaloacetate ***[OX-uh-low-AS-uh-tate]***

Y) Phosphoenolpyruvate ***[FAHS-foh-EE-nahl-PIE-roo-vate]***

Z) Alpha-ketoglutarate ***[alpha KEE-toh-GLUE-tuh-rate]***

ANSWER: X) OXALOACETATE

BONUS

20) Biology – *Short Answer* What type of speciation occurs when a population is separated into geographically isolated subpopulations?

ANSWER: ALLOPATRIC SPECIATION

TOSS-UP

21) Earth and Space – *Multiple Choice* Stars under 0.8 solar masses follow which track in order to become part of the main sequence?

W) Henyey track

X) Hayashi track

Y) Horizontal branch

Z) Subgiant branch

ANSWER: X) HAYASHI TRACK

BONUS

21) Earth and Space – *Multiple Choice* Which of the following best defines a glitch in a neutron star?

W) An increase in rotational speed

X) A decrease in rotational speed

Y) An increase in magnetic field strength

Z) A decrease in magnetic field strength

ANSWER: W) AN INCREASE IN ROTATIONAL SPEED

TOSS-UP

22) Math – *Short Answer* What is the mean of the set of integers that are greater than 2 and less than 11?

ANSWER: 13/2 (ACCEPT: 6.5)

BONUS

22) Math – *Short Answer* How many distinct real zeroes does the polynomial $3x^2 - 9x + 6$ have?

ANSWER: 2

TOSS-UP

23) Physics – *Short Answer* A magnet is dropped above a loop of wire such that the north pole of the magnet will fall through first. To an observer above the wire, in what direction is the induced current just before the magnet falls through the loop?

ANSWER: COUNTERCLOCKWISE

BONUS

23) Physics – *Short Answer* A square plane with a side length of 2 meters is within a uniform electric field of 75 N/C. If the electric field goes through the square at a 45 degree angle, what is the electric flux through the square?

ANSWER: $150\sqrt{2}$