

RR5

TOSSUP

1) Biology - *Short Answer* What theory of the origins of life suggests that self-replicating RNA was the original genetic material as both an informational and catalytic molecule?

ANSWER: RNA World Hypothesis [HL]

BONUS

1) Biology - *Multiple Choice:* Which of the following provides the order of whorls, from outermost to innermost in a flower following the ABC hypothesis that has a loss of function mutation in the A gene?

W) Carpels, Stamens, Stamens, Carpels
X) Petals, Stamens, Stamens, Carpels
Y) Sepals, Petals, Petals, Sepals
Z) No flower would form

ANSWER: W) Carpels, Stamens, Stamens, Carpels [HL]

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TOSSUP

2) Chemistry - *Multiple Choice* Which of the following cyclic hydrocarbons is the LEAST stable?

W) Cyclopropane
X) Cyclobutane
Y) Cyclopentane
Z) Cyclohexane

ANSWER: W) Cyclopropane

BONUS

2) Chemistry - *Short Answer* In the haber-bosch process, nitrogen gas and hydrogen gas react to form ammonia. What is the sum of the coefficients of each species in the least whole number coefficient representation of the haber-bosch process?

ANSWER: 6 [SO]

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TOSSUP

3) Earth and Space - *Multiple Choice* Which of the following rocks would make the best reservoir rock?

W) Sandstone
X) Mudstone
Y) Siltstone
Z) Shale

ANSWER: W) Sandstone [JY]

BONUS

3) Earth and Space - *Short Answer* What is the name of the geologic process in which the Earth's crust is compressed, folded, and uplifted during mountain building events?

ANSWER: Orogeny (ACCEPT: Orogenesis) [JY]

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TOSSUP

4) Math - *Short Answer* A 9-digit integer contains each of the digits 1-9 with no repeats. What is the probability that this integer is divisible by 15?

ANSWER: 1/9

BONUS

4) Math - *Short Answer* Let X be the sum of the first 2025 cube numbers. What is the largest prime that divides X?

ANSWER: 1013

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TOSSUP

5) Physics - *Short Answer* A charge q is centered on a sphere with radius R. The sphere's radius is then doubled. By what factor does the electric flux through the sphere change?

ANSWER: 1

BONUS

5) Physics - *Short Answer* An object is dropped from a 25 story building where each story is 5 meters. In seconds, how long does the object take to hit the ground?

ANSWER: 5 seconds

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TOSSUP

6) Biology- *Multiple Choice:* You find two genes in species that are very distantly related but have the same function. After further analysis you determine that the genes do not have any shared evolutionary ancestry. What term best describes this pair of genes?

W) Analogous
X) Homologous
Y) Orthologous
Z) Paralogous

ANSWER: W) Analogous [HL]

BONUS

6) Biology- *Short Answer:* What term refers to a leaf with a single petiole that bears multiple leaflets sharing a single axillary bud?

ANSWER: Compound Leaf (ACCEPT: Compound) [HL]

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TOSSUP

7) Chemistry - *Multiple Choice* Which of the following species has a nonzero value for its standard enthalpy of formation?

W) Graphite
X) Oxygen gas
Y) Liquid Bromine
Z) Diamond

ANSWER: Z) Diamond [SO]

BONUS

7) Chemistry - *Short Answer* Identify all of the following three factors that can change the Standard Gibbs Free Energy for a reaction:

1) Temperature
2) Volume
3) Concentration of species in solution

ANSWER: 1 ONLY [SO]

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TOSSUP

8) Earth and Space - *Short Answer* Identify all of the following three cloud types that are considered mid-level clouds:

1) Stratocumulus
2) Altocumulus
3) Altostratus

ANSWER: 2 and 3 [JY]

BONUS

8) Earth and Space - *Short Answer* Sometimes, a stream meander becomes so sharp that it pinches itself off and leaves a stagnant feature. What is the name of this feature?

ANSWER: Oxbow lake [JY]

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TOSSUP

9) Math - *Short Answer* Identify all of the following 4 values of n that would satisfy the equation n^4 is congruent to 1 mod 5.

1) 12
2) 13
3) 14
4) 15

ANSWER: 1, 2, and 3

BONUS

9) Math - *Short Answer* A square with side length 4 is morphed into another two-dimensional figure such that the perimeter remains constant. What is the maximum area of this new figure?

ANSWER: 64/pi

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TOSSUP

10) Physics - *Short Answer* What law states that the entropy of a perfect crystal at absolute 0 is 0?

ANSWER: Third Law of Thermodynamics

BONUS

10) Physics - *Short Answer* Sanjay experiences a drag force of bv^2 where v is his velocity and b is 5 N*s^2/m^2. If he has a mass of 50 kg, what is his terminal velocity? Assume g = 10 m/s^2.

ANSWER: 10 m/s

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TOSSUP

11) Biology - *Multiple Choice:* A patient develops metabolic alkalosis. Which of the following are likely to be observed upon physical examination in the emergency room?

W) Hyperventilation and increased partial pressure of carbon dioxide in the blood.
X) Hyperventilation and decreased partial pressure of carbon dioxide in the blood.
Y) Hypoventilation and increased partial pressure of carbon dioxide in the blood.
Z) Hypoventilation and decreased partial pressure of carbon dioxide in the blood.

ANSWER: X) Hyperventilation and decreased partial pressure of carbon dioxide in the blood. [AD]

BONUS

11) Biology - *Short Answer:* Identify all of the following three conditions likely to contribute to the rightward shift of the hemoglobin-oxygen dissociation curve?

1) Increased partial pressure of carbon dioxide.
2) Increased pH
3) Increased concentrations of 2,3 BPG

ANSWER: 1 and 3 [AD]

TOSSUP

12) Chemistry - *Multiple Choice* Carbon tetrachloride, CCl_4, has a noticeably higher boiling point than chloroform, $CHCl_3$. Which of the following intermolecular forces best accounts for this difference?

W) Dipole-Dipole
X) London Dispersion
Y) Hydrogen Bond
Z) Ion-Dipole

ANSWER: X) London Dispersion [SO]

BONUS

12) Chemistry - *Short Answer* Identify all of the following three changes that would increase the vapor pressure of a solvent:

1) Increasing the atmospheric pressure
2) Adding a nonvolatile solute
3) Increasing the temperature

ANSWER: 3 ONLY [SO]

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TOSSUP

13) Earth and Space - *Multiple Choice* Which of the following galaxy classes would have the highest metallicity?

W) Spiral
X) Elliptical
Y) Lenticular
Z) Irregular

ANSWER: X) Elliptical

BONUS

13) Earth and Space - *Multiple Choice* 21 cm radiation would best be used to detect which of the following?

W) H1 Region
X) H2 Region
Y) Giant Molecular Clouds
Z) Coronal Gas
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ANSWER: W) H1 Region

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TOSSUP

14) Math - *Short Answer* A piano has 88 keys. Likith and Monish independently and at random choose one of the 88 keys. What is the probability that Monish's key is higher than Likhith's key?

ANSWER: 87/176

BONUS

14) Math - *Short Answer* If the log base 2 of x plus the log base 4 of x plus the log base 16 of x equals 14 then what is x?

ANSWER: 256

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TOSSUP

15) Physics - *Short Answer* A Carnot heat engine operates between a hot reservoir at 400 kelvins and a cold reservoir at 280 kelvins. What is the maximum possible efficiency of this engine?

ANSWER: 0.3

BONUS

15) Physics - *Short Answer* What is the energy of a photon with a wavelength of 66 nm to 2 significant figures?

ANSWER: $3.0 * 10^{-18}$ J

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TOSSUP

16) Biology - *Multiple Choice:* Praneel is raising a population of frogs for his biology class, but unfortunately they all died because of a fungal infection of the skin. The pathogen responsible for this infection most likely belongs to which of the following phyla?

W) mucoromycota
X) ascomycota
Y) zoopagomycota
Z) chytridiomycota
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ANSWER: Z) chytridiomycota [AD]

BONUS

16) Biology - *Short Answer* Arjun finds mutant caterpillars that undergo metamorphosis on an earlier molt than wild type individuals. These individuals likely have a loss-of-function mutation in the gene encoding what hormone?

ANSWER: juvenile hormone [AD]

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TOSSUP

17) Chemistry - *Short Answer* In a certain type of electrochemical cell, changing the identity of the electrodes does not affect the voltage across the cell. What is the name for this cell, in which the electrodes are made using the same material with uneven concentrations?

ANSWER: Concentration cell [SO]

BONUS

17) Chemistry - *Short Answer* Order the following three bonds in terms of DECREASING bond polarity

1) B-H
2) C-H
3) O-H

ANSWER: 3, 2, 1 [SO]

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TOSSUP

18) Earth and Space - *Multiple Choice* Which of the following moons has the strongest surface gravitational acceleration?

W) Enceladus
X) Luna
Y) Callisto
Z) Europa

ANSWER: X) Luna

BONUS

18) Earth and Space - *Short Answer* A star has an apparent magnitude of 8 and an absolute magnitude of 3. What is the distance to the star in parsecs?

ANSWER: 100 parsecs

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TOSSUP

19) Math - *Short Answer* In a certain probability distribution, the value 20 has a z-score of 1.2, and the value 11 has a z-score of -.6. What is the standard deviation of this distribution?

ANSWER: 5

BONUS

19) Math - *Short Answer* The equation of a line tangent to a function f(x) at x = 4 is y = x+7. What is the equation of the line tangent to the function 2f(x) - 6 at x = 4?

ANSWER: y = 2x + 8

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TOSSUP

20) Physics - *Multiple Choice* An archer fish is a fish that shoots water at insects on branches above the water line. The archer fish notices an insect at an angle of 80 degrees from the horizon. Where should the archer fish aim to accurately hit its prey?

W) Exactly at the apparent angle of 80°
X) Slightly above the apparent angle of 80°
Y) Slightly below the apparent angle of 80°
Z) At 90° from the horizontal

ANSWER: Y) Slightly below the apparent angle of 80°

BONUS

20) Physics - *Short Answer* The police are chasing Edwin on the highway. The police car is traveling at 63 m/s while you're at rest. Anurag in the backseat of the police car hears the siren at a frequency of 400 Hz. At what frequency do you hear the siren? Assume the speed of sound is 343 m/s.

ANSWER: 490 Hz