SSBT Playoffs Round 3

TOSS UP

1) Chemistry – *Short Answer* What phase of liquid crystal is used in LCD screens?

ANSWER: NEMATIC

BONUS

1) Chemistry – *Short Answer* What word describes organic compounds that have a positive rotation when placed in a polarimeter?

ANSWER: DEXTROROTATORY

TOSS-UP

2) Physics – *Multiple Choice* Which of the following actions would decrease the size of diffraction rings seen around an object in a telescope?

W) Increasing effective focal length

X) Decreasing effective focal length

Y) Increasing diameter

Z) Decreasing diameter

ANSWER: Y) INCREASING DIAMETER

BONUS

2) Physics – *Short Answer* A ball is thrown straight upwards from the surface of the Earth with an initial velocity of 20 m/s. Assuming g is 10 m/s^2 and ignoring air resistance, how far above the ground in meters will the ball be when half of its initial kinetic energy has been converted to potential energy?

ANSWER: 10

TOSS-UP

3) Earth and Space – *Short Answer* What law is used to describe the flow of groundwater through a permeable aquifer?

ANSWER: DARCY'S LAW

BONUS

3) Earth and Space – *Multiple Choice* Which of the following depositional environments does loess form in?

W) Aeolian

X) Deltaic

Y) Fluvial

Z) Lacustrine

ANSWER: W) AEOLIAN

TOSS-UP

4) Math – *Short Answer* What is the slope of the tangent line of $x^2 - 3x + 1$ at $x = 5$?

ANSWER: 7

BONUS

4) Math – *Short Answer* A rectangle with side lengths 8 and 10 is inscribed in a circle. What is the area of the region inside the circle that does not overlap with the rectangle in simplest form?

ANSWER: $41\pi - 80$

TOSS-UP

5) Biology - *Short Answer* Platelets originate when cytoplasmic parts of what bone marrow cells are sent into circulation?

ANSWER: MEGAKARYOCYTES

BONUS

5) Biology - *Short Answer* Order the following layers of the adrenal cortex from exterior to interior. 1) Zona reticularis; 2) Zona glomerulosa; 3) Zona fascicularis.

ANSWER: 2, 3, 1

TOSS-UP

6) Chemistry – *Multiple Choice* Which of the following colors does sodium appear in a flame test?

W) Yellow

X) Red

Y) Lilac

Z) Pale green

ANSWER: W) Yellow

BONUS

6) Chemistry - *Short Answer* What is the molecular geometry of iodine pentafluoride?

ANSWER: SQUARE PYRAMIDAL

TOSS-UP

7) Physics – *Multiple Choice* A horizontal spring with one end attached to an unmoving block is oscillating in simple harmonic motion. At which of the following positions is the acceleration of the spring the greatest in magnitude?

W) The equilibrium point

X) The point of maximum displacement from equilibrium

Y) Between the equilibrium position and the point of maximum displacement

Z) The acceleration is always constant

ANSWER: X) THE POINT OF MAXIMUM DISPLACEMENT FROM EQUILIBRIUM POSITION

BONUS

7) Physics – *Multiple Choice* A biker is biking along an 86 meter track at a constant velocity of 7 m/s and can choose to stay at the same velocity or accelerate at a rate of 2 m/s^2 until the end of the track. If the biker completes this trip in exactly 10 seconds, how many seconds did he bike at a constant velocity before accelerating?

W) 3

X) 5

Y) 6

Z) 8

ANSWER: Z) 6

TOSS-UP

8) Earth and Space – *Short Answer* In a temperate ocean, the highest primary productivity typically occurs during what season?

ANSWER: SPRING

BONUS

8) Earth and Space – *Multiple Choice* Which of the following statements about Earth's inner core is false?

W) It is denser than the outer core

X) It is mostly composed of iron

Y) It contains the fastest seismic wave travel speeds

Z) S waves cannot pass through it

ANSWER: Y) IT CONTAINS THE FASTEST SEISMIC WAVE TRAVEL SPEEDS

TOSS-UP

9) Math – *Short Answer* What is the circumradius of an equilateral triangle with side length 1?

ANSWER: $\sqrt{3}/3$

BONUS

9) Math – *Short Answer* A car is at an intersection traveling towards a different intersection 10 blocks north and 5 blocks east. Assuming every block in the city is identical, how many unique paths can the car take such that they travel the shortest possible distance?

ANSWER: 3003

TOSS-UP

10) Energy – *Multiple Choice* Researchers at Princeton Plasma Physics Lab are developing Hall thrusters, which propel spacecraft by ionizing noble gases and pushing them backwards. These thrusters are useful because they have a high specific impulse, the impulse of a thruster divided by the weight of the fuel. What units is specific impulse measured in?

W) Newtons

X) Newtons per kilogram

Y) Newtons per second

Z) Seconds

ANSWER: Z) Seconds

BONUS

10) Energy – *Short Answer* Researchers at Argonne National Lab are investigating the ways neurons accept signals from the body, especially sensory and motor information, and how they process and merge these signals to send to the rest of the brain. What region of the brain are these researchers studying?

ANSWER: THALAMUS

TOSS-UP

11) Physics — *Short Answer* In meters, what is the wavelength of the first overtone in a closed half pipe with length 2 meters?

ANSWER: 8/3

BONUS

11) Physics – *Short Answer* A 100kg skydiver drops from a stationary helicopter 800 meters above the surface of the Earth. However, the skydiver has forgotten his parachute and arrives at the Earth's surface at a speed of 40 m/s after falling for 1 minute. Assuming g is 10 m/s^2, in Joules, how much work is done on the skydiver by air resistance?

ANSWER: -720000

TOSS-UP

12) Earth and Space – *Multiple Choice* In which of the following Köppen classifications would the strongest weathering occur?

W) A

X) B

Y) C

Z) D

ANSWER: W) A

BONUS

12) Earth and Space – *Short Answer* By name or number, identify all of the following three quantities that are typically higher for a rhyolitic magma than a basaltic magma: 1) Temperature; 2) Gas content; 3) Viscosity.

ANSWER: 2 AND 3

TOSS-UP

13) Math – *Multiple Choice* A triangle has two sides measuring 5 and 19. Which of the following side lengths could NOT be the length of the last side?

W) 15

X) 17

Y) 19

Z) 25

ANSWER: Z) 25

BONUS

13) Math – *Short Answer* An integer is called nice if exactly one of its digits is 6 and exactly one of its digits is 9. How many positive three digit integers are nice?

ANSWER: 46

TOSS-UP

14) Energy – *Short Answer* Researchers at Oak Ridge National Lab are using regional climate modeling to understand the role of topography, especially the Himalayas, in the formation of the Indian Summer Monsoon. What process, in which air is forced to rise and release moisture as it passes over the Himalayas, is primarily responsible for the localized monsoon?

ANSWER: OROGRAPHIC LIFT

BONUS

14) Energy – *Short Answer* Researchers in the Belle II experiment at Pacific Northwest National Lab are using particle accelerators to create B mesons, particles with a bottom antiquark bound to a regular quark. Identify all of the following three quark flavors that would create a charged B meson: 1) Up; 2) Strange; 3) Charm.

ANSWER: 1 AND 3

TOSS-UP

15) Biology - *Short Answer* What process involves the catabolism of long fatty acid chains into small acetyl CoA (coenzyme A) molecules which can then be fed into the citric acid cycle?

ANSWER: BETA OXIDATION (DO NOT ACCEPT: OXIDATION)

BONUS

15) Biology - *Short Answer* What is the name of the three membranous coverings that protects the neural tissues of the central nervous system?

ANSWER: MENINGES

TOSS-UP

16) Chemistry – *Short Answer* The Ka of carboxylic acid is $1x10^{-5}$. If the concentration of the conjugate base is 10 times less than the concentration of carboxylic acid, then what is the pH of the solution?

ANSWER: 4.0

BONUS

16) Chemistry – *Short Answer* Identify all of the following compounds that contain carbons as chiral centers: 1) 2 3-dimethylpentane; 2) 2-butanol; 3) 1-bromo 4-chloro cyclohexane.

ANSWER: ALL

TOSS-UP

17) Physics – *Multiple Choice* A biking man is pulling an upright wheelbarrow up a hill. Assuming that the wheelbarrow rolls without slipping, which of the following best describes the frictional force acting on the wheel of the wheelbarrow?

W) Static friction acting in the uphill direction

X) Static friction acting in the downhill direction

Y) Kinetic friction acting in the uphill direction

Z) Kinetic friction acting in the downhill direction

ANSWER: W) STATIC FRICTION ACTING IN THE UPHILL DIRECTION

BONUS

17) Physics – *Short Answer* Identify all of the 3 following statements that are true about a head-on collision from the center of mass reference frame: 1) The change in momentum is 0; 2) The observed velocities of the colliding bodies are the same; 3) The velocity of an outside observer is constant.

ANSWER: 1 AND 3

TOSS-UP

18) Earth and Space – *Short Answer* When temperatures in clouds reach below freezing in certain conditions, water vapor begins to deposit directly onto existing ice crystals via what process?

ANSWER: BERGERON PROCESS

BONUS

18) Earth and Space – *Short Answer* Southeastern France formerly hosted large bauxite mines. This bauxite formed long ago on top of a heavily leached and eroded limestone layer, which was then covered by another limestone layer as it fell below sea level. What type of unconformity does this sequence represent?

ANSWER: DISCONFORMITY

TOSS-UP

19) Biology - *Short Answer* What is the name of the class of enzymes which catalyze the transfer of an amino acid to the acceptor arm of a tRNA?

ANSWER: AMINOACYL TRNA SYNTHETASE

BONUS

19) Biology - *Short Answer* Many amphibians are characterized by their ability to breathe through both their lungs and through their skin. What are the names of these two types of respiration?

ANSWER: PULMONARY AND CUTANEOUS RESPIRATION

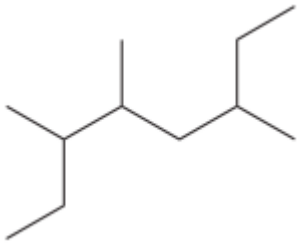
TOSS-UP

20) Chemistry – *Short Answer* Rank the following three ions in increasing ionic radii: 1) F-; 2) Na +; 3) Mg2+.

ANSWER: 3 2 1

VISUAL BONUS

20) Chemistry – *Short Answer* Correctly name the following alkane



image

ANSWER: 3,4,6-TRIMETHYLOCTANE (ACCEPT: 3-methyl,4-methyl,6-methyl octane)

TOSS-UP

21) Math – *Short Answer* An equilateral triangle with side length 4 has the same area as a trapezoid with height 8. What is the sum of the lengths of the two bases of the trapezoid?

ANSWER: $\sqrt{3}$

BONUS

21) Math – *Short Answer* What is the greatest common divisor of 2024 and 1580?

ANSWER: 4

TOSS-UP

22) Energy – *Short Answer* Researchers at Brookhaven National Lab recently discovered a vine with high levels of petroselinic acid, a useful monounsaturated fatty acid with formula $C_{18}H_{34}O_2$. How many double bonds does petroselinic acid contain?

ANSWER: 2

BONUS

22) Energy – *Multiple Choice* Researchers at Pacific Northwest National Lab are searching for Majorana particles in the beta decay of germanium-76. Which of the following best describes what would happen to the neutrinos released if they are Majorana fermions?

W) They would be emitted without absorption
X) They would be emitted, then absorbed
Y) They would immediately produce an antiparticle
Z) They would immediately annihilate

ANSWER: X) THEY WOULD BE EMITTED, THEN ABSORBED

TOSS-UP

23) Biology - *Short Answer* Large doses of ultraviolet radiation are a known carcinogen due to the creation of what irregular structure formed between two adjacent pyrimidines?

ANSWER: THYMINE DIMER (ACCEPT: CYCLOBUTYL RING FORMATION)

BONUS

23) Biology - *Short Answer* What is the name of the insoluble extracellular fibers caused by the misfolding of soluble secretory proteins and is characterized in neurodegenerative diseases such as Huntington's disease and Parkinson's Disease?

ANSWER: AMYLOID FIBRILS