NNHS ROUND 9

TOSS-UP

1) Physics – *Short Answer* Careful measurements have shown that the mass of an atom is less than the sum of the masses of its protons, neutrons, and electrons. What is the term for this difference?

ANSWER: MASS DEFECT

BONUS

1) Physics – *Short Answer* What phenomenon causes two uncharged conducting plates to experience a small attractive force when placed extremely close to each other in a vacuum?

ANSWER: CASIMIR EFFECT

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TOSS-UP

2) Biology – *Multiple Choice* According to the ABC hypothesis of flower formation, if the C gene was knocked out, what would the order of flower parts from inside to outside be?

W) Carpels, stamens, petals, sepals
X) Carpels, stamens, stamens, carpels
Y) Sepals, petals, petals, sepals
Z) Sepals, carpels, carpels, sepals

ANSWER: Y) SEPALS, PETALS, PETALS, SEPALS

BONUS

2) Biology – *Short Answer* On trees and other plants that exhibit secondary growth, small, raised areas on the periderm allow for living cells within the plant to exchange gases with the atmosphere. What are these structures called?

ANSWER: LENTICELS
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TOSS-UP

3) Earth and Space – *Short Answer* What is the term for a concordant pluton that forms from more viscous magma to create a lens-shaped structure?

ANSWER: LACCOLITH

BONUS

3) Earth and Space – *Multiple Choice* Which of the following is closest to the minimum wave steepness at which a wave will break?

W) 1/10
X) 1/7
Y) 1/5
Z) 1/4

ANSWER: X) 1/7

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TOSS-UP

4) Math – *Multiple Choice* Which of the following graphs does NOT pass through the third quadrant?

W) $y = x^3 + 5$
X) $y = 2x^2 - 3$
Y) $y = -7x - 2$
Z) $y = -3x + 4$

ANSWER: Z) $y = -3x + 4$

BONUS

4) Math – *Short Answer* What is the sample standard deviation of the set {1, 5, 6}?

ANSWER: $\sqrt{7}$
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TOSS-UP

5) Chemistry – *Short Answer* What reaction converts alkenes or alkynes to alkanes through the addition of hydrogen gas?

ANSWER: HYDROGENATION

BONUS

5) Chemistry – *Short Answer* At very low temperatures, helium forms a superfluid, losing all viscosity. What temperature marks the transition between ordinary and superfluid helium?

ANSWER: LAMBDA POINT

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TOSS-UP

6) Energy – *Short Answer* Researchers at the Joint Genome Institute are studying the shrub willow, which, like moths and some birds, uses what sex determination system in which the females, instead of the males, are heterogametic?

ANSWER: ZW

BONUS

6) Energy – *Multiple Choice* Researchers at the Joint Genome Institute are studying the ability of filamentous fungi to degrade the cell wall of plants. Which of the following model organisms did researchers examine for this study?

W) *Escherichia coli*
X) *Saccharomyces cerevisiae*
Y) *Neurospora crassa*
Z) *Caenorhabditis elegans*

ANSWER: Y) NEUROSPORA CRASSA
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TOSS-UP

7) Physics – *Short Answer* A pipe with one closed and one open end has a length of 2 meters. In meters, what is the wavelength of the third harmonic?

ANSWER: 8/5

BONUS

7) Physics – *Short Answer* According to Grand Unified Theory, which two fundamental forces are the first to merge into one force at high temperatures?

ANSWER: ELECTROMAGNETIC AND WEAK FORCE (ACCEPT: ELECTROWEAK FORCE)

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TOSS-UP

8) Biology – *Multiple Choice* What type of nephron extends deep into the medulla and is essential for production of urine that is hyperosmotic to body fluids?

W) Peritubular
X) Henle
Y) Cortical
Z) Juxtamedullary

ANSWER: Z) JUXTAMEDULLARY

BONUS

8) Biology – *Short Answer* What division of the autonomic nervous system corresponds with arousal and energy generation response?

ANSWER: SYMPATHETIC
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TOSS-UP

9) Earth and Space – *Multiple Choice* Which of the following planets undergoes retrograde motion?

W) Venus
X) Jupiter
Y) Saturn
Z) Neptune

ANSWER: W) VENUS

BONUS

9) Earth and Space – *Short Answer* What type of unconformity is characterized by younger sedimentary rock overlaying older metamorphic or igneous rock?

ANSWER: NONCONFORMITY

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TOSS-UP

10) Math – *Short Answer* A right triangle has legs of length 20 and 21. What is the length of the median to the hypotenuse?

ANSWER: 29/2

BONUS

10) Math – *Short Answer* Triangle ABC has a right angle at B, AB = 3, and BC = 4. D is a point on side AC such that BD is an angle bisector, and M is the midpoint of AC. What is the length of MD?

ANSWER: 5/14
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TOSS-UP

11) Chemistry – *Short Answer* Order the following four elements by increasing first ionization energy: 1) Lithium; 2) Beryllium; 3) Sodium; 4) Magnesium.

ANSWER: 3, 1, 4, 2

BONUS

11) Chemistry – *Short Answer* Diborane, B_2H_6, violates the octet rule by forming what kind of bonds between boron and hydrogen atoms?

ANSWER: 3-CENTER 2-ELECTRON BOND (ACCEPT: BANANA BOND)

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TOSS-UP

12) Energy – *Short Answer* Scientists at Argonne National Lab are studying how rotational superfluids transfer angular momentum. In particular, they were interested in how the fluids were able to transfer angular momentum in the absence of what force?

ANSWER: VISCOUS FORCE (ACCEPT: FRICTION; FLUID FRICTION; INTERNAL FRICTION)

BONUS

12) Energy – *Short Answer* Scientists at Argonne National Lab are studying how rotational superfluids transfer angular momentum. The scientists found that unlike typical fluids, superfluids do not create what small currents, allowing the atoms to remain in place?

ANSWER: EDDY
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TOSS-UP

13) Physics – *Short Answer* What is the reduced mass of a system that consists of a 3 kilogram and a 7 kilogram mass?

ANSWER: 21/10 KILOGRAMS

BONUS

13) Physics – *Multiple Choice* A stationary observer hears a siren approaching at a speed of 20 meters per second and hears a pitch of 1800 Hertz. Given that the speed of sound is 340 meters per second, approximately what frequency would a stationary observer hear from the same siren if the siren was moving away at 20 meters per second?

W) 1600 Hertz
X) 1700 Hertz
Y) 1900 Hertz
Z) 2000 Hertz

ANSWER: W) 1600 HERTZ

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TOSS-UP

14) Biology – *Short Answer* Beriberi is caused by a deficiency in what vitamin?

ANSWER: B_1 (ACCEPT: THIAMINE)

BONUS

14) Biology – *Short Answer* What phenomenon is characterized by left-right asymmetry of the organs in the chest and abdomen?

ANSWER: SITUS INVERSUS (ACCEPT: KARTAGENER'S SYNDROME)
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TOSS-UP

15) Earth and Space – *Short Answer* What class of minerals typically effervesces when a drop of hydrochloric acid reacts with its surface?

ANSWER: CARBONATES

BONUS

15) Earth and Space – *Multiple Choice* Which of the following statements is FALSE regarding the Richter scale and the moment magnitude scale?

W) Both scales are logarithmic
X) The Wood–Anderson seismograph is the standard for the Richter scale
Y) The Richter scale is better at estimating the size of large earthquakes
Z) The moment magnitude scale can be calculated from field studies

ANSWER: Y) THE RICHTER SCALE IS BETTER AT ESTIMATING THE SIZE OF LARGE EARTHQUAKES

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TOSS-UP

16) Math – *Short Answer* Five fair, six-sided dice are rolled. What is the probability that the sum of the numbers rolled is a multiple of three?

ANSWER: 1/3

BONUS

16) Math – *Short Answer* A square is rotated 45° around its center, forming a new square. The intersection of the two squares is a regular octagon with side length 3. What is the side length of the original square?

ANSWER: $3 + 3\sqrt{2}$
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TOSS-UP

17) Chemistry – *Short Answer* Identify all of the following three compounds that have the same empirical formula as formic acid: 1) Acetic acid; 2) Glucose; 3) 1-propanol.

ANSWER: NONE

BONUS

17) Chemistry – *Short Answer* According to MO theory, what is the bond order of the diatomic ion N_2^- ***[N two minus]***?

ANSWER: 2.5 (ACCEPT: 5/2)

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TOSS-UP

18) Energy – *Short Answer* Researchers at Lawrence Livermore National Lab are studying the production of acetaldehyde and hydrogen from ethanol using a silver catalyst at high temperatures. Identify all of the following three changes that would cause the equilibrium to shift towards the products: 1) Increasing pressure; 2) Adding more hydrogen; 3) Adding helium.

ANSWER: NONE

BONUS

18) Energy – *Short Answer* Researchers at Lawrence Livermore National Lab are studying the "neutron skin" found in many nuclei and in neutron stars. What limit gives the upper bound on the mass of a nonrotating neutron star, which, if exceeded, would lead to collapse into a black hole?

ANSWER: TOLMAN–OPPENHEIMER–VOLKOFF LIMIT (ACCEPT: TOV LIMIT)
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TOSS-UP

19) Physics – *Short Answer* What type of matter has a density and temperature between plasma and condensed matter?

ANSWER: WARM DENSE MATTER (ACCEPT: WDM)

BONUS

19) Physics – *Short Answer* Identify all of the following three statements that are true about PN-junctions: 1) Doping a semiconductor with boron will result in a p-type semiconductor; 2) A forward biased PN-junction has a built in electric field in the same direction as the battery-induced electric field; 3) Doping a semiconductor with arsenic will result in a p-type semiconductor.

ANSWER: 1 ONLY

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TOSS-UP

20) Biology – *Multiple Choice* In human females, approximately how many days after the beginning of the menstrual flow phase does ovulation occur?

W) 7
X) 14
Y) 21
Z) 28

ANSWER: X) 14

BONUS

20) Biology – *Short Answer* Identify all of the following three statements about phage replication that are true: 1) The host cell dies in the lysogenic cycle; 2) Temperate phages exclusively replicate using the lytic cycle; 3) A prophage is viral DNA that has been integrated into a bacterial chromosome.

ANSWER: 3 ONLY
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TOSS-UP

21) Earth and Space – *Multiple Choice* Which of the following best explains why the sidereal month is shorter than the synodic month?

W) The sidereal month fails to take into account the orbit of the moon
X) The sidereal month fails to take into account the rotation of the earth
Y) The synodic month fails to take into account the orbit of the earth around the sun
Z) The synodic month fails to take into account earth's axial tilt

ANSWER: Y) THE SYNODIC MONTH FAILS TO TAKE INTO ACCOUNT THE ORBIT OF THE EARTH AROUND THE SUN

BONUS

21) Earth and Space – *Short Answer* Rank the following four rocks by increasing crystallization temperature: 1) Olivine; 2) Quartz; 3) Muscovite; 4) Biotite.

ANSWER: 2, 3, 4, 1

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TOSS-UP

22) Math – *Short Answer* If rotations and reflections are considered equivalent, then how many ways are there to pick two of the six faces of a white cube and paint them blue?

ANSWER: 2

BONUS

22) Math – *Multiple Choice* Which of the following numbers has the largest sum of its positive integer divisors?

W) 36
X) 44
Y) 45
Z) 58

ANSWER: W) 36
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TOSS-UP

23) Chemistry – *Multiple Choice* Which of the following reaction orders has a half life that is independent of the reactant starting concentrations?

W) Zeroth
X) First
Y) Second
Z) Third

ANSWER: X) FIRST

BONUS

23) Chemistry – *Multiple Choice* The first noble gas compound ever synthesized contained what noble gas?

W) Neon
X) Argon
Y) Krypton
Z) Xenon

ANSWER: Z) XENON