NWI2 DE6

TOSS-UP

1) EARTH AND SPACE - *Short Answer* Order the following three oceanic sediment types in terms of increasing depth at which they dominate: 1) Abyssal clay; 2) Calcareous ooze; 3) Terrigenous sediment.

ANSWER: 3, 2, 1

BONUS

1) EARTH AND SPACE- *Multiple Choice* Shock metamorphism acting on sandstone typically produces which of the following pairs of minerals?

W) Anorthite and forsterite
X) Coesite and stishovite
Y) Garnet and staurolite
Z) Kyanite and staurolite

ANSWER: X) Coesite and stishovite

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TOSS-UP

2) BIOLOGY - *Short Answer* Identify the type of feedback relation between hormones insulin and glucagon as well as what type of pancreatic cell is responsible for secreting each.
ANSWER: NEGATIVE FEEDBACK; INSULIN - BETA CELLS; GLUCAGON - ALPHA CELLS (ACCEPT ANY VARIATION. DO NOT ACCEPT A PARTIAL, PARTIALLY CORRECT, OR INCOMPLETE ANSWER)

BONUS
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2) BIOLOGY - *Short Answer* Which of the following processes is NOT involved with the maturation of pre-mRNA before it becomes mature mRNA

W) Addition of a 5 prime cap
X) Splicing of introns
Y) Addition of a poly A tail
Z) Methylation of cytosine bases

ANSWER: Z) METHYLATION OF CYTOSINE BASES

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TOSS-UP

3) MATH - *Short Answer* If $68x^2$ has 90 factors, how many factors does $136x^3$ have?

ANSWER: 224

BONUS

3) MATH - *Short Answer* How many numbers less than 1176 are not coprime with 1176?

ANSWER: 840

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TOSS-UP

4) CHEMISTRY - *Short Answer* In terms of the reduced planck constant, ħ [READ AS: h-bar], what is the angular momentum of an electron in the $3d_{x^2-y^2}$ orbital?

ANSWER: $\sqrt{6}$ħ (Root six h-bar)

BONUS

4) Chemistry - *Short Answer* The atomic radius of aluminum is 143pm. If gold crystallizes in a face centered cubic structure, what is the side length of the unit cell?

ANSWER: $286\sqrt{2}$pm

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TOSS-UP

5) EARTH AND SPACE - *Short Answer* Once thought to be emission lines of a new element, some solar emission lines come from heavy metals missing as many as thirteen electrons. What layer of the Sun do these emission lines originate from?

ANSWER: Corona

BONUS

5) EARTH AND SPACE - *Short Answer* Which of the following best describes how the observed rotation curve of a galaxy differs from a predicted rotation curve that does not consider the presence of dark matter?

W) Similar near the center, higher near the edges
X) Similar near the center, lower near the edges
Y) Similar near the edges, higher near the center
Z) Similar near the edges, lower near the center

ANSWER: W) Similar near the center, higher near the edges

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TOSS-UP

6) ENERGY- *Short Answer* Scientists at the National Renewable Energy Lab are predicting crystal defects with a neural network that models complex processes using a set of interconnected nodes. What type of neural network are these scientists using?

ANSWER: Graph neural network (ACCEPT: Graph, GNN)

BONUS

6) ENERGY- *Short Answer* In machine learning, what is the term for the algorithm that adjusts model parameters to minimize the error between predicted and actual outputs, commonly used in training neural networks?

ANSWER: GRADIENT DESCENT

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TOSS-UP

7) PHYSICS- *Short Answer* An object of mass 4 kg has a moment of inertia of 10 kgm^2 when spinning in an axis that passes through its center of mass. If the object is instead spun about an axis 50 cm away from the center of mass, parallel to the original axis, what is the new moment of inertia, in kg m^2?

ANSWER: 11

BONUS

7) PHYSICS- *Short Answer* In nanotechnology, which semiconductor nanostructure exhibits unique optical and electronic properties due to quantum confinement, where the motion of charge carriers is restricted in all three spatial dimensions, and is used in applications such as fluorescence imaging and solar cells?

ANSWER: QUANTUM DOTS

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TOSS-UP

8) CHEMISTRY - *Short Answer* How many carbon atoms are there in benzophenone?
ANSWER: 13

BONUS

8) Chemistry - *Short Answer* Oscar is reacting 1,3-butadiene with HBr at room temperature, expecting to yield 3-bromobutene. However, he spent too much dilly-dallying and came back to his reaction after a long time had passed. What is the IUPAC name for the expected major product?

ANSWER: 1-bromobut-2-ene (ACCEPT: 1-bromo-2-butene)

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TOSS-UP
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9) EARTH AND SPACE - *Multiple Choice* In the Northern Hemisphere, the air pressure gradient in the upper troposphere typically points in what cardinal direction?

W) North
X) South
Y) East
Z) West

ANSWER: W) North

BONUS

9) EARTH AND SPACE - *Multiple Choice* Which of the following minerals does NOT commonly form a dodecahedral habit?

W) Almandine garnet
X) Galena
Y) Halite
Z) Pyrite

ANSWER: Y) Halite

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TOSS-UP

10) BIOLOGY- *Short Answer* What acronym refers to the most recent common ancestor of all current life on Earth, which is believed to have lived around 3.5 to 4 billion years ago?

ANSWER: LUCA (ACCEPT: LAST UNIVERSAL COMMON ANCESTOR)

BONUS

10) BIOLOGY- *Short Answer* In eukaryotic gene expression, which enzyme is responsible for adding a 5′ cap to the nascent pre-mRNA during transcription, and what is the primary function of this modification?

ANSWER: GUANYLYL TRANSFERASE
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TOSS-UP

11) CHEMISTRY - *Short Answer* Reaction of isopropyl alcohol with pyridinium chlorochromate (PCC) results in which of the following compounds?

ANSWER: Propanone

BONUS

11) CHEMISTRY - *Multiple Choice* Vicky is taking the IR spectrum of an unknown sample and notices that there are no peaks greater than 3000 cm^{-1}. Which of the following could be the identity of the sample?
W) Aniline
X) 2,3-dimethylbutene
Y) cyclohexane
Z) hexanol

ANSWER: Y) Cyclohexane

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TOSS-UP

12) MATH - *Short Answer* What is the equation of the quadratic with root -5+7i?

ANSWER: $x^2+10x+74$

BONUS

12) MATH - *Short Answer* Consider a standard 52 card deck of cards. If Oscar blindly draws 4 cards without replacement and an ace is considered 1, regardless of suit, what is the probability he draws 2 face cards then draws 2 value cards?

ANSWER: 264/4165

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TOSS-UP

13) EARTH AND SPACE *Short Answer* In photos, the edge of the Sun appears much darker than its center because light emitted there is not directed towards Earth. What name is given to this phenomenon?

ANSWER: Limb darkening

BONUS

13) EARTH AND SPACE Given that the Sun has an absolute magnitude of 5 and an apparent magnitude of -27, its distance from Earth in parsecs can be expressed as 10 to what power?

ANSWER: -5.4

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TOSS-UP

14) ENERGY- *Multiple Choice* An auto analyst is conducting a satisfaction survey, sampling from a list of 10,000 new car buyers. The list includes 2,500 Ford buyers, 2,500 GM buyers, 2,500 Honda buyers, and 2,500 Toyota buyers. The analyst selects a sample of 400 car buyers, by randomly sampling 100 buyers of each brand. Is this an example of a simple random sample?

W) Yes, because each buyer in the sample was randomly sampled.
X) Yes, because each buyer in the sample had an equal chance of being sampled.
Y) No, because every possible 400-buyer sample did not have an equal chance of being chosen.
Z) No, because the population consisted of purchasers of four different brands of car.

ANSWER: Y) NO, BECAUSE EVERY POSSIBLE 400-BUYER SAMPLE DID NOT HAVE AN EQUAL CHANCE OF BEING CHOSEN

BONUS

14) ENERGY- *Multiple Choice*Which of the following countries is the largest producer of nuclear power?
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W) The United States of America
X) Russia
Y) France
Z) North Korea

ANSWER: W) THE UNITED STATES OF AMERICA

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TOSS-UP

15) PHYSICS - *Short Answer* Which phenomenon, arising from quantum field theory, describes the attractive force between two uncharged, parallel conducting plates placed in a vacuum, resulting from changes in the vacuum energy between the plates?

ANSWER: CASIMIR EFFECT

BONUS

15) PHYSICS- *Short Answer* Which mathematical tool is used in signal processing and quantum mechanics to transform a function of time or space into a function of frequency, and is essential for analyzing the frequency components of signals or waveforms?

ANSWER: FOURIER TRANSFORM

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TOSS-UP

16) BIOLOGY- *Short Answer* Most calico cats are female due to the alleles for coat color being linked to the X-chromosome. Since females have two X-chromosomes, they can inherit one orange allele and one non-orange allele, resulting in a combination of orange, black and sometimes white fur. For the calico fur coloration to be present on a male cat, the cat would need a second copy of the X chromosome. Which genetic condition most commonly plagues male calico cats and is characterized by the genotype XXY.

ANSWER: KLINEFELTER'S SYNDROME

BONUS

16) BIOLOGY- *Short Answer* Which process in developing B and T cells involves the random rearrangement of gene segments to produce unique antigen receptors, allowing the immune system to recognize a broad range of pathogens?

ANSWER: VDJ RECOMBINATION

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TOSS-UP

17) ENERGY- *Short Answer* Piezoelectric materials generate an electric charge in response to mechanical stress. What is the most common crystal structure responsible for this effect?

ANSWER: TRIGONAL

BONUS

17) ENERGY- *Short Answer* What energy storage technology uses the conservation of angular momentum to store rotational energy and is often employed for grid stabilization and uninterruptible power supplies?

ANSWER: FLYWHEEL

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TOSS-UP

18) MATH - *Short Answer* $\int \left(\frac{4x^2+3}{x}\right)dx$

ANSWER: $2x^2+3\ln|x|+C$

BONUS

18) MATH - *Short Answer* The amount of words on Oscar's English essay at time t in minutes can be modeled by the function $W(t) = 50\int_0^t sin^2\pi x dx$. When t=4.5, at what rate, in words per minute, is Oscar adding new words to his essay?

ANSWER: 50

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TOSS-UP

19) EARTH AND SPACE - *Short Answer* Venus' atmosphere has a high-altitude layer of clouds primarily composed of what compound?

ANSWER: Sulfuric acid

BONUS

19) EARTH AND SPACE - *Short Answer* Order the following three types of galaxies in terms of increasing percentage composed of neutral gaseous hydrogen: 1) E0; 2) S0; 3) Sc.

ANSWER: 1, 2, 3

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TOSS-UP

20) BIOLOGY- *Short Answer* Mihir would like to know how similar humans are to Bornean orangutans. By name or number, identify all of the following three taxonomic ranks for which humans and Bornean orangutans share a classification

I) Genus
II) Family
III) Order

ANSWER: 2 AND 3

BONUS

20) BIOLOGY- *Multiple Choice* A person is bleeding profusely after a simple papercut. After consulting a textbook, a group of biology mains figure out this is not normal. Which of the following factors would not contribute to the bleeding?

W) Vitamin K deficiency
X) Hypocalcemia
Y) Thrombinogen inhibition
Z) Plasminogen inhibition

ANSWER: Z) PLASMINOGEN INHIBITION