**SSBT Playoffs Round 3**

---

**TOSS-UP**

1) Biology- *Short Answer* What prolonged process develops mature eggs in female ovaries?

ANSWER: OOGENESIS

**BONUS**

1) Biology - *Short Answer* What non-coding RNA is crucial in preventing transposons from being incorporated into the genome while also being involved in the formation of heterochromatin?

ANSWER: piRNA (ACCEPT: PIWI-INTERACTING RNA)

**TOSS-UP**

2) Earth and Space – *Short Answer* What compound are the clouds of Neptune and Uranus primarily composed of?

ANSWER: METHANE

**BONUS**

2) Earth and Space – *Short Answer* In the Milky Way, the central bar tends to appear yellow, while the outer arms appear blue. This is because while the arms actively form stars, the central bar contains what older stellar population?

ANSWER: POPULATION II

**TOSS UP**

3) Chemistry – *Multiple Choice* Which of the following compounds has the highest mass percent of oxygen?

W) Silver nitrate

X) Cesium hypochlorite

Y) Sodium carbonate

Z) Zinc sulfate

ANSWER: Y) SODIUM CARBONATE

**BONUS**

3) Chemistry - *Short Answer* What is the name of the reaction between an acyclic diene and an alkene which can form a cyclohexene ring?

ANSWER: DIELS-ALDER REACTION

**TOSS-UP**

4) Math – *Short Answer* What is the 69th term in the arithmetic sequence with first term 6 and second term 4?

ANSWER: -130

**BONUS**

4) Math – *Short Answer* A bike dealer currently sells bikes at a price of 130 dollars per bike and has 18 customers a month. If the bike dealer loses a customer for every 5 dollar increase in bike price and gains a customer for every 5 dollar decrease in bike price, what is the maximum possible monthly revenue in dollars?

ANSWER: 2420

**TOSS-UP**

5) Energy – *Short Answer* Researchers at Pacific Northwest National Lab are studying how changes in the water level of a river affect groundwater. What term is given to the process by which surface water moves through the surface to become groundwater?

ANSWER: INFILTRATION

**BONUS**

5) Energy – *Short Answer* Researchers at Oak Ridge National Lab are developing ways to synthesize polymorphs of silicon carbide, a useful semiconductor. However, recent research suggests that its properties depend more on the dopant added than the polymorph used, since different dopants replace different atoms. Identify all of the following three elements that would replace silicon when added to silicon carbide: 1) Nitrogen; 2) Aluminum; 3) Phosphorus.

ANSWER: 2 AND 3

**TOSS-UP**

6) Physics – *Short Answer* A man bikes for 5 minutes at a constant velocity of 10 m/s on a level surface. Assuming that the bicycle wheels do not slip, how many total radians has one wheel turned if it has a radius of 0.25 meters?

ANSWER: 12000

**BONUS**

6) Physics – *Short Answer* A man rolls a 4 kg bowling ball down a level bowling lane without slipping with an initial velocity 4 m/s and a constant acceleration of 2 $m/s^2$ until it collides with the pins after three seconds. Assuming that the ball rolls without sliding and is perfectly spherical with a radius 10 cm, what is the rotational kinetic energy of the ball in Joules right before it collides with the pins?

ANSWER: 80

**TOSS-UP**

7) Biology – *Short Answer* What is the name of the short untranslated sequence of ribonucleotides found in mRNA to help align the mRNA to the ribosome to initiate translation in bacteria?

ANSWER: SHINE-DALGARNO SEQUENCE

**BONUS**

7) Biology – *Short Answer* Identify all of the following three statements that are NOT true about thyroid hormones: 1) T4 can be interconverted into T3 via enzymes known as deiodinases; 2) T4

is found in a higher concentration in the circulatory system than T3; 3) T3 and T4 are both involved with releasing carbohydrates and lipids into the bloodstream

ANSWER: NONE

**TOSS-UP**

8) Earth and Space – *Short Answer* What is the name of the mechanism where water seeps into a rock's cracks and subsequently enlarges them by freezing into ice?

ANSWER: FROST WEDGING

**BONUS**

8) Earth and Space – *Short Answer* A gas giant orbits around a 2.0 solar mass star with a semi-major axis of 2 AU and a period of 4 years. To the nearest year, what would the period be if the gas giant had a semi-major axis of 4 AU?

ANSWER: 11

**TOSS-UP**

9) Chemistry - *Short Answer* Identify all of the following three combinations of primary, azimuthal, and magnetic quantum numbers of electrons that are possible in the electrons of a selenium atom: 1) 4, 4, -2; 2) 3, 2, 1; 3) 3, 2, -3

ANSWER: 2 ONLY

**BONUS**

9) Chemistry- *Short Answer* 0.5 M of aqueous silver nitrate and 0.45 M of aqueous potassium fluoride react to form 0.75 M of aqueous potassium nitrate and 0.20 M of silver fluoride. Assuming all external properties are constant, to two significant figures, what is the equilibrium constant of this reaction?

ANSWER: 0.67

**TOSS-UP**

10) Math – *Short Answer* What is the area of an ellipse with semi-major axis 5 and semi-minor axis 3?

ANSWER: 15π

**BONUS**

10) Math – *Short Answer* What is the simplified value of the complex expression $(4 - 4i)^4$?

ANSWER: -1024

**TOSS-UP**

11) Energy – *Short Answer* Researchers at the Critical Materials Institute are using organisms to extract metals from ores in order to promote recycling of rare elements. What name is given to the process they are using?

ANSWER: BIOLEACHING

**BONUS**

11) Energy – *Short Answer* Researchers at Argonne National Lab are studying dye-sensitized solar cells as a potential alternative to silicon cells. In these solar cells, dye is added to titanium dioxide in order to reduce what quantity, which is represented by the energy difference between the valence shell and the conduction band?

ANSWER: BAND GAP

**TOSS-UP**

12) Physics – *Short Answer* A 12 amp current is running through a circuit with three resistors connected in parallel with $R_1 = 2$ ohms, $R_2 = 5$ ohms, and $R_3 = 1$ ohms. In amps, what is the current passing through $R_3$?

ANSWER: 120/17

**BONUS**

12) Physics – *Short Answer* A cylindrical container with a hole at its bottom is half-filled with honey. If an identical container is taken to the Moon with gravitational acceleration g/6 and

honey is added until it reaches the brim, by what factor will the speed of the honey leaving through the hole be multiplied?

ANSWER: √3/3

**TOSSUP**

13) Biology - *Short Answer* What hormone, released by the posterior pituitary gland, stimulates smooth muscle contraction in the breast to release milk during lactation?

ANSWER: OXYTOCIN (DO NOT ACCEPT: VASOPRESSIN)

**BONUS**

13) Biology - *Short Answer* What is the name of parasitic plants' modified roots that allow them to penetrate the host plant?

ANSWER: HAUSTORIA

**TOSS-UP**

14) Earth and Space – *Short Answer* What name is given to the thick, stable blocks of Precambrian crust with little tectonic activity located inside large tectonic plates?

ANSWER: CRATONS

**BONUS**

14) Earth and Space – *Multiple Choice* A geologist investigates a batholith and notices that it contains several mantle xenoliths. Which of the following minerals would most likely be dominant in these xenoliths?

W) Potassium feldspar

X) Plagioclase feldspar

Y) Olivine

Z) Quartz

ANSWER: Y) OLIVINE

**TOSS-UP**

15) Chemistry – *Multiple Choice* Which of the following compounds is NOT soluble in water?

W) Lithium chloride

X) Lead (II) nitrate

Y) Iron (II) hydroxide

Z) Barium nitrate

ANSWER: Y) IRON (II) HYDROXIDE

**BONUS**

15) Chemistry- *Short Answer* Identify all of the following three statements that are true regarding the functional groups of hydrocarbon derivatives: 1) Ketones contain carbonyl groups bound to one carbon atom; 2) Free amino acids contain secondary amines at their nitrogenous end; 3) Ester linkages can be formed between carboxylic acids and alcohols.

ANSWER: 3 ONLY

**TOSS-UP**

16) Math – *Short Answer* A horse walks into a bar with 21 people inside. What is the average number of legs per organism in the bar after the horse enters?

ANSWER: 23/11

**BONUS**

16) Math – *Short Answer* What is the inradius of a triangle with side lengths 3, 4, and 5?

ANSWER: 1

**TOSS-UP**

17) Energy – *Multiple Choice* Researchers at Oak Ridge National Lab are currently developing new nuclear reactors that produce fissile uranium-233 from the naturally abundant thorium-232. The first step of this process involves neutron radiative capture, where a nucleus captures an extra neutron and emits which of the following particles?

W) Photon

X) Electron

Y) Neutrino

Z) Antineutrino

ANSWER: W) PHOTON

**BONUS**

17) Energy – *Short Answer* Researchers at Oak Ridge National Lab are building actuators using materials that naturally convert applied electric fields to mechanical stress via what effect?

ANSWER: PIEZOELECTRIC EFFECT

**TOSS-UP**

18) Physics – *Multiple Choice* In which of the following materials does sound travel fastest in?

W) Steel

X) Wood

Y) Glass

Z) Water

ANSWER: W) STEEL

**BONUS**

18) Physics – *Short Answer* Bosons that can be twisted to form fermions are known as what?

ANSWER: SKYRMIONS

**TOSS-UP**

19) Biology – *Multiple Choice* Which of the following parts of the nephron lacks aquaporins?

W) Proximal convoluted tubule

X) Distal convoluted tubule

Y) Descending loop of Henle

Z) Ascending loop of Henle

ANSWER: Z) ASCENDING LOOP OF HENLE

**BONUS**

19) Biology – *Short Answer* In the testes, sperm is produced in highly coiled tubes known as what?

ANSWER: SEMINIFEROUS TUBULES

**TOSS-UP**

20) Earth and Space – *Multiple Choice* An astronomer observes a star with a light curve that appears mostly flat with large, regular spikes approximately once a second. Which of the following astronomical bodies are they most likely observing?

W) Pulsar

X) Magnetar

Y) T Tauri star

Z) RR Lyrae variable

ANSWER: W) PULSAR

**BONUS**

20) Earth and Space - *Multiple Choice* Research suggests that the cosmic microwave background was created when the universe had an average temperature of 3,000 Kelvin. Which of the following is closest to the redshift of this background?

W) 10

X) 100

Y) 1,000

Z) 10,000

ANSWER: Y) 1,000

**TOSSUP**

21) Chemistry- *Short Answer* Order the following three molecules in terms of increasing boiling point: 1) Methyl iodide; 2) Dimethyl ether; 3) Methylamine.

ANSWER: 2, 3, 1

**VISUAL BONUS**

21) Chemistry – *Short Answer* Without stereo configuration, name the pictured compound using standard IUPAC nomenclature.

Image

ANSWER: 3-CHLORO-4-METHYL-2-PENTENE (ACCEPT: 3-CHLORO-4-METHYLPENT-2-ENE)

**TOSS-UP**

22) Math – *Short Answer* How many sides does a regular polygon with interior angles measuring 177 degrees have?

ANSWER: 120

**BONUS**

22) Math – *Short Answer* John wants to split his candies among his genderfluid homeboys. If he splits his candies into 2 groups, 1 is left over. If he splits his candies into 3 groups, 2 are left over. If he splits his candies into 7 groups, 3 are left over. What is the minimum possible number of candies that John has?

ANSWER: 17

**TOSS-UP**

23) Physics – *Short Answer* Identify all of the following three forces that are conservative: 1) Friction; 2) Spring force; 3) Gravitational force.

ANSWER: 2 AND 3

**BONUS**

23) Physics – *Short Answer* A 2 coulomb charge, restricted to move along the axial direction, is located 20 meters from a dipole of comparatively small length. If the charge was moved to 60 meters from the dipole, by what factor does the electric field at the location of the charge get multiplied by?

ANSWER: 1/27