

DE6

TOSSUP

1) Biology - *Multiple Choice* To determine the distance between two genes, you perform a cotransduction experiment. The cotransduction frequency is 6.4% and the length of the DNA strand is 1.25 minutes. What is the distance between the genes?

W) 0.25
X) 0.5
Y) 0.75
Z) 1.0

ANSWER: X) 0.5 [HL]

BONUS

1) Biology - *Multiple Choice* Which of the following eukaryotic DNA polymerases create a primer at the beginning of DNA replication, serving as the eukaryotic equivalent of primase?

W) Polymerase Epsilon
X) Polymerase Delta
Y) Polymerase Beta
Z) Polymerase Alpha

ANSWER: Z) Polymerase Alpha [HL]

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TOSSUP

2) Chemistry - *Multiple Choice* In which of the following mixtures of solutions would you expect to find a large negative deviation from Raoult's Law?

W) Water and benzene
X) Water and chloroform
Y) Water and ethanol
Z) Water and nitric acid

ANSWER: Z) Water and nitric acid [SO]

BONUS

2) Chemistry - *Short Answer* Identify all of the following three titrations which would NOT require the use of an indicator to determine the endpoint:

1) Oxalic acid with potassium permanganate
2) Iron (ii) chloride with cerric (iv) sulfate
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3) Hydrochloric acid with ammonia

ANSWER: 1 AND 2 [SO]

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TOSSUP

3) Math - *Short Answer* Lihkith starts off with a unit square. For each move, he splits every existing square into 9 different squares each with side length ⅓ of the original square. He then removes the center square among these 9 squares. If he keeps doing moves for the rest of time, the total area of the figure approaches what constant?

ANSWER: 0

BONUS

3) Math *Multiple Choice* What is the remainder when 20! is divided by 23?

W) 22
X) 11
Y) 20
Z) 19

ANSWER: X) 11

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TOSSUP

4) Earth and Space - *Multiple Choice* Heidi looks at a salinity profile from a vertical cross section taken perpendicular to the shoreline in an estuary and notices that the isohalines are nearly vertical throughout the water column. Which of the following estuary types would most likely produce this pattern?

W) Stratified
X) Partially-mixed
Y) Well-mixed
Z) Salt wedge

ANSWER: Y) Well-mixed [JY]

BONUS

4) Earth and Space - *Multiple Choice* Which of the following ores most commonly forms as a result of magmatic fluid immiscibility?

W) Massive chromite seams
X) Nickel-copper sulfides
Y) Pegmatitic lithium
Z) Layered intrusion magnetites

ANSWER: X) Nickel-copper sulfides [JY]

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TOSSUP

5) Physics Arjun gave up biology and is now studying QED. To predict how electrons can repel each other, he uses Feynman diagrams. Since there are infinitely many possible interactions through virtual particles, we assign probabilities to each interaction. Each interaction vertex reduces the probability by approximately what factor?

ANSWER: 1/137, ACCEPT FINE STRUCTURE CONSTANT OR 0.0073

BONUS

5) Physics A 1 kg mass is connected to a 10 N/m spring on a surface where the coefficients of static and kinetic friction are equal to 1. The mass is pulled a distance of 2 meters away from the spring's equilibrium position. Assume g = 10 m/s^2. Which of the following describes the resulting motion?

W) Simple Harmonic
X) Underdamped
Y) Critically damped
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Z) Over damped

ANSWER: Y) Critically damped

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TOSSUP

6) Biology - *Short Answer* What metabolic process that runs parallel to glycolysis is used to convert Glucose-6-phosphate and NADP+ to pentose sugars used for nucleotide synthesis and NADPH?

ANSWER: Pentose-Phosphate Pathway [HL]

BONUS

6) Biology - *Short Answer* A patient has a hypothetical autoimmune disease targeting the delta cells of the pancreas and duodenum, rendering them dysfunctional. Identify all of the following four effects you would expect this disease to have on the patient:

1) Increased blood T3 and T4 levels
2) Diarrhea
3) Increased sympathetic nervous system activity
4) Steatorrhea

ANSWER: 1, 2, 3 (ACCEPT: Increased blood T3 and T4 levels, Diarrhea, and Increased Sympathetic Nervous System Activity) [HL]

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TOSSUP

7) Math *Short Answer* There exist three similar parallelepipeds, A, B, and C such that the ratio of the surface area of figure A to figure B is 4 and the ratio of the largest length of figure A to the longest length of figure C is 3. What is the ratio of the volume of figure B to figure C?

ANSWER: 27/8

BONUS

7) Math *Short Answer* For what value of x does the function x^4 + 1/x^5 attain its minimum for positive values of x?

ANSWER: (5/4)^(1/9) (Accept: ninth root of 5/4)

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TOSSUP

8) Chemistry- *Multiple Choice* Which of the following conformations of ethane would be expected to have the largest torsional strain?

W) Staggered
X) Newman
Y) See-saw
Z) Eclipsed

ANSWER: Z) Eclipsed

BONUS

8) Chemistry- *Multiple Choice* Which of the following statements is true regarding the recrystallization process to purify a solute?

W) The formation of the new crystal lattice is endothermic
X) The formation of the new crystal lattice has positive entropy
Y) The solute must first be dissolved in a cold solvent
Z) The solute must first be dissolved in a warm solvent

ANSWER: Z) The solute must first be dissolved in a warm solvent [SO]

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TOSSUP

9) Earth and Space - *Multiple Choice* The Bergeron process and collision coalescence process are both methods of forming precipitation in clouds. Which of the following best describes the conditions necessary for use of the Bergeron process as opposed to collision coalescence?

W) The Bergeron process requires a warm, mixed-phase cloud while collision coalescence requires a cold, uniform-phase cloud
X) Collision coalescence requires a warm, mixed-phase cloud while the Bergeron process requires a cold, uniform-phase cloud
Y) The Bergeron process requires a cold, mixed-phase cloud while collision coalescence requires a warm, uniform-phase cloud
Z) Collision coalescence requires a cold, mixed-phase cloud while the Bergeron process requires a warm, uniform-phase cloud

ANSWER: Y) The Bergeron process requires a cold, mixed-phase cloud while collision coalescence requires a warm, uniform-phase cloud [JY]

BONUS

9) Earth and Space - *Short Answer* Identify all of the following three evolutionary paths of magmas that form out of the alkaline series:

1) Carbonatite series
2) Ultrapotassic series
3) Dacitic series

ANSWER: All [JY]

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TOSSUP

10) Physics - *Short Answer* Identify all of the following 3 forces that conserve baryon number:

1) Strong Force
2) Weak Force
3) Gravity

ANSWER: All

BONUS

10) Physics - Short Asnwer A material has surface tension of 1000 N/m and has forms a bubble of radius of 1 meter. If the atmospheric pressure outside 100 kPa, what is the pressure inside the bubble?

ANSWER: 104 kPa

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TOSSUP

11) Math *Multiple Choice* What can be said about the function f(x) = sin(2x) + x^2 (read: sine of open parenthesis 2x close parenthesis plus x^2) and its derivative f'(x) at x = 0?

W) f(x) is decreasing, f'(x) is decreasing
X) f(x) is decreasing, f'(x) is increasing
Y) f(x) is increasing, f'(x) is decreasing
Z) f(x) is increasing, f'(x) is increasing

ANSWER: Z) f(x) is increasing, f'(x) is increasing

BONUS

11) Math *Short Answer* What is the volume of the figure obtained by rotating the region bounded by x = 0, x = 2, y = x^2 and y = 0 about the x axis?

ANSWER: 32pi/5

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TOSSUP

12) Biology - *Multiple Choice* Which of the following correctly matches a cell-type found within human gonads to the hormone that it directly produces?

W) Sertoli Cells, Testosterone
X) Theca Cells, Estrogen
Y) Leydig Cells, Inhibin

Z) Granulosa Cells, Estrogen

ANSWER: Z [AD]

BONUS

12) Biology - *Short Answer* Edwin knocks-down the gene for a precursor protein produced by mice, resulting in mice that produce decreased amounts of ADH, MSH and beta-endorphin. What pro-hormone did Edwin likely knock-down?

ANSWER: pro-opiomelanocortin (POMC) [AD]

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TOSSUP

13) Earth and Space - *Short Answer* In asymptotic giant stars, the core is inert meaning that there is no fusion pressure to support the envelope of the star. What limit describes the maximum mass of an envelope an inert core can support?

ANSWER: Schonberg Chandrasekhar Limit (DO NOT ACCEPT: Chandrasekhar Limit)

BONUS

13) Earth and Space - *Short Answer* Identify all of the following 3 bodies that would have tholins on their surfaces or in their atmospheres:

1) Europa
2) Charon
3) Mars

ANSWER: 1 and 2

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TOSSUP

14) Chemistry- *Short Answer* Rubidium Fluoride is far more soluble than either Rubidium Chloride, or Rubidium Iodide. What theory best explains this, which characterizes lewis acids and bases based on their relative polarizabilities and charge densities?

ANSWER: Hard Soft Acid Base theory (ACCEPT: HSAB) [SO]

BONUS

14) Chemistry - *Short Answer* In the balanced redox reaction between Fe^{2+} and $Cr_2O_7^{2-}$ in acidic condition, what is the coefficient of the Fe^{2+} term?

ANSWER: 6 [SO]

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TOSSUP

15) Math *Short Answer* Convert 1331 base 9 to base 10

ANSWER: 1000

BONUS

15) Math *Short Answer* Convert the rectangular coordinate (1, -1, 3) into cylindrical coordinates.

ANSWER: (sqrt2, 7pi/4, 3) (DO NOT ACCEPT: (sqrt2, -pi/4, 3))

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TOSSUP

16) Physics - *Multiple Choice* Which of the following describes the wave function of a quantum particle at an infinite potential energy boundary?

W) Continuous but not differentiable
X) Differentiable but not continuous
Y) Both continuous and differentiable
Z) Neither continuous nor differentiable

ANSWER: W) Continuous but not differentiable

BONUS

16) Physics - *Short Answer* A circuit consists of a variable voltage source with a 2 ohm resistor, 1 henry inductor, and a 4 farad capacitor all connected in parallel. The charge in the capacitor in coulombs is given by the equation $q(t) = 4t^2 + 8t$. Calculate the current in the inductor t=1 assuming the current at t=0 is 0.

ANSWER: 2

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TOSSUP

17) Biology - *Multiple Choice* Sanjay takes away a mouse's food for a few hours every time it presses a button. What type of operant conditioning is exemplified by this experiment?

W) positive punishment
X) negative punishment
Y) positive reinforcement
Z) negative reinforcement

ANSWER: X) negative punishment

BONUS

17) Biology- *Short Answer:* Arjun likes studying toxins, but he is only interested in toxins that are known to cleave SNAREs. Identify all of the following four toxins that Arjun would likely be interested in.

1) Anatoxin-a
2) Botulism Toxin
3) Tetrodotoxin
4) Tetanus Toxin

ANSWER: 2, 4

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TOSSUP

18) Chemistry- *Short Answer* For element A, the reduction potential from A^{3+} to A^{+} is 0.6 volts, and the reduction potential from A^{+} to A is 0.3 volts. To one significant figure and in volts, what is the reduction potential for the reduction of A^{3+} to A?

ANSWER: 0.5 [SO]

BONUS

18) Chemistry- *Short Answer* Order the following three molecules in increasing value of their vant hoff factor in aqueous solution:

1) Lead (ii) iodide
2) Sodium nitrate
3) Iron (iii) chloride

ANSWER: 123 [SO]
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TOSSUP

19) Earth and Space - *Short Answer* Type II-P supernovae have a light curve that plateaus out for a few months before decreasing in brightness. This plateau is caused by the decay of what isotope?

ANSWER: Nickel-56

BONUS

19) Earth and Space - *Short Answer* Identify all of the following 3 statements that are true of bok globules:

1) They tend to have high luminosity, young stars
2) They tend to have low concentrations of gas
3) They are high in silicates and carbonaceous material

ANSWER: 23

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TOSSUP

20) Physics - *Short Answer* An object is accelerating at 10,000,000 m/s^2. The graph of his velocity over time graph follows the graph of what function?

ANSWER: Hyperbolic Tangent (DO NOT ACCEPT LINE/LINEAR)

BONUS

20) Physics - *Short Answer* A spaceship traveling at 0.8 c can resist projectiles of energies less than $24*10^{16}$ J. An alien shoots a projectile with a mass of 1 kg. How fast does the alien have to shoot the projectile in terms of c?

ANSWER: 25c/36