SSBT Playoffs Round 1

TOSS-UP

1) Physics – *Short Answer* What is the ideal mechanical advantage of an inclined plane with an angle of inclination of 30 degrees?

ANSWER: 2

BONUS

1) Physics – *Short Answer* Order the following objects of equal mass and volume in order of increasing times of travel if they are released simultaneously at the top of an inclined plane. 1. Box, 2. Hollow sphere, 3. Hoop

ANSWER: 1, 2, 3 (ACCEPT: BOX, HOLLOW SPHERE, HOOP)

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TOSS-UP

2) Chemistry – *Multiple Choice* Which of the following is the modern industrial method of producing sulfuric acid from sulfur dioxide?

W) Contact process
X) Mond process
Y) Hall-Herault process
Z) Bessemer process

ANSWER: W) CONTACT PROCESS

BONUS

2) Chemistry – *Short Answer* What effect can be used to describe the decreased solubility of Lead (II) chloride upon reaction with sodium chloride?

ANSWER: COMMON ION EFFECT
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TOSS-UP

3) Energy – *Short Answer* Researchers at Pacific Northwest National Lab are studying peroxisome beta-oxidation. What enzyme in peroxisomes is involved in most of the conversion of hydrogen peroxide to water and oxygen?

ANSWER: CATALASE

BONUS

3) Energy – *Short Answer* Researchers working at Fermi National Lab are studying the formation and evolution of low-mass and early-born stars. Order the following three stages in a star's formation in order. 1. T Tauri star, 2. Hayashi Track, 3. Henyey Track

ANSWER: 1, 2, 3 (ACCEPT: T TAURI STAR, HAYASHI TRACK, HENYEY TRACK)

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TOSS-UP

4) Earth and Space – *Multiple Choice* Which of the following metamorphic facies are formed at the highest pressure and temperature?

W) Blueschist
X) Hornfels
Y) Zeolite
Z) Eclogite

ANSWER: Z) ECLOGITE

BONUS

4) Earth and Space – *Short Answer* A star has a parallax angle of 0.25 arcseconds. Expressing your answer to the nearest lightyear, what is the distance to the star?

ANSWER: 13 LIGHTYEARS
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TOSS-UP

5) Math – *Multiple Choice* Which of the following is closest to the number of trailing zeroes at the end of the expansion of 420! **[read as: four-hundred-and-twenty factorial]**?

W) 80
X) 90
Y) 100
Z) 110

ANSWER: Y) 100

BONUS

5) Math – *Short Answer* A 4x4 grid has the same sum for its rows and columns. The numbers from -5 to 10 are plotted on this graph, so that it satisfies the previous condition. What is the sum of one of the grid's columns and one of the rows?

ANSWER: 20

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TOSS-UP

6) Chemistry – *Short Answer* The total enthalpy change of a reaction being independent of the sequence of steps taken is formulated from what law?

ANSWER: HESS'S LAW

BONUS

6) Chemistry – *Short Answer* To the nearest degree Celsius, what is the boiling point of a 10-molal solution of urea in water?

ANSWER: 105
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TOSS-UP

7) Physics – *Short Answer* A theory based on an object controlling a door between two chambers of gas could theoretically violate the second law of thermodynamics. What is the name of this thought experiment?

ANSWER: MAXWELL'S DEMON

BONUS

7) Physics – *Multiple Choice* Which of the following is closest to the amount that a 500 meter aluminum bridge will expand by if the temperature increases by 5 degrees Celsius, given that the thermal coefficient of expansion for aluminum is 10^{-5} per degree Celsius?

W) 0.25 centimeters
X) 0.5 centimeters
Y) 2.5 centimeters
Z) 5 centimeters

ANSWER: Y) 2.5 CENTIMETERS

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TOSS-UP

8) Biology – *Multiple Choice* In development, which of the following organisms lacks a medusa stage?

W) Sea nettle
X) Sea anemone
Y) True jellyfish
Z) Box jellyfish

ANSWER: X) SEA ANEMONE

BONUS

8) Biology – *Short Answer* Order the following three types of plant ground tissue in terms of increasing cell wall thickness. 1. Collenchyma, 2. Parenchyma, 3. Sclerenchyma

ANSWER: 2, 1, 3 (ACCEPT: PARENCHYMA, COLLENCHYMA, SCLERENCHYMA)
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TOSS-UP

9) Earth and Space – *Short Answer* Order the following three minerals in order of increasing number of cleavage planes. 1. Chlorite, 2. Fluorite, 3. Sphalerite

ANSWER: 1, 2, 3 (ACCEPT: CHLORITE, FLUORITE, SPHALERITE)

BONUS

9) Earth and Space – *Multiple Choice* When chemically weathered, which of the following minerals would most likely form kaolinite?

W) Olivine
X) Iron oxides
Y) Muscovite
Z) Anorthite

ANSWER: Z) ANORTHITE

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TOSS-UP

10) Math – *Multiple Choice* Which of the following base 5 numbers is a perfect square in base 10?

W) 11
X) 12
Y) 13
Z) 14

ANSWER: Z) 14

BONUS

10) Math – *Short Answer* Angle A is one of the non-right angles in a right triangle. If angle A has a cosine of 5/12, then as a fraction, what is the value of the tangent of the other non-right angle?

ANSWER: 5√119/119

11) Physics – *Short Answer* Order the following three fundamental forces in order of increasing strength. 1. Electromagnetic force, 2. Gravity, 3. Weak force
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TOSS-UP

ANSWER: 2, 3, 1 (ACCEPT: GRAVITY, WEAK FORCE, ELECTROMAGNETIC FORCE)

BONUS

11) Physics – *Short Answer* If water flows through a cylindrical pipe with a radius of 2 centimeters at a speed of 10 meters per second, then to two significant figures and in meters per second, how fast would the water flow if the pipe was enlarged to a radius of 3 centimeters?

ANSWER: 4.4

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TOSS-UP

12) Energy – *Multiple Choice* Towards the polar regions of Mars, NASA scientists have found erosion-carved troughs resembling spiders. These troughs were carved from the thawing of what substance?

W) Methane
X) Water
Y) Carbon dioxide
Z) Ammonia

ANSWER: Y) CARBON DIOXIDE

BONUS

12) Energy – *Short Answer* Scientists at Argonne Lab are studying exceptions in Chargaff's rules. If an ideal sample has 29% adenine bases, what percent of the sample consists of pyrimidines?

ANSWER: 50%
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TOSS-UP

13) Biology – *Multiple Choice* If the birth weight of a human is too low, it will have difficulty surviving after birth, and if it is too high, it would create complications in the birth process. Human birth weight is a trait that resulted from what type of selection?

W) Directional
X) Diversifying
Y) Stabilizing
Z) Sexual

ANSWER: Y) STABILIZING

BONUS

13) Biology – *Short Answer* Identify all of the following statements that are true regarding gram-positive bacteria. 1. They stain pink on the Gram stain, 2. They contain lipopolysaccharides, 3. They contain teichoic acids

ANSWER: 3 ONLY

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TOSS-UP

14) Earth and Space – *Multiple Choice* Stellar isochrones on a Hertzprung-Russel diagram represent a population of stars with a similar value of what property?

W) Metallicity
X) Age
Y) Temperature
Z) Luminosity

ANSWER: X) AGE

BONUS

14) Earth and Space – *Short Answer* Identify all of the following statements that are FALSE about cumulonimbus clouds. 1. Their anvil tops are positively charged, 2. Their cumulus stage has updrafts stronger than downdrafts, 3. They can form along squall lines

ANSWER: NONE

15) Math – *Short Answer* Assuming that rotations are indistinguishable, how many ways are there to arrange 5 friends at a circular table, assuming that Tony does not want to sit with Armann?
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TOSS-UP

ANSWER: 12

BONUS

15) Math – *Short Answer* Identify all of the following four points that can not lie outside a triangle. 1. Orthocenter, 2. Incenter, 3. Centroid 4. Circumcenter

ANSWER: 2 AND 3 (ACCEPT: INCENTER AND CENTROID)

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TOSS-UP

16) Chemistry – *Multiple Choice* For gases, which of the following pairs of variables are not inversely proportional to one another?

W) Pressure and volume
X) Root-mean square velocity and molar mass
Y) Strength of intermolecular forces and temperature
Z) Temperature and entropy

ANSWER: Z) TEMPERATURE AND ENTROPY

BONUS

16) Chemistry – *Short Answer* Consider the reaction in the Haber-Bosch process, $N_2 + 3H_2 \rightarrow 2NH_3$ **[read as: N two plus three H two yields two N H three]**. Identify all of the following three changes that would shift the reaction to the right. 1. Addition of NH_3, 2. Increase in pressure, 3. Increase in temperature

ANSWER: 2 ONLY (ACCEPT: INCREASE IN PRESSURE)
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TOSS-UP

17) Energy – *Short Answer* Scientists at Brookhaven National Lab are studying complexes made by copper (II). These complexes adopt what six-ligand defining geometry, also exemplified by sulfur hexafluoride?

ANSWER: OCTAHEDRAL

BONUS

17) Energy – *Multiple Choice* Scientists at Sandia National Labs are studying protein denaturation. A protein will most likely be denatured if it is transferred from an aqueous solution to which of the following solvents?

W) Ethanol
X) Acetone
Y) DMSO
Z) Chloroform

ANSWER: Z) CHLOROFORM

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TOSS-UP

18) Biology – *Short Answer* What structure, mostly composed of intermediate filaments surrounds the nuclear envelope and provides structure for the nucleus?

ANSWER: NUCLEAR LAMINA (ACCEPT: LAMINA)

BONUS

18) Biology – *Multiple Choice* Which of the following is not true regarding the SA node?

W) It is located in the right atrium of the heart
X) Purkinje fibers initiate action potentials slower than the SA node
Y) It has the greatest automaticity in the heart
Z) The AV node sends a signal to the SA node to contract

ANSWER: Z) THE AV NODE SENDS A SIGNAL TO THE SA NODE TO CONTRACT
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TOSS-UP

19) Earth and Space – *Short Answer* W Virginis, RR Lyrae, and Cepheid stars all lie in what region of the Hertzprung-Russel diagram?

ANSWER: INSTABILITY STRIP

BONUS

19) Earth and Space – *Multiple Choice* Which of the following is the reason why most of the Earth's greatest deserts are located near 30 degrees north and south latitude?

W) Air is sinking and surface air pressure at those latitudes is high
X) Air is rising and surface air pressure at those latitudes is high
Y) Air is sinking and rising air pressure at those latitudes is low
Z) Air is rising and rising air pressure at those latitudes is low

ANSWER: W) AIR IS SINKING AND SURFACE AIR PRESSURE AT THOSE LATITUDES IS HIGH

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TOSS-UP

20) Math – *Multiple Choice* Which of the following is a property of the number of factors of any perfect square greater than 17 squared?

W) Odd
X) Multiple of 3
Y) Multiple of 17
Z) Multiple of a perfect cube

ANSWER: W) ODD

BONUS

20) Math – *Short Answer* How many perfect cube divisors does 12^{22} **[read as: twelve to the power of twenty-two]** have?

ANSWER: 120
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TOSS-UP

21) Physics – *Multiple Choice* Which of the following laws disproves the existence of magnetic monopoles?

W) Gauss's law of electricity
X) Gauss's law of magnetism
Y) Ampere's law
Z) Lenz's law

ANSWER: X) GAUSS'S LAW OF MAGNETISM

BONUS

21) Physics – *Short Answer* Identify all of the following three particles that would violate the Pauli Exclusion Principle. 1. Photon, 2. Electron, 3. Tauon

ANSWER: 1 ONLY (ACCEPT: PHOTON)

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TOSS-UP

22) Chemistry – *Multiple Choice* Which of the following ions has the smallest radius?

W) Mg^{2+}
X) F^{-}
Y) O^{2-}
Z) Al^{3+}

ANSWER: Z) Al^{3+}

BONUS

22) Chemistry – *Short Answer* Order the following three compounds in order of decreasing ring strain. 1. Cyclobutane, 2. Cyclohexane, 3. Cyclopropane

ANSWER: 3, 1, 2 (ACCEPT: CYCLOPROPANE, CYCLOBUTANE, CYCLOHEXANE)
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TOSS-UP

23) Biology – *Short Answer* Alzheimer's disease is mainly caused by the buildup of beta-amyloid plaques and what other general class of proteins?

ANSWER: TAU PROTEINS

BONUS

23) Biology – *Short Answer* Identify all of the following statements that are true regarding DNA replication in E. Coli. 1. It uses DNA Polymerase III, 2. It is semiconservative, 3. DNA gyrase is required

ANSWER: ALL