NNHS ROUND 2

TOSS-UP

1) Physics – *Short Answer* What is the speed of a 5-kilogram particle with a kinetic energy of 10 joules?

ANSWER: 2 METERS PER SECOND

BONUS

1) Physics – *Multiple Choice* Which of the following quantities has the same units as energy?

W) Torque
X) Angular momentum
Y) Acceleration
Z) Mass

ANSWER: W) TORQUE

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TOSS-UP

2) Biology – *Short Answer* In a grassland ecosystem, primary producers absorb a total of 10,000 kilojoules of light energy and use 4,000 kilojoules of energy on cellular respiration. What is the net primary production of this ecosystem?

ANSWER: 6000 KILOJOULES

BONUS

2) Biology – *Short Answer* Known as the 'pacemaker' of the heart, what node in the heart initiates atrial contraction?

ANSWER: SINOATRIAL NODE (ACCEPT: SA NODE)
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TOSS-UP

3) Earth and Space – *Short Answer* The Earth's inner core is primarily composed of iron and what other element?

ANSWER: NICKEL

BONUS

3) Earth and Space – *Multiple Choice* Pulsations of Cepheid variable stars are primarily caused by changes in which of the following quantities?

W) Temperature
X) Radius
Y) Distance to Earth
Z) Orientation

ANSWER: X) RADIUS

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TOSS-UP

4) Math – *Short Answer* What is the value of the base-6 number 34 in base 10?

ANSWER: 22

BONUS

4) Math – *Short Answer* What is the degree measure of the acute angle formed by the hands of an analog clock at 3:30 pm?

ANSWER: 75°
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TOSS-UP

5) Chemistry – *Short Answer* What term describes an unstable solution in which an excess amount of solute is dissolved?

ANSWER: SUPERSATURATED (DO NOT ACCEPT: SATURATED)

BONUS

5) Chemistry – *Short Answer* What is the only element that cannot form a solid under atmospheric pressure?

ANSWER: HELIUM

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TOSS-UP

6) Energy – *Multiple Choice* Researchers at the Princeton Plasma Physics Laboratory are using their knowledge of fusion to develop a solution for chronic shortages of Technetium-99 for medical exams. Technetium-99 is produced by the radioactive decay of Molybdenum-99. This is an example of which of the following types of radioactive decay?

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

ANSWER: X) BETA

BONUS

6) Energy – *Short Answer* Researchers at the Princeton Plasma Physics Laboratory are studying nuclear fusion in the National Spherical Torus Experiment. The researchers used what type of magnetic confinement device that is typically used in fusion?

ANSWER: TOKAMAK
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TOSS-UP

7) Physics – *Short Answer* Identify all of the following three quantities that are considered thermodynamic path functions: 1) Entropy; 2) Work; 3) Volume.

ANSWER: 2 ONLY

BONUS

7) Physics – *Short Answer* What effect causes high frequency alternating current to become concentrated near the surface of a conductor, increasing its effective resistance?

ANSWER: SKIN EFFECT

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TOSS-UP

8) Biology – *Multiple Choice* Which of the following is considered a biotic factor?

W) Temperature
X) Precipitation
Y) Disease prevalence
Z) Amount of sunlight

ANSWER: Y) DISEASE PREVALENCE

BONUS

8) Biology – *Multiple Choice* Which of the following elements is NOT found in thyroxine?

W) Carbon
X) Nitrogen
Y) Iodine
Z) Sulfur

ANSWER: Z) SULFUR
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TOSS-UP

9) Earth and Space – *Short Answer* What phenomenon occurs when an object's orbital period is equal to its rotational period?

ANSWER: TIDAL LOCKING

BONUS

9) Earth and Space – *Multiple Choice* Which of the following was one of the greatest challenges for early planetary models prior to the heliocentric model?

W) The Earth's shape was not thought to be round
X) The Earth's rotation was not understood
Y) Some planets appear to move backwards through the sky
Z) Telescopes were not built to track planets precisely

ANSWER: Y) SOME PLANETS APPEAR TO MOVE BACKWARDS THROUGH THE SKY

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TOSS-UP

10) Math – *Short Answer* In degrees, what is the measure of an exterior angle of a regular pentagon?

ANSWER: 72

BONUS

10) Math – *Short Answer* A triangle has side lengths of 3, 4, and 5. What is the length of the altitude to the side with length 5?

ANSWER: 12/5
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TOSS-UP

11) Chemistry – *Short Answer* What law, used in the Born-Haber cycle, states that the total enthalpy change of a reaction is the same regardless of the intermediate steps in the reaction?

ANSWER: HESS'S LAW

BONUS

11) Chemistry – *Multiple Choice* Which of the following statements is true regarding reduction-oxidation reactions?

W) The reducing agent loses electrons, undergoing reduction
X) The reducing agent loses electrons, undergoing oxidation
Y) The oxidizing agent loses electrons, undergoing reduction
Z) The oxidizing agent loses electrons, undergoing oxidation

ANSWER: X) THE REDUCING AGENT LOSES ELECTRONS, UNDERGOING OXIDATION

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TOSS-UP

12) Energy – *Short Answer* Researchers at SLAC National Accelerator Laboratory are looking for dark photons. These particles could mediate forces in what type of exotic matter, which is believed to hold galaxies together?

ANSWER: DARK MATTER (DO NOT ACCEPT: DARK ENERGY)

BONUS

12) Energy – *Short Answer* Researchers at SLAC National Accelerator Laboratory are using the Linac Coherent Light Source. The scientists collected evidence for the precipitation of what allotrope of carbon in gas giants by recreating their extreme environments?

ANSWER: DIAMOND
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TOSS-UP

13) Physics – *Short Answer* Rank the following four particles by increasing rest mass: 1) Electron; 2) Photon; 3) Proton; 4) Neutron.

ANSWER: 2, 1, 3, 4

BONUS

13) Physics – *Short Answer* A string has tension T and wave velocity v. If the tension in the string is multiplied by 4 and the length is doubled, then by what factor will the wave velocity in the string be multiplied by?

ANSWER: 2

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TOSS-UP

14) Biology – *Short Answer* What hormone causes an increase in aquaporins in the collecting duct of nephrons, resulting in water reabsorption?

ANSWER: ANTIDIURETIC HORMONE (ACCEPT: ADH; VASOPRESSIN)

BONUS

14) Biology – *Multiple Choice* Malpighian tubules can be found in which of the following organisms?

W) Fruit fly
X) Earthworm
Y) Flatworm
Z) Starfish

ANSWER: W) FRUIT FLY
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TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following types of magma is the hottest?

W) Basaltic
X) Andesitic
Y) Rhyolitic
Z) Slatic

ANSWER: W) BASALTIC

BONUS

15) Earth and Space – *Multiple Choice* Which of the following statements is true regarding the variations in density and temperature in high and low latitude ocean waters?

W) In low latitude waters, a thermocline is present but a pycnocline is not
X) In high latitude waters, a thermocline is not present, but a pycnocline is present
Y) In low latitude waters, both a thermocline and a pycnocline are present
Z) Both low latitude and high latitude waters have a thermocline and a pycnocline

ANSWER: Y) IN LOW LATITUDE WATERS, BOTH A THERMOCLINE AND A PYCNOCLINE ARE PRESENT

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TOSS-UP

16) Math – *Short Answer* How many real roots does the polynomial $x^4 + 1$ have?

ANSWER: 0

BONUS

16) Math – *Short Answer* What is the remainder when 8! ***[8 factorial]*** is divided by 11?

ANSWER: 5
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TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following statements about entropy is FALSE?

W) Liquids generally have higher entropy than solids
X) Gases generally have higher entropy than liquids
Y) Polyatomic gases generally have less entropy than monatomic gases
Z) Standard entropy is calculated at 25° celsius

ANSWER: Y) POLYATOMIC GASES GENERALLY HAVE LESS ENTROPY THAN MONATOMIC GASES

BONUS

17) Chemistry – *Short Answer* Ascorbic acid has the chemical formula $C_6H_8O_6$. To the nearest gram, what is the molar mass of ascorbic acid?

ANSWER: 176

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TOSS-UP

18) Energy – *Short Answer* Researchers at Thomas Jefferson National Lab are using the Continuous Electron Beam Accelerator Facility, or CEBAF, to study the Standard Model. They are using the CEBAF to test what theory, which governs the strong interaction between quarks and gluons?

ANSWER: QUANTUM CHROMODYNAMICS (ACCEPT: QCD)

BONUS

18) Energy – *Short Answer* Researchers at Thomas Jefferson National Lab are using the Continuous Electron Beam Accelerator Facility to study potential parity violations in electron scattering. Identify all of the following three symmetry violations that the scientists have detected: 1) C; 2) CP; 3) CPT.

ANSWER: 1 AND 2
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TOSS-UP

19) Physics – *Multiple Choice* A 5-kilogram ball has a position given by $x = t^{1.5}$. What is the velocity of the ball at $t = 4$?

W) 3
X) 6
Y) 8
Z) 12

ANSWER: W) 3

BONUS

19) Physics – *Short Answer* The beta-minus decay of a neutron produces a proton, an electron, and what other particle?

ANSWER: NEUTRINO (ACCEPT: ANTINEUTRINO; ELECTRON ANTINEUTRINO)

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TOSS-UP

20) Biology – *Multiple Choice* Which of the following pairs of hormones do NOT have opposite effects?

W) Glucagon and insulin
X) Aldosterone and atrial natriuretic peptide
Y) Parathyroid hormone and calcitonin
Z) Estradiol and testosterone

ANSWER: Z) ESTRADIOL AND TESTOSTERONE

BONUS

20) Biology – *Short Answer* Hibernation is an example of what physiological state of decreased activity and metabolism?

ANSWER: TORPOR
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TOSS-UP

21) Earth and Space – *Short Answer* What is the term for an informal group of stars that is typically smaller than a constellation?

ANSWER: ASTERISM

BONUS

21) Earth and Space – *Short Answer* Rank the following four minerals by increasing hardness on the Mohs hardness scale: 1) Gypsum; 2) Corundum; 3) Quartz; 4) Feldspar.

ANSWER: 1, 4, 3, 2

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TOSS-UP

22) Math – *Multiple Choice* Which of the following functions is NOT differentiable at $x = 0$?

W) The absolute value of x
X) $\sin(x)$
Y) $\cos(x)$
Z) e^x

ANSWER: W) THE ABSOLUTE VALUE OF X

BONUS

22) Math – *Short Answer* How many values of x in the closed interval $[0, 2\pi]$ satisfy the equation $\cos(x) = \cos(2x)$?

ANSWER: 4
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TOSS-UP

23) Chemistry – *Multiple Choice* Which of the following acids is the strongest?

W) Hypochlorous acid
X) Chlorous acid
Y) Chloric acid
Z) Perchloric acid

ANSWER: Z) PERCHLORIC ACID

BONUS

23) Chemistry – *Short Answer* Acetic acid has a K_a of $1.8 * 10^{-5}$. To the nearest integer, what is the pH of a 0.1 molar acetic acid solution?

ANSWER: 3