**NWI2 DE1**

**TOSS-UP**

1) MATH – *Short Answer* What is the 20th term of an arithmetic sequence whose first term is 7 and the common difference is 4?

ANSWER: 83

**BONUS**

1) MATH – *Short Answer* Given that a=3i-4j, b=7i-3j,c=-2i+5j, what is the value of a dot ( 3b - 2c)?

ANWER: 151

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**TOSS-UP**

2) EARTH AND SPACE - *Short Answer* While on a hike with Oscar, Bernie noticed the sky in the distance was covered with rain-producing, sheet-like clouds. Including the proper prefix, what type of clouds are these?

ANSWER: NIMBOSTRATUS

**BONUS**

2) EARTH AND SPACE - *Short Answer* While on the same hike, Bernie noticed that the clouds in the distance were moving towards him. Given that the clouds directly above him were cirrus and the ones in the distance were nimbostratus, what type of front is most likely approaching?

ANSWER: WARM FRONT

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**TOSS-UP**

3) Energy – *Short Answer* Researchers at SLAC are attempting to use the LUX-ZEPLIN detector to observe WIMPs, potential candidates for dark matter. Identify all of the following three forces that WIMPs are thought to interact with: 1) Electromagnetic force; 2) Weak force; 3) Gravity.

ANSWER: 2 AND 3

**BONUS**

3) Energy – *Multiple Choice* Researchers at SLAC are using the BICEP Array in Antarctica to observe the cosmic microwave background at different frequencies. When the cosmic microwave background was produced, its peak wavelength was in which of the following regions of the electromagnetic spectrum?

W) Radio
X) Infrared
Y) Ultraviolet
Z) X-ray

ANSWER: X) INFRARED

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**TOSS-UP**

4) BIOLOGY – *Multiple Choice* Which of the following immune cells are part of the adaptive immune system?

W) Neutrophils
X) Monocytes
Y) Basophils
Z) B Cells

ANSWER: Z) B CELLS

**BONUS**

4) BIOLOGY – *Short Answer* If the birth weight of a human is too low, it will have difficulty surviving after birth. If it is too high, it would create complications in the birth process. Human birth weight is a trait that results from what type of selection?

ANSWER: STABILIZING
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**TOSS-UP**

5) CHEMISTRY- *Short Answer* Oscar is performing a titration experiment by adding 1 M HCl to 25mL of an unknown concentration of $Ca(OH)_2$. If he needs to add 30mL of HCl to reach the equivalence point, what is the molarity of $Ca(OH)_2$?

ANSWER: 0.6M

**BONUS**

5) CHEMISTRY - *Multiple Choice* Oscar, while listening to Die With a Smile, forgot to remove the 10mL of 1M NaOH in a beaker he just added 90mL of 1M HCl into. He then used this mixture to find the concentration of a KOH solution. Which of the following best describes Oscar's results?

W) The calculated concentration of KOH will be higher than the true value because his initial solution was more basic
X) The calculated concentration of KOH will be higher than the true value because his initial solution was more acidic
Y) The calculated concentration of KOH will be lower than the true value because his initial solution was more basic
Z) The calculated concentration of KOH will be lower 1than the true value because his initial solution was more acidic

ANSWER: W) THE CALCULATED CONCENTRATION OF KOH WILL BE HIGHER THAN THE TRUE VALUE BECAUSE HIS INITIAL SOLUTION WAS MORE BASIC

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**TOSS-UP**

6) PHYSICS - *Short Answer* What SI-derived unit is used to measure the property of a circuit element whose voltage drop is proportional to the integral of the flowing current?

ANSWER: FARAD

**BONUS**

6) PHYSICS - *Multiple Choice* Which of the following 4 elementary particles has a net spin of 0?

1) Up

2) Down
3) Electron
4) Neutrino

Answer: None

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**TOSS-UP**

7) MATH - *Short Answer* Oscar, while getting bored during dinner at Popeyes, decides to count the number of permutations while ignoring spaces in the 7-letter restaurant name. How many permutations does he get? 0

ANSWER) 1260

**BONUS**

7) MATH - *Short Answer* Find the integral from 0 to 3 of $x^3 - 3x^2 + 5$ (Read as: X cubed minus 3 X squared plus 5)

ANSWER: 33/4 (Accept: 8.25)

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**TOSS-UP**

8) EARTH AND SPACE *Multiple Choice* Which of the following layers of the atmosphere are aurorae present within?
W) mesosphere
X) asthenosphere
Y) thermosphere
Z) stratosphere

ANSWER: Y) THERMOSPHERE

**BONUS**

8) EARTH AND SPACE *Multiple Choice* A stream's thalweg connects points with the greatest value of which of the following?
W) substrate grain size
X) temperature

Y) depth
Z) flow velocity

ANSWER: Y) DEPTH

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**TOSS-UP**

9) Energy – *Short Answer* Idaho National Lab scientists are developing new kinds of nuclear fuels to prioritize efficiency. These new fuels are replacing what uranium-containing compound most commonly used as fuel in nuclear reactors?

ANSWER: Uranium dioxide (ACCEPT: $UO_2$, urania)

**BONUS**

9) Energy – *Multiple Choice* Researchers at Ames Lab are studying plant responses to fungal attacks in the rhizosphere. Which of the following groups of enzymes is commonly released to combat fungal infections?

W) Amylases
X) Cellulases
Y) Chitinases
Z) Lipases

ANSWER: Y) Chitinases

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**TOSS-UP**

10) BIOLOGY - *Short Answer* What term refers to the ribosomal binding site in bacterial mRNA that enables the initiation of protein synthesis by aligning the ribosome with the start codon and is located approximately 8 bases upstream of the start codon AUG?

ANSWER: SHINE-DALGARNO SEQUENCE

BONUS

10) BIOLOGY - *Multiple Choice* Which of the following gasses does the enzyme PEP Carboxylase have the highest affinity for?

W) $CO_2$
X) $O_2$
Y) $N_2$
Z) Water Vapor

ANSWER: W) $CO_2$

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**TOSS-UP**

11) CHEMISTRY - *Short Answer* Calculate the average oxidation state of tin in the mineral with formula $Sn_{21}Cl_{16}(OH)_{14}O_6$

ANSWER: +2

**BONUS**

11) CHEMISTRY - *Short Answer* Heterogeneous catalysts often utilize adsorption to speed up the chemical reaction. What is the name given when the adsorbed material is held together by chemical bonds?

ANSWER: CHEMISORPTION

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**TOSS UP**

12) PHYSICS – *Multiple Choice*—Unpolarized light is passed through two polarizing filters, the first directed vertically and the second directed 45 degrees with respect to the vertical. Which of the following is closest to the fraction of the intensity of the light that emerges from the filter?
W) 0.25
X) 0.5
Y) 0.75
Z) 0.9

ANSWER: W) 0.25

**BONUS**

12) PHYSICS – *Short Answer*—You are in a spaceship and you throw a tennis ball. It takes 2.4 seconds for the ball to hit a tennis racket from the instant you throw the ball and when it hits the tennis racket is 2.4 seconds. Another spaceship traveling at a speed ⅘ of the speed of light from your frame of reference. From the frame of reference of the other ship, to the nearest tenth of a second, how long does it take for the ball to hit the racket?

ANSWER: 4.0

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**TOSS-UP**

13) MATH – *Multiple Choice*—For the curve y equals three x cubed minus two x squared plus four, at which of the following x-coordinates is the slope of the tangent line zero?

W) Negative 2/3
X) 1
Y) 4/9
Z) 2/9

ANSWER: Y) 4/9

**BONUS**

13) MATH – *Short Answer*—A triangle has side lengths 7, 24, and 25. A circle is inscribed in the triangle. Find the radius of the circle.

ANSWER: 3

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**TOSS-UP**

14) EARTH AND SPACE *Multiple Choice* Which of the following terms properly describes the prevalent biome from 15 to 30 degrees north and south, at which the Hadley Cell is present?
W) tundra
X) rainforest
Y) arid
Z) temperate forest

ANSWER: Y) arid

**BONUS**

14) EARTH AND SPACE *Multiple Choice* Which of the following, upon contact with a southward-moving continental polar air mass, would most likely create a cold front?
W) southward-moving maritime tropical air mass
X) northward-moving maritime tropical air mass
Y) southward-moving continental tropical air mass
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Z) northward-moving continental polar air mass

ANSWER: X) northward-moving maritime tropical air mass

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**TOSS-UP**

15) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab are studying periods of the early universe in which the rate of expansion of the universe accelerated over time. Identify all of the following three periods of the early universe that these researchers are studying: 1) Inflationary epoch; 2) Planck epoch; 3) Quark epoch.

ANSWER: 1 only

**BONUS**

15) Energy – *Short Answer* Scientists at Los Alamos National Lab are developing SmartTensors, an AI data analysis tool that uses unsupervised learning. Identify all of the following three statements that are true of unsupervised learning: 1) Data is generally unlabeled; 2) Neural networks learn using gradient descent; 3) Neural networks identify data attributes via clustering.

ANSWER: All

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**TOSS-UP**

16) BIOLOGY – *Multiple Choice* According to the endosymbiotic theory, which of the following is evidence that mitochondria and chloroplasts originated from free-living prokaryotes?

W) Their ability to perform photosynthesis and aerobic respiration independently
X) Their replication by binary fission and presence of circular DNA
Y) Their dependence on the host cell for reproduction
Z) Their role in eukaryotic cell signaling

ANSWER: X) Their replication by binary fission and presence of circular DNA

**BONUS**

16) BIOLOGY – Short Answer What unique polysaccharide is found in the cell walls of some Archaea, providing structural support in extreme environments?

ANSWER: Pseudomurein

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**TOSS-UP**

17) CHEMISTRY - *Short Answer* The shape of mercury's meniscus in a glass tube is different from that of water's meniscus primarily due to the interactions of what two forces?

ANSWER: COHESION AND ADHESION

17) CHEMISTRY - *Short Answer* According to molecular orbital theory, identify all of the following three statements that are true of a molecule of oxygen: 1) the 2s sigma bonding orbitals are lower energy than the 2s orbitals, 2) all of the pi bonding orbitals are degenerate, 3) the unpaired electrons reside in the 2p pi antibonding orbitals

ANSWER: 2 AND 3

**TOSS-UP**

18) PHYSICS - *Short Answer* Two elevators each have a spring with spring constant K attached to the ceiling. Elevator A's spring has a mass of 2M attached to it while elevator B has a mass of M attached to the spring. If elevator B suddenly accelerates upwards with constant acceleration a, which elevator's spring will have a longer period of oscillation?

ANSWER: Elevator A (Accept: Elevator with mass 2M)

**BONUS**

18) PHYSICS - *Short Answer* In nuclear physics, magic numbers refer to the numbers of nucleons (protons or neutrons) that result in a complete, highly stable shell within an atomic nucleus. By name or number, name all of the following numbers that are magic numbers:

1) 2
2) 20
3) 42
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4) 82
Answer: 1, 2, 4 (Accept: All but 3; 2,20,82)

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**TOSS-UP**

19) MATH - *Multiple Choice* Oscar has a shelf with 7 books on it. If the shelf contains 3 blue books, 2 red books, 1 green book and 1 yellow book. What is the probability that he randomly picks 4 books without replacement in the order, yellow, red, blue, green ?

W) 3/140
X) 1/70
Y) 1/140
Z) 1/35

ANSWER: Y (Accept: 1/140)

**BONUS**

19) MATH - *Short Answer* What is the equation of the line that is tangent to the graph $y = x^3 - 3x^2 - 2x + 5$(Read as: y equals x cubed minus 3 x squared minus 2 x plus 5) at the point (2,-3)?

ANSWER: y=-2x+1

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**TOSS-UP**

20) EARTH AND SPACE - *Short Answer* While driving along the Thruway, Alex notices that the rock layers along the side of the road are gneiss at the bottom, and shale at the top, with an uneven break between them. What type of unconformity is this?

ANSWER: nonconformity

**BONUS**

20) EARTH AND SPACE - *Multiple Choice* The horse latitudes are areas of constant high pressure due to the sinking of air from the Hadley and Ferrel Cells. At which of the following latitudes does this occur?
W) 0 degrees

X) 23.5 degrees
Y) 30 degrees
Z) 66 degrees

ANSWER: Y) 30 degrees