THUMB: SINGLE ELIMINATION 3

1) Math – *Multiple Choice* What is the area of a circle inscribed in an equilateral triangle with side length 2?

W) pi/4
X) pi/3
Y) pi/2
Z) pi

ANSWER: X) pi/3 [AX]

2) Earth and Space – *Multiple Choice* After developing a helium burning shell, red giants generally move in which of the following directions on the HR diagram?

W) Up and left
X) Up and right
Y) Down and left
Z) Down and right

ANSWER: X) Up and right [FJ]

3) Physics – *Short Answer* What idealized thermodynamic cycle involves two isentropic and two isochoric processes and is commonly applied to automobile engines?

ANSWER: Otto cycle [FJ]

4) Chemistry – *Multiple Choice* Which of the following cyclic hydrocarbons has the least ring strain?
W) Cyclopropane
X) Cyclobutane
Y) Cyclopentane
Z) Cyclohexane

ANSWER: Z [DS] [SY]

5) Biology - *Multiple Choice* Which of the following names describes the conserved eukaryotic mRNA sequence that surrounds the Start Codon which is vital for translation initiation?

W) Kozak consensus sequence
X) Shine dalgarno sequence
Y) TATA box
Z) Internal ribosomal entry site

ANSWER: W) Kozak consensus sequence [SY]

6) Math – *Multiple Choice* Which of the following integers is closest to the p = 3 Minkowski distance between the points (1,4) and (4,10)?

W) 6
X) 7
Y) 8
Z) 9

ANSWER: W) 6 [OM]

7) Earth and Space – *Short Answer* Sand grains can roll on the seafloor and accumulate concentric layers of calcium carbonate deposits. These grains can then be cemented together to form what specific sedimentary rock?

ANSWER: Oolitic limestone (Accept: Oolite; Do not accept: limestone) [FJ]

8) Physics – *Short Answer* Alex is accelerating at a constant pace of 10 meters per second squared around a circular track with circumference 10π. In meters per second squared, what is the centripetal acceleration of Alex after he has completed one lap around the track?

ANSWER: 40π [FJ]

9) Chemistry - *Short Answer* Richard the British chemist wants to figure out the structure of the transition state in a reaction. What postulate states that the transition state of a reaction most resembles the species which is higher in free energy?

ANSWER: Hammond's postulate [SY]

10) Biology - *Short Answer* Some fish use a mesh of opposite-flowing arteries and veins called a *rete mirabile* to fill and maintain the high partial pressures of air in their swim bladder. What general mechanism, also used to upkeep the high osmolarities in the loop of Henle and retain heat in endotherms, is characterized by the transfer of things between opposite flowing ducts to maintain a concentration gradient?

ANSWER: Countercurrent exchange OR Countercurrent multiplication [SY]

11) Math - *Multiple Choice* Two brackets are considered the same if the possible opponents a player can face in any given round is the same in both brackets for all players. How many different ways can an 8 person seeded single elimination bracket be arranged so that no 1st to 4th seeded player faces another 1st to 4th seeded player in the first round?

W) 24
X) 48
Y) 72
Z) 96

ANSWER: Y) 72 [OM]

12) Earth and Space – *Short Answer* Identify all of the following three planets that experience prograde orbit around the Sun: 1) Mercury 2) Venus 3) Jupiter

ANSWER: All [FJ]

13) Physics – *Short Answer* A hole opens through the center of the Earth, and Alex falls in. He starts oscillating in simple harmonic motion about the Earth's center. In terms of the Earth's gravitational acceleration **g** and the Earth's radius **R**, what is his angular velocity?

ANSWER: sqrt(g/R) [AX]

14) Chemistry – *Multiple Choice* For converting diethyl zinc to ethane gas, which of the following reagents would be effective?

W) Potassium Hydroxide
X) Hydrochloric Acid
Y) Sodium Amide
Z) Lithium Aluminum Hydride

ANSWER: X) Hydrochloric Acid [DS]

15) Biology - *Short answer* Sean is performing a diversity study on Austinland, where diversity is represented by the raw number of species. Austinland has just two distinct ecosystems, ecosystem A and B. The gamma diversity of Austinland is 8. The alpha diversity of ecosystems A and B, respectively, are 6 and 3. What must be the beta diversity between ecosystems A and B?

ANSWER: 7 [SY]

16) Math - *Short Answer* When comparing the means of a continuous variable across three or more distinct sample groups, conducting multiple pairwise t-tests increases the family-wise error rate. What statistical test avoids this problem by partitioning the total variance into components, specifically comparing the variance between groups to the variance within groups using an F-statistic?

ANSWER: ANOVA test [AX]

17) Earth and Space – *Short Answer* The Twomey effect suggests that the addition of what entities would increase cloud albedo, thus cooling the earth?

ANSWER: Cloud condensation nuclei (Accept: CCNs, condensation nuclei) [FJ]

18) Physics – *Multiple Choice* Unpolarized light with initial intensity **I** passes through a series of three linear polarizers. The first polarizer's axis is vertical, the second polarizer's axis is oriented 45 degrees to the vertical, and the last polarizer's axis is vertical again. Which of the following is closest to the initial intensity of light that passes through the entire system?

W) I/16
X) I/8
Y) I/4
Z) I/2

ANSWER: X) I/8 [AX]

19) Chemistry - *Multiple Choice* 2,3-dibromobutane is an organic molecule with two stereocenters AND an internal plane of symmetry. Knowing this, how many stereoisomers does 2,3-dibromobutane have?

ANSWER: 3 [SY]

20) Biology – *Multiple Choice* Within a nephron, which of the following is closest to the proportion of fluid filtered from the blood that is reabsorbed in the proximal convoluted tubule, knowing that about two-thirds of sodium absorption occurs in that section?

W) 0
X) 1/3
Y) 2/3
Z) 1

ANSWER: Y) ⅔ [SY]

21) Math - *Multiple Choice* What is the sum of the digits of the first 99 positive integers?

W) 855
X) 900
Y) 945
Z) 990

ANSWER: X) 900 [OM]

22) Earth and Space – *Multiple Choice* Which of the following environments is most likely to create a sequence containing zeolite, greenschist and granulite?

W) Accretionary wedge
X) Collisional mountain belt
Y) Continental hotspot
Z) Continental craton

ANSWER: X) Collisional mountain belt [FJ]

23) Physics – *Short Answer* Liquid helium transitions into superfluid helium II when it is cooled below approximately 2.17 Kelvin, a phenomenon driven by Bose-Einstein statistics. What specific name is given to the point at which this phase transition occurs?

ANSWER: Lambda point (ACCEPT: Lambda) [AX]

24) Chemistry – *Short Answer* Bubble, reaction, and diffusion are all forms of what electrochemical quantity?

ANSWER: Overpotential [AlX]

25) Biology – *Short Answer* By name or number, identify all of the following three hormones that are secreted from the hypothalamus:

1) Thyroid Stimulating hormone
2) Growth Hormone releasing hormone
3) Gonadotropin releasing hormone

ANSWER: 2 and 3 [SY]