SSBT FINALS 2

TOSS-UP

1) Chemistry - *Short Answer* Rank the following three bonds by increasing bond dissociation energy; 1) Oxygen sp2 bonded to hydrogen; 2) Carbon sp2 bonded to Hydrogen; 3) Carbon sp bonded to Hydrogen;

ANSWER: 2, 3, 1

BONUS

1) Chemistry- *Short Answer* Identify all of the following three reactions that proceed via a carbon anion intermediate? 1) Williamson's ether synthesis; 2) E2 substitution; 3) Oxymercuration-Demercuration

ANSWER: NONE

TOSS-UP

2) Math – *Short Answer* A ball is dropped from 81 meters above the ground such that it bounces to ⅔ its height every time. What value does the distance traveled downward by the ball approach?

ANSWER: 135

BONUS

2) Math – *Short Answer* An equilateral triangle with side length 6 is formed from the vertices of a regular hexagon. What is the area of the hexagon?

ANSWER: 18sqrt3

TOSS-UP

3) Earth and Space – *Short Answer* Identify all of the following three Lagrangian (luh - grahn - geean) points that are considered stable: 1) L1; 2) L2; 3) L3.

ANSWER: NONE

BONUS

3) Earth and Space – *Short Answer* The hardness of a water sample is determined by measuring the molar concentrations of what two ions?

ANSWER: Mg2+ AND Ca2+ (IN ANY ORDER; ACCEPT: MAGNESIUM AND CALCIUM)

TOSS-UP

4) Biology - *Short Answer* Dr. Euler is currently studying the effects of increasing the concentration of colony-stimulating factors, known as CSFs, a group of compounds known to stimulate progenitor cells. Identify all of the following 3 groups of cells which would be primarily affected by increased levels of CSFs. 1) Granulocytes; 2) Monocytes; 3) Leukocytes.

ANSWER: 1 AND 2

BONUS

4) Biology - *Short Answer* Identify all of the following three statements that are correct regarding RNA metabolism.
I) snoRNPs catalyze pseudouridine (soo-door-idine) formation in rRNAs
II) Group I intron homing involves the use of an RNA intermediate
III) Virusoids involve the use of a highly-conserved hammerhead ribozyme for RNA cleavage

ANSWER: I only

TOSS-UP

5) Physics – *Short Answer* The slope of the elastic region of a stress-strain curve best represents what quantity?

ANSWER: Young's Modulus

BONUS

5) Physics – *Short Answer* If a 65-kilogram man climbs from the bottom to the top of a vertical 8-meter pole in 13 seconds. Assuming g to be 10m/s2, what is the man's average power output, in watts?

ANSWER: 400

TOSS-UP

6) Chemistry - *Short Answer* Rank the following three compounds by increasing covalent character between the Mn --O bond; 1) MnO2; 2) MnO4-; 3) MnO.

ANSWER: 3,1,2

BONUS

6) Chemistry - *Short Answer* Identify all of the following three coordination complexes which are paramagnetic 1) Pt(Cl4)-2 2) AuF4- 3) Co(NO3)2

ANSWER: 3 ONLY

TOSS-UP

7) Math – *Short Answer* What is the greatest prime divisor of $56^2 - 55^2$?

ANSWER: 37

BONUS

7) Math – *Short Answer* Three two-digit hexadecimal numbers are used to represent red, green, and blue in a color code with 00 being the darkest shade and FF being the lightest. A confused programmer confuses FF for the darkest shade and 00 for the lightest shade and enters 4A6F0E as a color code. What color code did he intend to enter?

ANSWER: B590F1

TOSS-UP

8) Earth and Space – *Multiple Choice* Which of the following metamorphic conditions would most likely produce migmatite?

W) High lithostatic pressure and high temperature

X) High lithostatic pressure and low temperature

Y) High differential pressure and high temperature

Z) High differential pressure and low temperature

ANSWER: Y) HIGH DIFFERENTIAL PRESSURE AND HIGH TEMPERATURE

BONUS

8) Earth and Space – *Multiple Choice* Which of the following igneous rocks does NOT have a glassy texture?

W) Pumice

X) Tachylite

Y) Dacite

Z) Hyaloclastite

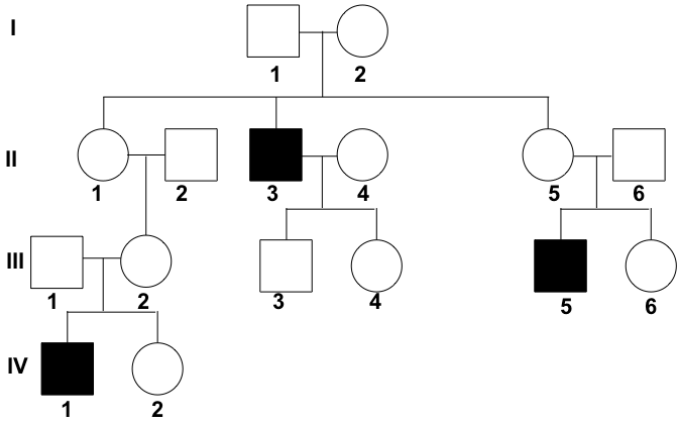
ANSWER: Y) DACITE

TOSS-UP

9) Biology - *Short Answer* Histamine and the anticlotting factor heparin are secreted primarily by what group of immune cells?

ANSWER: Basophils

VISUAL BONUS



9) Biology - *Multiple Choice* Which of the following diseases would most likely be associated with this pedigree?

W) Huntington's Disease
X) Tay-Sachs Disease
Y) Hemophilia A
Z) Cystic Fibrosis

ANSWER: X) Hemophilia A

TOSS-UP

10) Physics - *Short Answer* Idenitfy all of the following 4 particles have a Baryon number of +1: 1) Pion ; 2) Muon; 3) Proton; 4) Omega Baryon.

ANSWER: 3 AND 4

BONUS

10) Physics – *Short Answer* Identify all of the following that are true about thermodynamically reversible processes: 1) they generally occur super speedy fast; 2) heat can be exchanged with the environment; 3) it represents the process where the most work can be extracted between 2 states.

ANSWER: 3 ONLY

TOSS-UP

11) Energy – *Short Answer* Researchers at the International Gemini Observatory noticed mysterious flashes of energy far from any obvious galactic home. They found that such flashes originated from as far as 10 billion light-years away. These flashes are a result of colliding neutron stars resulting in what immensely energetic phenomena?

ANSWER: SHORT GAMMA RAY BURSTS (ACCEPT: Gamma Ray Burst)

BONUS

11) Energy – *Short Answer* Researchers at the University of Mannheim-Heidelberg are studying the extensive effects of alcoholism on the brain. The team tested its hypothesis using research in fruit flies and mouse models and found ethanol-induced changes in what phenomena, characterized by the morphological remodeling of neurons?

ANSWER: NEUROPLASTICITY (ACCEPT: PLASTICITY)

TOSS-UP

12) Chemistry - *Multiple Choice* Which of the following would be the most stable conformation of 1-chloro 3-t-butyl trans cyclohexane?

W) Chlorine and tert butyl are equatorial

X) Chlorine is equatorial and tert butyl is axial
Y) Chlorine is axial and tert butyl is equatorial
Z) Chlorine and tert butyl are equatorial

ANSWER: Y) CHLORINE IS AXIAL AND TERT BUTYL IS EQUATORIAL

BONUS

12) Chemistry - *Short Answer* The compounds tert-butyl hydroperoxide, Titanium tetraisopropoxide, and (-)-DET, are commonly used during epoxide synthesis. Identify all of the following three compounds where Titanium tetraisopropoxide and (-)-DET would NOT be necessary: 1) 2-buten-1-ol; 2) 2-penten-1-ol; 3) 3-Hexen-1,6-diol.

ANSWER: 3 ONLY

TOSS-UP

13) Math – *Short Answer* Gas prices are increasing exponentially by increasing 20% each day. If the price of gas three days ago was 5 dollars per gallon, what is the exact price now in dollars per gallon?

ANSWER: 8.64

BONUS

13) Math – *Short Answer* A cow is outside a square barn with side length 8 meters and is attached to a corner of the barn by a 10 meter rope. What is the area in terms of pi that the cow can walk in?

ANSWER: 77π

TOSS-UP

14) Earth and Space – *Short Answer* What is the name of the phenomenon where the edges of a star are observed to be dimmer than the center?

ANSWER: LIMB DARKENING

BONUS

14) Earth and Space – *Short Answer* Order the following three stellar populations in terms of increasing metallicity: 1) Population I; 2) Population II; 3) Population III.

ANSWER: 3, 2, 1

TOSS-UP

15) Biology- *Short Answer* What cardiac muscle structure, located in mammalian hearts, separates the right atrium from the left ventricle to prevent the mix of oxygenated and deoxygenated blood?

ANSWER: Atrioventricular Septum

BONUS

15) Biology - *Short Answer* Identify all of the following three statements that are correct regarding how increased loads affect isotonic contraction: 1) Latent period increases; 2) Shortening velocity is increased; 3) Length of muscle contraction increases.

ANSWER: 1 ONLY

TOSS-UP

16) Physics – *Multiple Choice* Which of the following ranges of light is most transparent in Earth's atmosphere?

W) less than 300 nm

X) from 300 to 800 nm

Y) from 800 to 1100 nm

Z) more than 1100 nm

ANSWER: X) FROM 300 TO 800 NM

BONUS

16) Physics – *Short Answer* Scientists can prove the existence of dark matter by comparing the density of all the baryonic matter in the universe with what other physical quantity?

ANSWER: Critical density

TOSS-UP

17) Energy – *Multiple Choice* The two-dimensional material graphene has received extensive attention by researchers at Lawrence Berkeley National Laboratory due to its novel properties which promise breakthroughs in nanotechnology. Which of the following characteristics of graphene were discovered?

W) Low strength, low toughness

X) High strength, low toughness

Y) Low strength, high toughness

Z) High strength, high toughness

ANSWER: X) High strength, low toughness

BONUS

17) Energy – *Short Answer* Researchers from Tokyo Metropolitan University have developed a way to produce high quality monolayers of transition metal dichalcogenides. Which of the following methods, a process in which thin films are formed on a heated substrate, did the researchers use to deposit such monolayers?

W) Lacustrine deposition [luh kuh strin]

X) Aeolian deposition

Y) Alluvial deposition

Z) Chemical vapor deposition

ANSWER: Z) Chemical vapor deposition

TOSS-UP

18) Chemistry - *Short Answer* Identify all of the following three gases that would be produced at the anode in a galvanic cell with a Copper (II) Sulfate electrolyte: 1) Oxygen gas; 2) Hydrogen gas; 3) Sulfur dioxide

ANSWER: 1 only

BONUS

18) Chemistry - *Short Answer* Peter is studying the use of *N-bromosuccinimide* , also known as NBS, a common reagent but useful compound for donating a bromine radical in solution. NBS is used as a reagent in what reaction, known to directly compete against the ionic addition of bromine across a pi bond in the presence of diatomic bromine?

ANSWER: Bromination

TOSS-UP

19) Math – *Short Answer* A square is plotted an a plane such that a diagonal can be formed by connecting the points (1, -5) and (5, 1). What are the other two points on the square?

ANSWER: (0,0) AND (6, -4) [IN ANY ORDER]

BONUS

19) Math – *Short Answer* The sum of zeros of a quadratic polynomial with leading coefficient 4 is 1. If the product of the sums of the zeroes and their respective reciprocals is 4, what are the possible quadratic polynomials?

ANSWER: $4x^2 - 4x + 20$ AND $4x^2 - 4x + 4$ [IN ANY ORDER]

TOSS-UP

20) Earth and Space – *Short Answer* How many times less luminous is a star that has 8 times the radius and 1/4 the surface temperature of another star?

ANSWER: 4

BONUS

20) Earth and Space – *Short Answer* A Zungenbecken is a type of lake that forms as glacial meltwater fills in the hollow region left by a retreating glacier. Which of the following lake types best describes a Zungenbecken?

W) Pluvial

X) Proglacial

Y) Finger

Z) Epishelf

ANSWER: X) PROGLACIAL

TOSS-UP

21) Biology - *Short Answer* What compound is produced in addition to acetyl CoA during the oxidation of an odd-carbon fatty acid?

ANSWER: Propionyl-CoA

BONUS

21) Biology - *Short Answer* Peter and Armaan are currently studying alpha oxidation, a process involving the breakdown of unusual fatty acids as beta oxidation is not possible due to presence of a methyl group. They find this process to be crucial as many of their patients who lack key enzymes for alpha oxidation show an uncommon disorder which includes symptoms such as blindness and deafness. What is the name of this disorder?

ANSWER: Refsum Disease

TOSS-UP

22) Physics – *Short Answer* A heat engine absorbs 360 J of heat from a hot reservoir, does work and ejects an amount of heat of 200 J into the surroundings (cold reservoir). What is the efficiency of the heat engine rounded to 3 significant figures?

ANSWER: 44.4%

BONUS

22) Physics – *Short Answer* In the calculation of the critical density of the universe, in terms of gravitational constant G, mass M, and radius R of the universe, what is the approximate velocity of a particle at the edge of the universe?

ANSWER: sqrt(2GM/r) (escape velocity)

TOSS-UP

23) Energy – *Short Answer* A research team led by Prof. Yu Luo from Nanyang Technological University has uncovered a new type of free-electron radiation by exploring the interaction between a free-charged particle and Dyakonov surface waves. What form of radiation was also involved, emitted when a charged particle moves in a dielectric medium at a speed greater than the speed of light in that medium?

ANSWER: CHERENKOV

BONUS

23) Energy – *Short Answer* Scientists at Rice University are developing light-activated Hemithioindigo (HTI) molecules that destroy gram-positive bacteria. Similar molecules react to light by undergoing a conformational change, resulting in a drill-like motion. The newly developed molecules instead enhance the generation of what kind of chemical which destroys drug-resistant bacteria along with the biofilms they form?

ANSWER: REACTIVE OXYGEN SPECIES