NNHS ROUND 10

TOSS-UP

1) Physics – *Short Answer* At high energies, photons will undergo what process, creating an electron and a positron?

ANSWER: PAIR PRODUCTION

BONUS

1) Physics – *Multiple Choice* What is the escape velocity of a 2 million kilogram rocket at the surface of Pluto, which has a mass of $1.3 * 10^{22}$ kilograms and a radius of $1.2 * 10^{3}$ kilometers?

W) 600 meters per second
X) 850 meters per second
Y) 1200 meters per second
Z) 2000 meters per second

ANSWER: Y) 1200 METERS PER SECOND

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TOSS-UP

2) Biology – *Short Answer* Order the following four essential elements in plants from most to least common by percent mass in dry tissue: 1) Carbon; 2) Calcium; 3) Iron; 4) Nitrogen.

ANSWER: 1, 4, 2, 3

BONUS

2) Biology – *Short Answer* What pouch, used by hydras, consists of a digestive compartment with a single opening?

ANSWER: GASTROVASCULAR CAVITY
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TOSS-UP

3) Earth and Space – *Multiple Choice* Which of the following best describes the direction of air movement around an anticyclone and a cyclone respectively, in the southern hemisphere?

W) Clockwise, clockwise
X) Clockwise, counterclockwise
Y) Counterclockwise, clockwise
Z) Counterclockwise, counterclockwise

ANSWER: Y) COUNTERCLOCKWISE, CLOCKWISE

BONUS

3) Earth and Space – *Short Answer* Identify all of the following three features that are erosional shoreline features: 1) Tombolo; 2) Sea stack; 3) Sea arch.

ANSWER: 2 AND 3

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TOSS-UP

4) Math – *Multiple Choice* Which of the following pairs of regular polygons CANNOT tessellate the plane, if both polygons have the same side length?

W) Square and octagon
X) Pentagon and decagon
Y) Triangle and square
Z) Hexagon and triangle

ANSWER: X) PENTAGON AND DECAGON

BONUS

4) Math – *Short Answer* A convex heptagon has all of its diagonals drawn in, and no three diagonals intersect at the same point. How many intersections are there inside the heptagon?

ANSWER: 35
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TOSS-UP

5) Chemistry – *Multiple Choice* Which of the following is closest to the longest wavelength in the Lyman series for hydrogen?

W) 90 nanometers
X) 120 nanometers
Y) 360 nanometers
Z) 660 nanometers

ANSWER: X) 120 NANOMETERS

BONUS

5) Chemistry – *Short Answer* To the nearest kilojoule, what is the change in Gibbs free energy of the reduction of one mole of silver (I) ion to silver, if Faraday's constant is 96500 coulombs per mole and the standard reduction potential is +0.80 volts?

ANSWER: –77 (DO NOT ACCEPT: 77)

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TOSS-UP

6) Energy – *Short Answer* Researchers at Oak Ridge National Laboratory are using neutron scattering to analyze lipid membranes. In particular, they are focusing on what molecule in the lipid membrane that regulates its stiffness?

ANSWER: CHOLESTEROL

BONUS

6) Energy – *Short Answer* Researchers at Oak Ridge National Laboratory are creating antidotes to a specific class of poisons known as organophosphates. Many organophosphates are nerve agents that attack what enzyme critical to the degradation of neurotransmitters in a synapse?

ANSWER: ACETYLCHOLINESTERASE
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TOSS-UP

7) Physics – *Short Answer* What statement describes the minimum resolvable detail of an imaging process?

ANSWER: RAYLEIGH CRITERION

BONUS

7) Physics – *Short Answer* What type of superconductor does not exhibit a complete Meissner effect and exhibits a phase of mixed ordinary and superconducting properties?

ANSWER: TYPE II

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TOSS-UP

8) Biology – *Multiple Choice* Which of the following plant hormones is NOT involved in the plant's defense against pathogens or herbivores?

W) Auxins
X) Salicylic Acid
Y) Systemin
Z) Jasmonates

ANSWER: W) AUXINS

BONUS

8) Biology – *Short Answer* What reddish protein is found in root nodules that limits the amount of O_2 present to provide proper conditions for nitrogen fixation?

ANSWER: LEGHEMOGLOBIN
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TOSS-UP

9) Earth and Space – *Short Answer* What is the term for the time it takes for the moon to return to the same angular position from the Sun as seen from the Earth?

ANSWER: SYNODIC PERIOD

BONUS

9) Earth and Space – *Short Answer* In the fossil record, a thin band of rock, known as the KT boundary, separates the Mesozoic and Cenozoic eras. What element is found in unusually high amounts in this rock layer, and is hypothesized to have been deposited by a meteorite impact?

ANSWER: IRIDIUM

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TOSS-UP

10) Math – *Multiple Choice* A committee of four members is selected from a group of n people. For which of the following values of n will adding an additional person to the group exactly double the number of possible ways to choose the committee?

W) 5
X) 6
Y) 7
Z) 8

ANSWER: Y) 7

BONUS

10) Math – *Short Answer* What is the mean and median of the first 6 positive integers that are NOT prime?

ANSWER: MEAN IS 19/3 AND MEDIAN IS 7 (ACCEPT: 19/3 AND 7)
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TOSS-UP

11) Chemistry – *Short Answer* What is the VSEPR molecular shape of the tri-iodide ion?

ANSWER: LINEAR

BONUS

11) Chemistry – *Short Answer* What number determines the electrostatic potential in a crystal by approximating the ions as point charges?

ANSWER: MADELUNG CONSTANT

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TOSS-UP

12) Energy – *Short Answer* Researchers at Fermilab are studying quantum computing. One reason that quantum computers are much faster than traditional computers is because quantum bits, or qubits, are able to be in many different states at the same time before they are observed. What is the name of this ability?

ANSWER: SUPERPOSITION

BONUS

12) Energy – *Short Answer* Researchers at Fermilab are studying quantum computing, which could break modem cryptography schemes due to the ability to factor integers extremely quickly. What is the sum of the prime factors of 1554?

ANSWER: 49
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TOSS-UP

13) Physics – *Short Answer* What theory correctly predicted the anomalous orbit of Mercury?

ANSWER: GENERAL RELATIVITY (ACCEPT: GR; GENERAL THEORY OF RELATIVITY; GTR; DO NOT ACCEPT: RELATIVITY; SPECIAL RELATIVITY)

BONUS

13) Physics – *Short Answer* A conducting square with side length 2 meters has a charge of 7 nanocoulombs. To one significant figure, what is the electric field at a point very close to the conducting sheet?

ANSWER: 1000 VOLTS PER METER

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TOSS-UP

14) Biology – *Multiple Choice* How many codons code for amino acids in the universal genetic code?

W) 61
X) 62
Y) 63
Z) 64

ANSWER: W) 61

BONUS

14) Biology – *Multiple Choice* Which of the following amino acids would most likely be found in a histone?

W) Aspartic acid
X) Leucine
Y) Serine
Z) Lysine

ANSWER: Z) LYSINE
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TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following periods did NOT experience a mass extinction?

W) Devonian
X) Permian
Y) Cretaceous
Z) Tertiary

ANSWER: Z) TERTIARY

BONUS

15) Earth and Space – *Multiple Choice* Which of the following is the primary ore of zinc?

W) Galena
X) Sphalerite
Y) Chalcopyrite
Z) Cinnabar

ANSWER: X) SPHALERITE

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TOSS-UP

16) Math – *Short Answer* A fair coin is flipped three times. What is the probability that no two consecutive coin flips are the same?

ANSWER: 1/4

BONUS

16) Math – *Short Answer* A fair coin is flipped until it lands heads two times in a row. What is the expected number of coin flips until this occurs?

ANSWER: 6
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TOSS-UP

17) Chemistry – *Short Answer* Identify all of the following three principles that do NOT apply to atoms with excited electrons: 1) Aufbau principle; 2) Pauli exclusion principle; 3) Hund's rule.

ANSWER: 1 AND 3

BONUS

17) Chemistry – *Short Answer* To the nearest tenth, how many grams of oxygen gas are required to completely combust 1.2 grams of ethane, if the molar mass of ethane is 30 grams per mole?

ANSWER: 4.5

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TOSS-UP

18) Energy – *Short Answer* Researchers at Oak Ridge National Laboratory are studying the application of solvent extraction to cobalt recovery. Solvent extraction relies on what property, that describes two liquids such as oil and water, that do not mix?

ANSWER: IMMISCIBILITY

BONUS

18) Energy – *Multiple Choice* Researchers at Oak Ridge National Laboratory are studying the fine-root growth of plants found in northern peatlands. Peat, the main component of peatlands, is typically composed of organisms from the Sphagnum genus. Which of the following clades would Sphagnum fall under?

W) Bryophyta
X) Lycophyta
Y) Monilophyta
Z) Anthophyta

ANSWER: W) BRYOPHYTA
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TOSS-UP

19) Physics – *Short Answer* Identify all of the following three forces that are conservative: 1) Kinetic friction; 2) Lorentz force; 3) Centrifugal force.

ANSWER: 2 ONLY

BONUS

19) Physics – *Short Answer* What statement equates the probability density to the square of the wavefunction?

ANSWER: BORN INTERPRETATION (ACCEPT: BORN LAW)

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TOSS-UP

20) Biology – *Short Answer* Arrange the following four sections of the digestive tract in the order in which food travels: 1) Stomach; 2) Duodenum; 3) Cecum; 4) Ileum.

ANSWER: 1, 2, 4, 3

BONUS

20) Biology – *Multiple Choice* Which of the following organs, utilized by annelids, is characterized by segmentation and serves in both excretory and osmoregulatory functions?

W) Protonephridia ***[pro-toh-nef-reed-yee-ah]***
X) Metanephridia
Y) Malpighian ***[mel-pig-hee-yan]*** tubules
Z) Nephrons

ANSWER: X) METANEPHRIDIA
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TOSS-UP

21) Earth and Space – *Short Answer* What is the name of the point on the celestial sphere that is directly above an observer on Earth?

ANSWER: ZENITH

BONUS

21) Earth and Space – *Multiple Choice* Which of the following is the correct Bayer designation of Betelgeuse?

W) Alpha orionis
X) Beta orionis
Y) Gamma orionis
Z) Delta orionis

ANSWER: W) ALPHA ORIONIS

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TOSS-UP

22) Math – *Short Answer* In terms of x, what is the sum of the first three terms of the Maclaurin series of the natural logarithm of x?

ANSWER: $x - 1/2x^2 + 1/3x^3$

BONUS

22) Math – *Short Answer* How many ways are there to place three indistinguishable rooks on an 8 by 8 chess board such that no two rooks are on the same row or column?

ANSWER: 18816
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TOSS-UP

23) Chemistry – *Multiple Choice* Which of the following is NOT an oxoacid?

W) Carbonic acid
X) Hydrosulfuric acid
Y) Hypochlorous acid
Z) Nitric acid

ANSWER: X) HYDROSULFURIC ACID

BONUS

23) Chemistry – *Multiple Choice* Which of the following metals can be oxidized by silver cations?

W) Copper
X) Mercury
Y) Platinum
Z) Gold

ANSWER: W) COPPER