NWI2 RR3

TOSS-UP

1) PHYSICS - *Short Answer* What type of semiconductor is silicon doped with phosphorus?

ANSWER: N-type

BONUS

1) PHYSICS - *Short Answer* In kg meters squared, what is the moment of inertia of a solid cylinder with a radius of 3 meters and a mass of 5kg if the axis of rotation is straight through the center of the top circle?

ANSWER: 45/2 (Accept: 22.5)

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TOSS-UP

2) MATH - *Multiple Choice* Which of the following values of f prime of c is guaranteed by the function f(x) equals x squared plus three x plus five on the interval one to five?

W) 8/3
X) 9
Y) 15/7
Z) 15

ANSWER: X) 9

BONUS

2) MATH – *Short Answer* A standard six-sided die is rolled three times. What is the probability that the sum of the three rolls is exactly 10?

ANSWER: 1/8 (Accept 0.125, 12.5%)

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TOSS-UP

3) EARTH AND SPACE - *Multiple Choice* Which of the following statements does not lend evidence to support the continental drift theory?

W) Polar wandering curves are identical on all continents

X) Identical rock types can be found on either side of the Atlantic ocean

Y) Seafloor sediment grows thicker further away from mid-oceanic ridges

Z) Similar fossils can be found on either side of the Atlantic ocean

ANSWER: W) POLAR WANDERING CURVES ARE IDENTICAL ON ALL CONTINENTS

BONUS

3) EARTH AND SPACE - *Short Answer* By name or number, rank the following three layers of oceanic crust from youngest to oldest: 1) basalt dikes, 2) pillow basalt, 3) seafloor sediment

ANSWER: 3, 2, 1

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TOSS-UP

4) ENERGY – *Short Answer* Researchers are using graph based models to represent traffic dynamics in densely populated cities. What word describes a graph where each node is connected to every other node?

ANSWER: Complete

BONUS

4) ENERGY – *Short Answer* Researchers are working on thinning key caches by using query-driven pruning to reduce expensive memory costs. Identify all of the following 3 computer components that can store memory: 1) SSD; 2) SDRAM; 3) ROM.

ANSWER: all

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TOSS-UP

5) BIOLOGY - *Short Answer* Oscar is stressed out about his upcoming APUSH test. His adrenal glands release epinephrine which binds to a mechanism that results in the creation of what second messenger?

ANSWER: CYCLIC AMP (ACCEPT: cAMP)

BONUS

5) BIOLOGY - Multiple Choice Steroid hormones have a mechanism of action distinct from that of peptide hormones, like epinephrine. Which of the following statements best describes steroid hormones' mechanism of action?

W) They diffuse through the cell membrane, enter the nucleus and induce DNA transcription

X) They diffuse through the cell membrane and selectively promote translation

Y) They secrete granzymes, inducing apoptosis in selected cells

Z) They bind to a receptor that activates a tyrosine kinase

ANSWER: W) THEY DIFFUSE THROUGH THE CELL MEMBRANE, ENTER THE NUCLEUS AND INDUCE DNA TRANSCRIPTION

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TOSS-UP

6) CHEMISTRY - *Multiple Choice* Which of the following is the molecular formula of propanol?

W) C3H4

X) C6H6O

Y) C6H6O2

Z) C3H8O

ANSWER: Z)C3H8O

BONUS
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6) CHEMISTRY - *Multiple Choice* If the reaction A + B → C + D (Read as: A plus B yields C plus D) is spontaneous only at low temperatures, which of the following must be the signs for ΔH and ΔS respectively?

W) Negative, Negative
X) Negative, Positive
Y) Positive, Negative
Z) Positive, Positive

ANSWER: W) NEGATIVE, NEGATIVE

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TOSS-UP

7) PHYSICS - *Multiple Choice* Which of the following elements has the highest nuclear binding energy?

W) Hydrogen-1
X) Carbon-16
Y) Iron-56
Z) Uranium-238

ANSWER: Y) Iron-56

BONUS

7) PHYSICS - *Short Answer* What is the length of a string, in meters, required to produce a 2nd harmonic of 400 Hertz if the speed of waves in the string is known to be 200 meters per second and the string is fixed at both ends?

Answer 0.5

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TOSS-UP

8) MATH – *Short Answer* Oscar is a massive Giants fan and decides to go watch a game of Football game. If the team can score either 7 points or 3 points, what is the largest possible value unobtainable by the Giants?

ANSWER: 11

BONUS

8) MATH- *Short Answer* An arithmetic sequence has first term 5 and third term 11. What is the sum of the first 54 terms?

ANSWER: 4563

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TOSS UP

9) EARTH AND SPACE *Short Answer* What is the name of the aggregation of galaxies which includes the Milky Way, Andromeda, and Triangulum Galaxies?
ANSWER: Local Group

BONUS

9) EARTH AND SPACE *Short Answer* If a star has a parallax angle of 3.14 milliarcseconds, what is its distance in parsecs, to the nearest whole number?
ANSWER: 318

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TOSS UP

10) ENERGY *Short Answer* Los Alamos National Lab is researching the use of artificial intelligence to predict "blue-green tides" in water bodies across the United States. "Blue-green tides" refer to what event, spurred by excess nitrate runoff and increased water temperatures?
ANSWER: harmful algal bloom (accept algal bloom)

BONUS

10) ENERGY *Multiple Choice* Oscar decided to go scuba diving in Skaneateles (p: skinny-atlas) Lake, and noticed it was extremely deep compared to its width. This characteristic of glacial erosion is also known as which of the following?
W) overdeepening
X) scouring
Y) plucking
Z) glacial chatter
ANSWER: W) overdeepening

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TOSS UP

11) BIOLOGY - Short Answer An ecosystem consists of species A with 15 individuals, species B with 60 individuals, and species C with 45 individuals. By name or number, identify all of the following three changes that would increase species richness in the ecosystem: 1) introducing species D with 15 individuals, 2) increasing species C by 15 individuals, 3) increasing all species by 15 individuals

ANSWER: 1 ONLY

BONUS

11) BIOLOGY - Short Answer A biology class has 100 students at the beginning of the year. Half of those students will eventually drop, but most students drop towards the beginning of the year, with fewer students dropping the class as the year progresses. This situation is analogous to what type of survivorship curve?

ANSWER: TYPE III

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TOSS-UP

12) Chemistry - *Short Answer* In the reaction A + B → C, the rate of formation of C doubles when the concentration of A quadruples, and gets cut by a factor of 3 when the concentration of B triples. What is the overall order of the reaction?

ANSWER: -½

BONUS

12) Chemistry - *Short Answer* Oscar is performing a thermal decomposition of sodium bicarbonate into sodium carbonate, carbon dioxide, and water. He takes 21 grams of sodium bicarbonate (with molar mass 84) and forms 10.6 grams of sodium carbonate (with molar mass 106). What is the percent yield of Oscar's reaction?

ANSWER: 80%

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TOSS-UP

13) PHYSICS - *Short Answer* What is the equivalent capacitance of a circuit consisting of a 2 Farad capacitor in parallel with a 4 Farad and 6 Farad capacitor in series?

Answer:4.4 Farads or 22/5 Farads

BONUS

13) PHYSICS - *Short Answer* A cannonball is fired from a cannon on the ground with a speed of 200 m/s at an angle of 15 degrees. Neglecting air resistance and to the nearest thousand, what distance will the cannonball reach before hitting the ground in meters.

W) 2000 meters

X) 3000 meters

Y) 4000 meters

Z) 5000 meters

Answer: W). 2000

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TOSS-UP

14) MATH - *Short Answer* How many ways are there to seat 6 board committee members around a circular table if the president and vice-president must sit next to each other?

ANSWER: 48 ways

BONUS

14) MATH - *Short Answer* A ship starts traveling at point A, at a bearing of 57 degrees. After traveling 60 miles, the ship turns to a bearing of 147 degrees and travels a distance of 144 miles to point C. In miles, what is the distance between points A and C?

ANSWER: 156

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TOSS UP

15) EARTH AND SPACE *Short Answer* How many constellations are officially designated by the International Astronomical Union?

ANSWER: 88 (accept 89 if they argue for Argo)

BONUS

15) EARTH AND SPACE *Multiple Choice* Which of the following minerals would be the first to crystallize in a cooling magma chamber?

W) quartz

X) biotite

Y) muscovite

Z) pyroxene

ANSWER: Z) pyroxene

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TOSS-UP

16) ENERGY - *Short Answer* Researchers at the Composite Materials Research Laboratory at the University of Rochester are developing stress/strain sensors. What SI-derived base unit is used to measure stress?

ANSWER: PASCAL

BONUS

16) ENERGY - *Short Answer* Researchers at the MEMS and Energy Harvesting are studying micro-electromechanical systems. In particular, they are developing highly energy efficient forms of what type of machine that produces physical motion, force or torque from an electrical, pneumatic or hydraulic input?

ANSWER: ACTUATOR

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TOSS UP

17) BIOLOGY - Short Answer By name or number, rank the following three areas from closest to the apical meristem to furthest from the apical meristem: 1) area of maturation, 2) area of cell division, 3) area of elongation

ANSWER: 2, 3, 1

BONUS

17) BIOLOGY - Short Answer Water moving through plants can do so through various pathways. In the apoplastic pathway, water moves through the cell walls of adjoining cells. However, water cannot move beyond the cortex due to the presence of what barrier in the root endodermis?

ANSWER: CASPARIAN STRIP

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TOSS-UP

18) CHEMISTRY - *Short Answer* A sample of an ideal gas is enclosed in a 4L tube with an extendable piston. If the piston extends, reducing the volume to 2L, how much work, in joules, is done if the pressure is kept constant at 25Pa?

ANSWER: 50

BONUS

18) CHEMISTRY - *Short Answer* Oscar is attempting to calculate the specific heat of his new element, Oscarium. He takes a 100 gram block of the Oscarium, currently at 25°C, and places it into a 500mL cup of water at 100°C. Assuming no heat is lost to the environment, and the final temperature of the cup and block is 40°C, what is the specific heat of Oscarium, in joules per gram Kelvin, assuming the specific heat of water is 4.2 J/g K?

ANSWER: 8.4

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TOSS-UP

19) PHYSICS - *Short Answer* An electron is traveling due south when it experiences a magnetic field that is pointing vertically upward. In what direction will the electron be deflected when it initially encounters the field?

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

ANSWER: Y) East

BONUS

19) PHYSICS - *Multiple Choice* How does the electrical resistance of metals and semiconductors generally change with an increase in temperature?
W) Resistance increases for both metals and semiconductors.
X) Resistance decreases for both metals and semiconductors.
Y) Resistance increases for metals but decreases for semiconductors.
Z) Resistance decreases for metals but increases for semiconductors.

ANSWER: Y) Resistance increases for metals but decreases for semiconductors

TOSS-UP

20) MATH - *Short Answer* Oscar owns 34 socks, 13 red, 11 blue, 6 green, and 4 yellow. If Oscar puts on a blindfold and randomly starts picking socks, how many socks must he choose, so that he can guarantee he has chosen all possible socks of any color?

ANSWER: 31

BONUS

20) MATH - *Short Answer* The weather forecast for the next 4 days states that there is a 40% chance of rain on each of the first 2 days and a 60% chance of rain on each of the last 2 days. What is the probability that it will rain on exactly three of the four days?

ANSWER: 12/25