SSBT Playoffs Round 2

TOSS-UP

1) Biology – *Short Answer* Viruses which coexist with their host cells and utilize their cellular mechanisms to produce proteins and replicate genetic material are known to be in what replicative cycle?

ANSWER: LYSOGENIC (DO NOT ACCEPT: LYTIC)

BONUS

1) Biology – *Short Answer* Identify all of the following three actions that occur as a result of a high cortisol concentration in blood plasma: 1) Uptake of amino acids by the liver for gluconeogenesis; 2) Inhibition of inflammation and immune response; 3) Decreased blood pressure

ANSWER: 1 AND 2

TOSS-UP

2) Physics – *Short Answer* A massless string is attached to the ceiling with its other end attached to a ball with mass 5 kg. Assuming gravity is 10 m/s^2, if the ball is moving in uniform circular motion with the string forming an angle of 60 degrees to the vertical, what is the magnitude of the centripetal force on the ball in Newtons?

ANSWER: $50\sqrt{3}$

BONUS

2) Physics – *Short Answer* A person stands still on an escalator moving upwards at a constant speed. Identify all of the following three forces that are doing work on this person: 1) Gravity; 2) Normal force; 3) Friction.

ANSWER: 1 AND 2

TOSS-UP

3) Earth and Space – *Multiple Choice* Which of the following best describes the effect of a volcanic eruption on climate?

W) Short and long-term warming

X) Short and long-term cooling

Y) Short-term warming and long-term cooling

Z) Short-term cooling and long-term warming

ANSWER: Z) SHORT-TERM COOLING AND LONG-TERM WARMING

BONUS

3) Earth and Space – *Multiple Choice* Which of the following ocean floor features would most likely be associated with an atoll?

W) Mid-ocean ridge

X) Hydrothermal vent

Y) Continental shelf

Z) Guyot

ANSWER: Z) GUYOT

TOSS-UP

4) Math – *Multiple Choice* Which of the following convex polygons does not have an even number of diagonals?

W) Equilateral triangle

X) Square

Y) Regular octagon

Z) Regular decagon

ANSWER: Z) REGULAR DECAGON

BONUS

4) Math – *Short Answer* What is the tens digit of 7^{100}?

ANSWER: 0

TOSS UP

5) Chemistry – *Short Answer* Order the following three allotropes of phosphorus in terms of increasing reactivity: 1) Red; 2) White; 3) Black.

ANSWER: 2, 1, 3

BONUS

5) Chemistry – *Short Answer* A compound is determined to be 90% carbon and 10% hydrogen by mass. If the molar masses of carbon and hydrogen are assumed to be 12 and 1 grams per mole respectively, what is the empirical formula of the compound?

ANSWER: C_3H_4

TOSS-UP

6) Energy – *Multiple Choice* The DUNE experiment at Fermilab is searching for signals of proton decay in order to learn about the unification of fundamental forces. During the grand unification epoch of the early universe, all except which of these forces were merged into a single force?

W) Gravity

X) Electromagnetic

Y) Strong interaction

Z) Weak interaction

ANSWER: W) GRAVITY

BONUS

6) Energy – *Short Answer* Researchers at Argonne National Lab are studying the Drell-Yan process in protons. In this process, a quark and antiquark annihilate to create a virtual photon, which then forms a muon and an antimuon via what process?

ANSWER: PAIR PRODUCTION

TOSS-UP

7) Biology - *Short Answer* Assume that a certain plant has 1000 calories of energy stored in its body. Approximately how many of this plant's calories will a secondary consumer obtain?

ANSWER: 10

BONUS

7) Biology - *Multiple Choice* Histones are proteins which attach to DNA to form the chromatin found inside the nucleus. Which of the following amino acids would you expect to find in the histone's primary structure that interacts with the sugar-phosphate backbone of DNA?

W) Glycine

X) Glutamate

Y) Proline

Z) Lysine

ANSWER: Z) LYSINE

TOSS-UP

8) Physics – *Short Answer* An optical telescope with an objective lens focal length of 5 cm and an eyepiece lens of focal length 2 cm are arranged in series. If light is observed from a distant source, what is the maximum magnification of the telescope?

ANSWER: 5/2

BONUS

8) Physics – *Multiple Choice* A 10 kilogram satellite 300 km away from a planet's surface has a circular orbit with an orbital period of 1 hour. Which of the following is closest to the magnitude of the gravitational force between the planet and the satellite in Newtons?

W) 1

X) 100

Y) 750

Z) 2000

ANSWER: W) 1

TOSSUP

9) Earth and Space - *Short Answer* An oceanographer notices that while the wind is blowing due north, the surface current moves northeast, and the subsurface currents blow almost directly east. What type of transport is this movement an example of?

ANSWER: EKMAN TRANSPORT

BONUS

9) Earth and Space - *Short Answer* By name or number, identify all of the following three changes that would slow down an earthquake wave: 1) Increase in temperature; 2) Increase in density; 3) Increase in rigidity.

ANSWER: 1 AND 2

TOSS-UP

10) Math – *Short Answer* How many edges does a polyhedron with 8 faces and 6 vertices have?

ANSWER: 12

BONUS

10) Math – *Short Answer* How many integer values of x satisfy $|x^2 - 6| < 10$ (the absolute value of x squared minus six is less than 10)?

ANSWER: 7

TOSS UP

11) Chemistry – *Short Answer* What is the formal charge on the carbon atom in carbon tetrachloride?

ANSWER: 0

BONUS

11) Chemistry – *Multiple Choice* Which of the following is not true of thermotropic liquid crystals?

W) They are used in LCD displays

X) They are the type of liquid crystals that compose cell membranes

Y) They are produced by slowly heating or cooling a solid or liquid

Z) As temperature changes, the phase also changes

ANSWER: X) THEY ARE THE TYPE OF LIQUID CRYSTALS THAT COMPOSE CELL MEMBRANES

TOSS-UP

12) Energy – *Multiple Choice* Researchers at Lawrence Livermore National Lab recently used high-performance supercomputing to model the binding of antibodies onto SARS-CoV-2. Which of the following types of antibodies is primarily responsible for this binding?

W) IgA

X) IgE

Y) IgG

Z) IgM

ANSWER: Y) IgG

BONUS

12) Energy – *Short Answer* Researchers at the National Renewable Energy Lab are working to create single-walled carbon nanotubes, which are formed from a sheet of carbon with a hexagonal pattern. What is the hybridization of each of the carbon atoms in these nanotubes?

ANSWER: sp^2

TOSS-UP

13) Biology – *Short Answer* During glycolysis, dihydroxyacetone phosphate ***[dy-hy-DROX-ee-ass-uh-tone FOS-fate]*** undergoes isomerization into what 3 carbon sugar, that is also a product of the Calvin-Benson Cycle?

ANSWER: G3P (ACCEPT: GLYCERALDEHYDE-3-PHOSPHATE)

BONUS

13) Biology - *Short Answer* What is the name of the viral immune response system in bacteria which involves a RNA-protein complex that binds to complementary DNA incorporated into the cell's genome by a virus and degrades it?

ANSWER: CRISPR-CAS System

TOSS-UP

14) Physics – *Short Answer* In microfarads, what is the equivalent capacitance of 3 capacitors connected in series with capacitances of 2 μF ***[micro-farads]***, 3 μF, and 5 μF respectively?

ANSWER: 30/31

BONUS

14) Physics – *Short Answer* A 12-V power source and three resistors are connected in series with $R_1 = 7$ ohms, $R_2 = 4$ ohms, and $R_3 = 5$ ohms. In volts, what is the voltage drop across R_2?

ANSWER: 3

TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following structures is not found in active galactic nuclei?

W) Herbig-Haro objects

X) Relativistic jets

Y) Accretion disks

Z) Opaque torus

ANSWER: W) HERBIG-HARO OBJECTS

BONUS

15) Earth and Space – *Multiple Choice* Which of the following is not true of quasars?

W) Quasars are usually radio-loud

X) Quasars with relativistic jets directed at the Earth are called blazars

Y) The brightness of quasars is due to gas and dust falling into the black hole

Z) Quasars are thought to be more common billions of years ago

ANSWER: W) QUASARS ARE USUALLY RADIO-LOUD

TOSS-UP

16) Math – *Short Answer* A man has 5 different colors of socks. If he randomly draws out individual socks, what is the least number of socks he must draw to guarantee that he draws 2 pairs of same colored socks?

ANSWER: 8

BONUS

16) Math – *Short Answer* A ball pit starts with the same number of blue, red, green, and yellow balls. After a month, the ball pit is missing no blue balls, 5 red balls, 14 green balls, and 10 yellow balls. If there are now 3 times as many blue balls as green balls, how many total balls did the ball pit end with?

ANSWER: 55

TOSS-UP

17) Chemistry - *Short Answer* What process occurs when a liquid does not form a solid as it is cooled past its freezing point?

ANSWER: SUPERCOOLING

BONUS

17) Chemistry – *Multiple Choice* Which of the following allotropes forms when tin is cooled below 13.2°C, in a process commonly known as tin pest?

W) White tin

X) Brown tin

Y) Gray tin

Z) Black tin

ANSWER: Y) GRAY TIN

TOSS-UP

18) Energy – *Short Answer* Researchers at Brookhaven National Lab are using the Relativistic Heavy Ion Collider to study color confinement. Identify all of the following three particles that are subject to color confinement: 1) Quarks; 2) Gluons; 3) Electrons.

ANSWER: 1 AND 2

BONUS

18) Energy – *Multiple Choice* Researchers at Thomas Jefferson National Accelerator Facility recently discovered that allowing oxygen to diffuse interstitially through the metal of a particle accelerator improves its efficiency. Which of the following metals would likely allow the most diffusion of oxygen?

W) Aluminum

X) Iron

Y) Niobium

Z) Cadmium

ANSWER: Y) NIOBIUM

TOSS-UP

19) Biology – *Short Answer* When female mammals inactivate one of their X chromosomes, it subsequently forms what highly condensed heterochromatin structure?

ANSWER: BARR BODY

BONUS

19) Biology – *Multiple Choice* The heart, trachea, and esophagus are all housed in which of the following regions of the body?

W) Corpus callosum

X) Mediastinum ***[mee-dee-uh-STY-num]***

Y) Foramen magnum

Z) Abdominal fissure

ANSWER: X) MEDIASTINUM

TOSS-UP

20) Physics – *Short Answer* A block with mass 8 kg is sliding across ice at 6 m/s when it bumps into a 4kg block at rest, resulting in a completely inelastic collision. In meters per second, what is the velocity of both blocks after the collision, assuming there is no friction?

ANSWER: 4

BONUS

20) Physics – *Short Answer* How much work, in joules, is necessary to stretch a string from rest with spring constant 200 N/m a distance of 5 meters?

ANSWER: 2500

TOSS-UP

21) Earth and Space – *Short Answer* The absence of what common element differentiates a Type II Supernova from a Type I Supernova?

ANSWER: HYDROGEN

BONUS

21) Earth and Space – *Short Answer* Despite a temperature below -50ºC, the underwater ocean of Titan is thought to remain liquid due to the presence of what compound?

W) Carbon dioxide

X) Nitrous oxide

Y) Sulfur dioxide

Z) Ammonia

ANSWER: Z) AMMONIA

TOSS-UP

22) Math – *Short Answer* How many terms are in the simplified expansion of $(x + y)^{200}$?

ANSWER: 201

BONUS

22) Math – *Short Answer* What is the sum of all 5-digit numbers in the form of 1357X that are divisible by 6, where X can be any digit?

ANSWER: 27150

TOSS-UP

23) Chemistry – *Short Answer* To two significant figures, how many times larger is the rate of effusion of diatomic oxygen than sulfur dioxide?

ANSWER: 1.4

BONUS

23) Chemistry – *Short Answer* Identify all of the following three statements that are correct regarding the kinetic molecular theory of ideal gasses: 1) The volume of individual particles is assumed to be negligible; 2) Particles interact with one another; 3) Particles exert attractive forces on each other during collisions.

ANSWER: 1 AND 2