NWI2 DE7

TOSS UP

1) CHEMISTRY - *Multiple Choice* Which of the following compounds has the lowest index of hydrogen deficiency (IHD) value?

W) Ethylene
X) Methanal
Y) Methanoic acid
Z) Methanol

ANSWER: Z) Methanol

BONUS

1) CHEMISTRY - *Short Answer* Order the following 4 diacids in order of increasing number of carbons: 1) adipic acid, 2) malonic acid, 3) oxalic acid, 4) succinic acid

ANSWER: 3, 2, 4, 1

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TOSS UP

2) PHYSICS - *Short Answer* What experiment disproved the existence of the luminiferous aether?

Answer: Michelson Morley experiment

BONUS

2) PHYSICS - *Multiple Choice* From your frame of reference, a ship is traveling at 3/4 c. To the nearest tenth, what would the ratio between the elapsed time of the ship from your reference frame be compared to your own time?

w. 1.3

x. 1.4

y. 1.5

z. 1.6

Answer:y. 1.5
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TOSS UP

3) MATH - *Short Answer* What is the upper limit of the error when approximating cos(1) using the first three terms of the Maclaurin series for cos(x)?

ANSWER: 1/720

BONUS

3) MATH - *Multiple Choice* A circle with radius 6 has a sector of degree 60 removed from it, what is the volume when it is turned into a cone?

W) $8\sqrt{11}\pi$
X) $\frac{25}{3}\sqrt{11}\pi$
Y) $\frac{28}{3}\sqrt{11}\pi$
Z) $7\sqrt{11}\pi$

Answer: X) $\frac{25}{3}\sqrt{11}\pi$

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TOSS UP

4) EARTH AND SPACE - *Short Answer* A geologist discovers an igneous feldspar crystal that they believe cycled through the magma chamber it formed in, creating circular layers of lighter and darker material. What type of zoning does this crystal exhibit?

ANSWER: Oscillatory

BONUS

4) EARTH AND SPACE - *Short Answer* 30 Doradus, or the Tarantula Nebula, is an extremely luminous and active starburst region located in the Large Magellanic Cloud. Given that the nebula is 49 kiloparsecs away and has an apparent magnitude of +8, what is its absolute magnitude, to the nearest whole number?

ANSWER: -10

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TOSS UP
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5) ENERGY- *Short Answer* Suppose a researcher conducts an experiment to test a hypothesis. If she doubles her sample size, which of the following will increase?

I) The power of the hypothesis test
II) The effect size of the hypothesis test
III) The probability of making a type II error

ANSWER: I ONLY

BONUS

5) ENERGY- With respect to experimental design, which of the following statements are true?

I) Blinding controls for the effects of confounding
II) Randomization controls for effects of lurking variables.
III) Each experimental factor has one treatment level

ANSWER: II ONLY

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TOSS UP

6) BIOLOGY- *Short Answer* By name or number identify all of the following 4 amino acids would you most likely find in the transmembrane domain of a G-coupled domain receptor?
I) Leucine
II) Isoleucine
III) Serine
IV) Threonine

ANSWER: I, II, III, IV (ACCEPT: ALL)

BONUS

6) BIOLOGY

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TOSS UP

7) CHEMISTRY - *Multiple Choice* Which of the following is the closest to the boiling point elevation constant of water in kelvin per molal?

W) 0.3
X) 0.4
Y) 0.5
Z) 0.6

ANSWER: Y) 0.5

BONUS

7) CHEMISTRY - *Multiple Choice* Which of the following number of pi electrons can't be found in an aromatic compound?

W) 6
X) 10
Y) 12
Z) 14

ANSWER: Y)12

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TOSS UP

8) PHYSICS - *Multiple Choice* Noether's theorem states that a symmetry in the action of a system implies a conservation law. What symmetry implies the conservation of energy?

W) Translational

X) Rotational

Y) Parity

Z) Time

Answer: Z) Time

BONUS

8) PHYSICS - *Short Answer* A current loop rotates in a uniform magnetic field of magnitude 7.5x10^-3 teslas. The loop has an area of 4 x 10^-3 square meters. The angle between the area vector and the magnetic field changes from 0 degrees to 180 degrees in 2.0 seconds. IN volts and to 1 significant figure, what is the magnitude of the average induced EMF in the loop?
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Answer: 3x10^-5

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TOSS UP

9) MATH - *Multiple Choice* Oscar is researching the benefits of having better air quality. To do so, he needs to find the average air quality throughout the day, which he models as the function A(t) = 4sin(πt/12) +2, where t is in hours. Which of the following is the average air quality from t=0 to t=24.

W) 3π/4
X) 12/π
Y) 2
Z) π/3+2

ANSWER: Y) 2

BONUS

9) MATH - *Short Answer* Solve the following equation for all values between 0 and 2π: $3cos(2x) + 9sin(x/2) - 3$?

ANSWER: x= 0, 2π, π/3, 5π/3

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TOSS UP

10) EARTH AND SPACE - *Multiple Choice* A Wolf-Rayet star would most likely produce which of the following types of supernovae?
W) 1a
X) 1b
Y) 2-L
Z) 2-P
ANSWER: X) 1b

BONUS

10) EARTH AND SPACE - *Short Answer* Order the following three Galilean moons in terms of increasing presence of craters on their surfaces: 1) Europa; 2) Ganymede; 3) Io.

ANSWER: 3, 1, 2

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TOSS UP
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11) ENERGY – *Multiple Choice* Scientists at Sandia National Lab are studying the formation of aerosols in the troposphere via Criegee intermediates, carbonyl oxides with one positive and one negative charge center. Criegee intermediates are examples of what type of molecules, which contain an equal number of positively and negatively charged functional groups?

ANSWER: Zwitterions

BONUS

11) ENERGY – *Multiple Choice* Scientists at Lawrence Livermore National Lab are working on separating seismic waves generated by earthquakes and nuclear tests. Which of the following best describes how nuclear tests compare to earthquakes on average?

W) Higher magnitude and relatively stronger P waves
X) Higher magnitude and relatively stronger S waves
Y) Lower magnitude and relatively stronger P waves
Z) Lower magnitude and relatively stronger S waves

ANSWER: W) Higher magnitude and relatively stronger P waves

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TOSS UP

12) BIOLOGY What order do chimpanzees belong to?

ANSWER: Primates

BONUS

12) BIOLOGY In Mihir's zoo, chimpanzees which normally have 5 fingers have developed mutations. which allows some to have 6 fingers and others to have 4. If the chimpanzees with 6 and 4 fingers are more likely to grab the bananas that Mihir throws at them than the chimpanzees with 5 fingers, what type of natural selection is exhibited?

ANSWER: Disruptive selection

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TOSS UP

13) CHEMISTRY - *Multiple Choice* Which of the following reactions is an oxidation reaction?

W) Williamson ether synthesis

X) Formation of epoxides from halohydrins
Y) Dihydroxylation of alkenes
Z) Acid-catalyzed water addition to alkenes

ANSWER: X) Formation of epoxides from halohydrins

BONUS

13) CHEMISTRY - Short Answer What is the IUPAC name of the major product when acetylene is exposed to the following sequence of reagents? If no reaction occurs in a step, state the last product that is formed: ethyl bromide in sodium amide, mercury (II) sulfate in aqueous sulfuric acid, hydrogen with palladium catalyst, and para-toluene sulfonic acid with heat?

ANSWER: 2-butene or but-2-ene

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TOSS UP

14) EARTH AND SPACE - *Multiple Choice* In what season does Earth's atmospheric carbon dioxide concentration increase most rapidly?
W) Spring
X) Summer
Y) Fall
Z) Winter
ANSWER: Z) Winter

BONUS

14) EARTH AND SPACE - A wave in the open ocean has a wavelength of 40 meters. In meters, what is the approximate depth of the wave base in this region, to the nearest ten?
ANSWER: 20

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TOSS-UP

15) MATH- *Short Answer* A restaurant has a special that allows you to order any 3 of 12 possible items, and allows duplicates of the same item. How many different orders are possible?

ANSWER: 364

BONUS

15) MATH - *Multiple Choice* Which mathematical theorem states that legendre (p/q) (said as "legendre p on q") times legendre (q/p)=(-1)^((p-1)/2)((q-1)/2) where p and q are distinct odd primes

W) Quadratic reciprocity
X) Wilson's theorem
Y) Primitive root theorem
Z) Legendre's formula

ANSWER: W) Quadratic reciprocity

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TOSS UP

16) EARTH AND SPACE - *Multiple Choice* Which of the following events occurred during the Pleistocene epoch?
W) formation of Isthmus of Panama
X) closing of Tethys Sea
Y) Himalayan orogeny
Z) last glacial maximum
ANSWER: Z) last glacial maximum

BONUS

16) EARTH AND SPACE - *Short Answer* What type of magmatic eruption would be classified as having large gas bubbles and a VEI of 1 to 2?
ANSWER: strombolian

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TOSS UP

17) CHEMISTRY - *Short Answer* If a reaction is first order, and has a rate constant of ln(4) inverse seconds, what is the time, in seconds, of the half life of the reaction?

ANSWER: 1/2

BONUS

17) CHEMISTRY - *Multiple Choice* If, for a certain reaction, the value for the reaction quotient Q is less than the value of the equilibrium constant K, which of the following is true regarding its delta G value?

W) $\Delta G < 0$

X) $\Delta G > 0$
Y) $\Delta G = 0$
Z) The sign of ΔG cannot be determined with the given information

ANSWER: W) $\Delta G < 0$

TOSS UP

18) BIOLOGY - *Short Answer* By name or number, identify all of the following three values that increase as you move from the base of the lung to the apex of the lung: 1) V/Q ratio, 2) PaO2, 3) PaCO2

ANSWER: 1 AND 2

BONUS

18) BIOLOGY - *Multiple Choice* Which of the following is not a normal physiological response to or effect of hypernatremia?
W) Increased secretion of ANP
X) Decreased Na+ reabsorption
Y) Constriction of the afferent arteriole
Z) Increased effective arterial blood volume

ANSWER: Y) CONSTRICTION OF THE AFFERENT ARTERIOLE

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TOSS UP

19) ENERGY- *Multiple Choice* Suppose X and Y are independent random variables. The variance of X is equal to 16 and the variance of Y is equal to 9. Let Z = X + Y. What is the standard deviation of Z.

W) 2
X) 5
Y) 10
Z) 25

ANSWER: X) 5

BONUS
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19) ENERGY- *Short Answer* Identify all of the following statements that are true

I) Random Sampling is a good way to reduce response bias
II) To guard against bias from undercoverage, use a convenience sample
III) Increasing sample size tends to reduce survey bias
IV) To guard against nonresponse bias, use a mail-in survey

ANSWER: NONE OF THE ABOVE

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TOSS UP

20) EARTH AND SPACE - *Short Answer* Which of the following Hubble Galaxy Classifications is properly matched to its common name?
W) SBc, spiral
X) Sa, elliptical
Y) SBb, barred spiral
Z) S0, spiral
ANSWER: Y) SBb, barred spiral

BONUS

20) EARTH AND SPACE - *Short Answer* Order the following three Solar System bodies based on increasing radius: 1) Mercury, 2) Ganymede, 3) Callisto
ANSWER: 3, 1, 2
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