



## DOUBLE ELIMINATION 3

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### TOSS-UP

1) X-Risk - *Short Answer* Identify all of the following four solar system moons that are believed to have subsurface liquid water deposits: 1) Enceladus [en-SEL-uh-dis]; 2) Europa; 3) Ganymede; 4) Titan.

ANSWER: All

### BONUS

1) X-Risk - *Short Answer* Many antibiotics have a beta-lactam ring in their structure. These antibiotics work by inhibiting the biosynthesis of what component of a bacterial cell?

ANSWER: Cell wall (ACCEPT: Peptidoglycan)

### TOSS-UP

2) Math - *Multiple Choice* How many petals does the graph of the rose have with the function  $r = 2 \sin(4\theta)$  [r equals 2 sin of 4 theta] have?

W) 2

X) 4

Y) 6

Z) 8

ANSWER: Z) 8

### BONUS

2) Math - *Short Answer* A shape is constructed by revolving the region bounded by  $y = \sqrt{x}$ ,  $y = 0$ , and  $x = 4$  around the x-axis. What is the volume of this shape?

ANSWER:  $8\pi$

### TOSS-UP

3) Chemistry - *Short Answer* Identify all of the following three properties of water that are expected to increase upon adding a non-volatile solute to form an aqueous solution: 1) Freezing point; 2) Boiling point; 3) Vapor pressure.

ANSWER: 2 only

### BONUS

3) Chemistry - *Multiple Choice* Which of the following are the signs of  $\Delta H$  and  $\Delta S$  for a reaction that is spontaneous at all temperatures?

- W) Positive and positive
- X) Positive and negative
- Y) Negative and positive
- Z) Negative and negative

ANSWER: Y) Negative and positive

### TOSS-UP

4) Earth and Space - *Multiple Choice* Which of the following minerals falls on the continuous series of crystallization in Bowen's reaction series?

W) Amphibole

X) Plagioclase

Y) Pyroxene

Z) Olivine

ANSWER: X) Plagioclase

### BONUS

4) Earth and Space - *Short Answer* Identify all of the following three types of plutons that are discordant: 1) Dikes; 2) Sills; 3) Laccoliths.

ANSWER: 1 only

### TOSS-UP

5) Biology - *Multiple Choice* During which phase of the cell cycle does the nuclear membrane disintegrate?

- W) Prophase
- X) Prometaphase
- Y) Metaphase
- Z) Anaphase

ANSWER: X) Prometaphase

### BONUS

5) Biology - *Multiple Choice* Which of the following best describes a K-selected species?

- W) Semelparous [seh-MEL-puh-rus]
- X) Unstable environment
- Y) Exponential growth
- Z) Type I survivorship curve

ANSWER: Z) Type I survivorship curve

### TOSS-UP

6) Physics - *Short Answer* What type of elastic scattering by the Coulomb potential occurs when alpha particles are fired at gold nuclei?

ANSWER: Rutherford scattering

### BONUS

6) Physics - *Short Answer* A particle's position along x is given by the function  $x(t) = 5t^3 - 4t$  and its velocity is denoted as  $v(t)$ . Identify all of the following three statements that are true about this particle: 1) There is work being done on the particle; 2) The particle is accelerating; 3) The speed at  $t = 2$  is greater than at  $t = 1$ .

ANSWER: All

### TOSS-UP

7) X-Risk - *Short Answer* Ricin is a unique toxin because it is poisonous to eukaryotes, but not prokaryotes. What organelle, which is different in eukaryotes and prokaryotes, does ricin interfere with?

ANSWER: Ribosome

### BONUS

7) X-Risk - *Short Answer* What astronomical phenomena, often caused by core-collapse supernovae, can result in increased levels of ground-based UV radiation and significant DNA damage?

ANSWER: Gamma-ray bursts



### TOSS-UP

8) Math - *Short Answer* Alice gets paid \$500 for every car she sells, along with a \$60,000 yearly salary. Brian gets paid \$600 for every car he sells, with a \$54,000 yearly salary. If they sold the same amount of cars and earned the same amount of money in the year 2022, how many cars did one of them sell?

ANSWER: 60

### BONUS

8) Math - *Multiple Choice* What is the indefinite integral of  $\sec(x)$ ?

W)  $\ln |\sec x| + C$  [ln of the absolute value of secant x plus C]

X)  $\ln |\sec x + \tan x| + C$  [ln of the absolute value of the quantity secant x plus tangent x plus c]

Y)  $\ln |\csc x| + C$  [ln of the absolute value of cosecant x plus c]

Z)  $\ln |\csc x + \cot x| + C$  [ln of the absolute value of the quantity cosecant x plus cotangent x plus c]

ANSWER: X)  $\ln |\sec x + \tan x| + C$  [ln of the absolute value of the quantity secant x plus tangent x plus c]

### TOSS-UP

9) Chemistry - *Multiple Choice* Which of the following ions is amphoteric [am-foh-TAIR-ic] in water?

- W) Sulfate
- X) Bisulfite
- Y) Oxalate
- Z) Phosphate

ANSWER: X) Bisulfite

### BONUS

9) Chemistry - *Short Answer* Order the following three salts by increasing solubility in water: 1)  $\text{Ag}_2\text{SO}_4$ ; 2)  $\text{MgCl}_2$ ; 3)  $\text{AgCl}$ .

ANSWER: 3, 1, 2

### TOSS-UP

10) Earth and Space - *Multiple Choice* In the most massive of stars, a sudden decrease in radiation pressure may be caused by what phenomenon, causing a premature supernova detonation without a remnant?

- W) Photodisintegration
- X) Pair production
- Y) Entanglement
- Z) Stellar flare

ANSWER: X) Pair production

### BONUS

10) Earth and Space - *Multiple Choice* Soft gamma repeaters are a type of which of the following astronomical objects?

- W) Black hole
- X) Quasar
- Y) Magnetar
- Z) Pulsar

ANSWER: Y) Magnetar

### TOSS-UP

11) Biology - *Short Answer* Borrelia Burgdorferi [burg-dur-FAIR-ee] is the causative agent of what disease, which causes a bulls-eye rash to appear on the skin?

ANSWER: Lyme disease

### BONUS

11) Biology - *Multiple Choice* Which of the following molecules is NOT involved in the mediation of long term potentiation?

W) Glutamate

X) NMDA receptors

Y) 5-HT receptors

Z) AMPA receptors

ANSWER: Y) 5-HT receptors

### TOSS-UP

12) Physics - *Multiple Choice* A loop of wire is set up so that it wraps around the z-axis, while a constant magnetic field points in the z-direction. Which of the following would NOT induce a current in the wire loop?

- W) Decreasing the magnetic field along the z-axis
- X) Increasing loop area along the z-axis
- Y) Rotating the loop about the y-axis
- Z) Rotating the loop around the z-axis

ANSWER: Z) Rotating the loop around the z-axis

### BONUS

12) Physics - *Short Answer* A RC circuit has two 20 Ohm resistors set up in parallel and three 1.5 Farad capacitors in series. What is the effective resistance and capacitance of the resistors and capacitors in ohms and farads, respectively?

ANSWER: 10 and 0.5

### TOSS-UP

13) X-Risk - *Multiple Choice* The Monty Hall problem is a classic example of needing to use what type of probability theory to solve, in which it is a measure of the probability of an event occurring, given that another event has already occurred?

W) Conditional probability

X) Joint probability

Y) Marginal probability

Z) Prior probability

ANSWER: W) Conditional probability

### BONUS

13) X-Risk - *Short Answer* Asteroid mining may be useful in order to procure water ice for future space missions. The best candidates for mining water ice are extinct comets, many of which can be found in what group of asteroids present at Jupiter's Lagrange points?

ANSWER: Trojans

### TOSS-UP

14) Math - *Multiple Choice* The point (2, 5) is reflected across the x-axis, the y-axis, the line  $y = x$ , and the x-axis again. What is the sum of the coordinates of the transformed point?

W) -7

X) -3

Y) 3

Z) 7

ANSWER: X) -3

### BONUS

14) Math - *Short Answer* What is the area of the triangle formed by the intersection of the lines  $y = 2x$ ,  $y = -\frac{x}{2} + 10$ , and the x-axis?

ANSWER: 80

### TOSS-UP

15) Chemistry - *Multiple Choice* What variable is held constant in a bomb calorimeter [cal-ur-IM-it-ur]?

W) Temperature

X) Pressure

Y) Volume

Z) Enthalpy

ANSWER: Y) Volume

### BONUS

15) Chemistry - *Short Answer* How many atoms are in a body-centered cubic unit cell?

ANSWER: 2



### **TOSS-UP**

16) Earth and Space - *Short Answer* Peter discovers a drumlin field and decides to go sledding. He notices that his sled always goes slowest when sledding towards the southwest. Based on this information, in what direction did the glaciers recede?

ANSWER: Northeast

### **BONUS**

16) Earth and Space - *Short Answer* What term describes the feature formed by oceanic sediments scraped off the subducting plate onto the obducting plate?

ANSWER: Accretionary wedge (ACCEPT: Accretionary prism)

### TOSS-UP

17) Biology - *Short Answer* Identify all of the following three changes that would increase the conduction speed of a neuron: 1) Increase in diameter; 2) Increase in length; 3) Increase in myelination.

ANSWER: 1 and 3

### BONUS

17) Biology - *Multiple Choice* How many molecules of ATP and NADPH are required respectively for the reduction of 3 molecules of carbon dioxide into glyceraldehyde [GLIS-er-AL-duh-hide] 3 phosphate?

W) 9, 6

X) 18, 12

Y) 12, 18

Z) 18, 18

ANSWER: W) 9, 6

### TOSS-UP

18) Physics - *Multiple Choice* Which of the following time and force pairs will result in the largest change in momentum for a particle?

- W) 1 second, 100 Newtons
- X) 2 seconds, 55 Newtons
- Y) 3 seconds, 35 Newtons
- Z) 4 seconds, 25 Newtons

ANSWER: X) 2 seconds, 55 Newtons

### BONUS

18) Physics - *Multiple Choice* Which of the following descriptions of an electromagnetic plane wave transmitted through a different medium than the original is true?

- W) The wave will travel at the speed of light
- X) The electric field can only point in one direction
- Y) The electric and magnetic fields must be out of phase
- Z) The magnetic field can only point in one direction

ANSWER: Y) The electric and magnetic fields must be out of phase

### TOSS-UP

19) X-Risk - *Multiple Choice* On which of the following continents is human genetic diversity highest?

- W) Africa
- X) Asia
- Y) Europe
- Z) North America

ANSWER: W) Africa

### BONUS

19) X-Risk - *Short Answer* The Three Mile Island site consisted of what type of water reactor, which also constitutes the majority of the world's nuclear reactors?

ANSWER: Pressurized water reactor (ACCEPT: Pressurized)

### TOSS-UP

20) Math - *Short Answer* If 2 percent of  $a$  is 600, what is 54 percent of  $a$ ?

ANSWER: 16200

### BONUS

20) Math - *Short Answer* Evan rolls 6 standard dice simultaneously. Expressing your answer as a fraction in simplest form, what is the probability that the product is divisible by 3?

ANSWER:  $\frac{665}{729}$

### TOSS-UP

21) Chemistry - *Short Answer* Gaseous hydrogen can react with solid iodine to form gaseous hydrogen iodide according to the reaction  $\text{H}_2(\text{g}) + \text{I}_2(\text{s}) \longrightarrow 2\text{HI}(\text{g})$  [H-two gas plus I-two solid yields two-H-I gas]. Identify all of the following three changes that would shift the reaction to the right: 1) Adding more iodine; 2) Adding more hydrogen iodide; 3) Increasing the volume.

ANSWER: 3 only

### BONUS

21) Chemistry - *Multiple Choice* For an ideal sample of gas molecules, which of the following graphs relating temperature and the root-mean-square speed of the gas molecules would yield a straight line?

- W) Temperature versus speed
- X) Temperature squared versus speed
- Y) Temperature versus speed squared
- Z) Logarithm of temperature versus speed

ANSWER: Y) Temperature versus speed squared

### TOSS-UP

22) Earth and Space - *Multiple Choice* Which of the following best describes the general color trend of the Milky Way from the center outwards?

- W) Redder
- X) Bluer
- Y) Redder, then bluer
- Z) Bluer, then redder

ANSWER: X) Bluer

### BONUS

22) Earth and Space - *Multiple Choice* Which of the following best describes the driving factor for spiral arm rotation in the Milky Way?

- W) Central black hole
- X) Galactic cluster orbit
- Y) Galactic merger
- Z) Stellar density

ANSWER: Z) Stellar density

### TOSS-UP

23) Biology - *Multiple Choice* Nicholas takes a random plant in his backyard. and notices that the plant's stem has dispersed vascular tissue. Which of the following observations would he NOT observe?

W) Parallel venation

X) Pollen with a single hole

Y) The lack of a vascular cambium

Z) Flowers with organs in multiples of 5

ANSWER: Z) Flowers with organs in multiples of 5

### BONUS

23) Biology - *Short Answer* Identify all of the following three features that are present in monocots: 1) Floral organs in multiples of 3; 2) Taproot system; 3) Scattered vascular bundles.

ANSWER: 1 and 3



### TOSS-UP

24) Physics - *Multiple Choice* A block of mass 4 kilograms is placed on an inclined plane at an angle 30 degrees with respect to the horizontal. What is the minimum coefficient of static friction such that the block will not slip?

W)  $\frac{\sqrt{2}}{2}$

X)  $\frac{\sqrt{2}}{3}$

Y)  $\frac{\sqrt{3}}{3}$

Z)  $\frac{\sqrt{3}}{2}$

ANSWER: Y)  $\frac{\sqrt{3}}{3}$

### BONUS

24) Physics - *Short Answer* In SI base units, what are the dimensions of the universal gravitational constant G [big G]?

ANSWER:  $m^3kg^{-1}s^{-2}$