

DE2

TOSSUP

1) Biology - *Multiple Choice* Which of the following treatments would result in an increase in the average rate of mitochondrial oxygen consumption?

W) Treatment with rotenone
X) Treatment with potassium cyanide
Y) Treatment with 2,3 dinitrophenol
Z) Treatment with oligomycin

ANSWER: Y) Treatment with 2,3 dinitrophenol [AD]

BONUS

1) Biology - *Short Answer* Praneel, having been stabbed in the chest, is suffering from tension pneumothorax. Select all of the following three options that correctly describe respiratory changes that would occur as a result of this injury.

1) Increase in transpulmonary pressure
2) Increase in intrapleural pressure
3) Increase in transthoracic pressure

ANSWER: 2, 3 [AD]

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TOSSUP

2) Chemistry - *Multiple Choice* Which of the following elements has the highest 5th ionization energy?

W) Magnesium
X) Aluminum
Y) Silicon
Z) Phosphorus

ANSWER: Y) Silicon [SO]

BONUS

2) Chemistry - *Short Answer* Identify all of the following three transition metal ions that are colored in aqueous solution:

1) Fe^{3+}
2) Zn^{2+}
3) Sc^{3+}
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ANSWER: 1 ONLY [SO]

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TOSSUP

3) Earth and Space - *Short Answer* Identify all of the following three minerals that are ores of copper:

1) Chalcopyrite
2) Azurite
3) Bornite

ANSWER: All [JY]

BONUS

3) Earth and Space - *Short Answer* Order the following three stages in the development of a roche moutonnee (ROE-sh-moo-ton-nay) in chronological order:

1) Plucking of the lee side
2) Abrasion and polishing of the stoss side
3) Glacier encounters resistant bedrock mass

ANSWER: 3, 1, 2 [JY]

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TOSSUP

4) Math - Short Answer One of the keys of the calculator is the squaring key, which replaces the number x on the display with x^2. The calculator currently displays the number 2. How many times must Monish press the squaring key in order for the calculator to display a number greater than 500?

ANSWER: 4

BONUS

4) Math - Short Answer An ant is standing on vertex A of Heptegon ABCDEFG. Every second the ant moves with probability ½ clockwise or counter clockwise. What is the probability that the ant reaches point D before it reaches point E.

ANSWER: 1/2

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TOSSUP

5) Physics Short Answer Alien spaceships are chasing each other around a red dwarf star with a mass of 10^{30} kg. One of the ships launches itself at escape velocity away from the star. What is the total energy of its orbit if the spaceship starts at a distance of 200,000 km away from the star?

ANSWER: 0

BONUS

5) Physics - *Short Answer* An object is placed in water and ¾ of its volume is above the water. If the same object is placed in oil with a density 0.6 times that of water, what fraction of the object's volume will be above the water?

ANSWER: 7/12

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TOSSUP

6) Biology - *Multiple Choice* What type of glycosidic linkages join branches to the rest of the glycogen molecule?

W) 1, 4 alpha glycosidic linkages
X) 1, 4 beta glycosidic linkages
Y) 1, 6 alpha glycosidic linkages
Z) 1,6 beta glycosidic linkages

ANSWER: Y) 1,6 alpha glycosidic linkages [HL]

BONUS

6) Biology - *Short Answer* What variation of the citric acid cycle found in only plants, used to synthesize four carbon carbohydrates from two carbon compounds by skipping decarboxylation steps, occurs in peroxisome derivatives by a similar name?

ANSWER: Glyoxylate Cycle [HL]

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TOSSUP

7) Chemistry - *Short Answer* Identify all of the following three compounds which are expected to have a positive slope for the solid-liquid boundary line on their phase diagram:

1) Water
2) Ammonia
3) Hydrogen Fluoride

ANSWER: 2 AND 3 [SO]

BONUS

7) Chemistry - *Multiple Choice* Which of the following techniques would best be used to separate a mixture of dyes into its individual components?

W) Thin Layer Chromatography
X) Gas Chromatography
Y) Fractional Distillation
Z) Filtration

ANSWER: W) Thin Layer Chromatography [SO]

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TOSSUP

8) Earth and Space - *Short Answer* Order the following four ions in order of decreasing concentration in seawater:

1) Chloride
2) Sulfate
3) Magnesium
4) Sodium

ANSWER: 1, 4, 2, 3 [JY]

BONUS

8) Earth and Space - *Short Answer* Identify all of the following three types of precipitation that require the presence of a warm layer of air below their point of formation in order to reach the surface in their listed form:

1) Snow
2) Sleet
3) Freezing rain

ANSWER: 2 and 3 [JY]
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TOSSUP

9) Math - *Multiple Choice* What is the maximum number of intersections between 5 lines and 1 circle?

W) 10
X) 15
Y) 20
Z) 25

ANSWER: Y) 20

BONUS

9) Math - Short Answer A bag has 3 red marbles, 4 green marbles and 6 blue marbles. If Sanjay randomly pulls out two marbles from the bag, what is the probability that both marbles are the same color?

ANSWER: 4/13

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TOSSUP

10) Physics Short Answer What principle states that the difference in potential and kinetic energy integrated over time is minimized over a particle's path?

ANSWER: Principle of Least Action

BONUS

10) Physics *Short Answer* 2 Capacitors are connected in parallel, one with a capacitance of 2 farads and the other with a capacitance of 4 farads. What is the charge on the 4 farad capacitor if the potential energy of the 2 farad capacitor is 16 J?

ANSWER: 16 C

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TOSSUP

11) Biology - *Multiple Choice* In an effort to cure cancer, Sanjay is studying Abl1 kinase, and seeks to purify it from a culture of fibroblasts. In order to do so, he uses a form of affinity chromatography that binds proteins to nickel ions. In order for this to work, Sanjay must tag Abl1 kinase with which of the following amino acids?

W) aspartic acid
X) lysine
Y) arginine
Z) histidine

ANSWER: Z) histidine[AD]

BONUS

11) Biology - *Short Answer* For his biology class, Praneel is dissecting an earthworm. He finds a peculiar network of tubules that seems to collect fluid from the coelom and functions in the production of urine. What is the term for the structure he has likely encountered?

ANSWER: metanephridia (ACCEPT: metanephridium) [AD]

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TOSSUP

12) Chemistry- *Multiple Choice* Carbon-14 is an isotope of Carbon that lies slightly above the band of stability. Which of the following specific types of nuclear decay is Carbon-14 most likely to undergo?

W) Beta-minus
X) Beta-plus
Y) Positron emission
Z) Electron capture

ANSWER: W) Beta-minus [SO]

BONUS

12) Chemistry - *Short Answer* Which quantum number describes the orientations of subshells in three-dimensional space?

ANSWER: Magnetic quantum number (ACCEPT: ml) [SO]

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TOSSUP

13) Earth and Space - *Multiple Choice* Which of the following is closest to the rate of star formation in stars per year in the Milky Way?

W) 1
X) 100
Y) 10000
Z) 1000000

ANSWER: W) 1

BONUS

13) Earth and Space - *Multiple Choice* Which of the following explains the blue stars found in certain old Elliptical galaxies?

W) Recent star formation triggered by galaxy mergers
X) Stars formed by stellar collisions or mass transfer
Y) Gravitational lensing of background spiral galaxies
Z) Reflection of light from nearby quasars

ANSWER: X) Stars formed by stellar collisions or mass transfer

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TOSSUP

14) Math - S*hort Answer* How many ordered triples of integers (a,b,c) have the property that a*b*c = 2025?

W) 60
X) 72
Y) 90
Z) 108

ANSWER: Y) 90

BONUS

14) Math - S*hort Answer* Call a number n, special if exactly ¼ of its divisors are odd. What is the smallest special number that has more than 2 odd factors?

ANSWER: 72

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TOSSUP

15) Physics - *Short Answer* Arjun plots the current density on the y axis of a graph and the electric field on the x axis. The resistivity is equal to what power of the slope?

ANSWER: -1

BONUS:

15) Physics - *Short Answer* Sanjay pushes a box with a force given by 2i + 4j + k through a displacement vector of 0i + 8j + 2k. What is the average power given by the force if this process takes 2 seconds?

ANSWER: 17 Watts

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TOSSUP

16) Biology - *Multiple Choice* Which of the following groups of protozoans, which include *Trypanosoma brucei,* the causative agent of African Sleeping Sickness, are characterized by the presence of an organelle with a large mass of mitochondrial DNA?

W) Diplomonads
X) Kinetoplastids
Y) Dinoflagellates
Z) Oomycetes

ANSWER: X) Kinetoplastids [AD]

BONUS

16) Biology - *Short Answer* After a long day of studying math, Monish is enjoying some strawberries. Identify all of the following four options that correctly characterize strawberries:

1) Simple Fruit
2) Multiple Fruit
3) Aggregate Fruit
4) Accessory Fruit

ANSWER: 3, 4 [AD]

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TOSSUP

17) Chemistry- *Short Answer* In the arrhenius equation, what constant, symbolized by the letter A, represents the frequency of properly oriented collisions?

ANSWER: Pre-exponential Factor [SO]

BONUS

17) Chemistry- *Multiple Choice* In a voltaic cell between tin and copper, the tin is oxidized to tin (ii) ions, while the copper is reduced from copper (ii) ions. Which of the following changes will increase the voltage of the voltaic cell?

W) Increasing the surface area of the tin electrode
X) Increasing the surface area of the copper electrode
Y) Increasing the concentration of tin(ii) ions
Z) Increasing the concentration of copper(ii) ions

ANSWER: Z) Increasing the concentration of copper(ii) ions [SO]

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TOSSUP

18) Earth and Space - *Short Answer* Earendal is a star discovered by the JWST and holds the record for the farthest star ever observed. Despite the fact that it is over 26 billion light years away, JWST could make it out due to the large galaxy cluster in front of it. What phenomenon predicted by general relativity explains how Earendal can be seen?

ANSWER: Gravitational Lensing

BONUS

18) Earth and Space - *Multiple Choice* On radio maps of the moon Titan, radar mapping of the Xanadu Region shows dark areas punctuated by slits of bright light. Which of the following features could this indicate?

W) Cryovolcanic Basins
X) Lakes
Y) Mountain Ranges
Z) Dunes

ANSWER: Z) Dunes

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TOSSUP

19) Math - *Short Answer* Arjun wants to buy eggs to cook for a Science Bowl Tournament. The bakery sells eggs in either a dozen, 12 eggs, or a baker's dozen, 13 eggs. What is the largest number of eggs that he cannot buy?

ANSWER: 131

BONUS

19) Math - *Short Answer* What is the slope of the line perpendicular to the inverse function of the line y = 12x - 3?

ANSWER: -12

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TOSSUP

20) Physics - *Short Answer* In magnetohydrodynamics of an incompressible fluid, identify all of the following 4 options that are true:

1) The curl of the magnetic field is 0
2) The divergence of the magnetic field is 0
3) The curl of the fluid velocity field is 0
4) The divergence of the fluid velocity field is 0

ANSWER: 2,4

BONUS

20) Physics - *Short Answer* In a universe where matter is constrained to 2D, what is the adiabatic index for a monoatomic gas?

ANSWER: 2
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