NNHS ROUND 4

TOSS-UP

1) Physics – *Short Answer* At constant pressure, thermodynamic work is equal to the product of pressure and the change in what quantity?

ANSWER: VOLUME

BONUS

1) Physics – *Short Answer* Rank the following three objects in terms of increasing moment of inertia about their central axis: 1) Rod of mass M and length 2R; 2) Solid cylinder of mass M and radius R; 3) Solid sphere of mass M and radius R.

ANSWER: 1, 3, 2

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TOSS-UP

2) Biology – *Multiple Choice* Which of the following statements about the opening of stomata in plants is FALSE?

W) Abscisic acid induces closure of stomata
X) Light stimulates guard cells to become flaccid, opening the stomata
Y) CAM plants only open their stomata at night
Z) Stomata open in response to depletion of CO_2 in the leaf's air spaces

ANSWER: X) LIGHT STIMULATES GUARD CELLS TO BECOME FLACCID, OPENING THE STOMATA

BONUS

2) Biology – *Short Answer* Root pressure causes the exudation of water on the tips of leaves. What is this process called?

ANSWER: GUTTATION
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TOSS-UP

3) Earth and Space – *Short Answer* The moon is slowly drifting away from the Earth due to what phenomenon, caused by the moon's gravitational pull on the Earth's tides?

ANSWER: TIDAL BULGE

BONUS

3) Earth and Space – *Multiple Choice* Which star, with an apparent magnitude of 0, is used as the standard reference point for apparent magnitude?

W) Sun
X) Sirius
Y) Vega
Z) Rigel

ANSWER: Y) VEGA

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TOSS-UP

4) Math – *Multiple Choice* How many positive, real values of x satisfy the equation $\ln(10x) + \ln(2x) = \ln(20x^2)$?

W) 0
X) 1
Y) 2
Z) Infinitely many

ANSWER: Z) INFINITELY MANY

BONUS

4) Math – *Short Answer* A drawer contains three blue socks and eight white socks. If you pull two socks out of the drawer independently at random, what is the probability that they are different colors?

ANSWER: 24/55
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TOSS-UP

5) Chemistry – *Short Answer* In x-ray crystallography, what law is used to determine the scatter angle in terms of the wavelength of incident light?

ANSWER: BRAGG'S LAW

BONUS

5) Chemistry – *Short Answer* Water has a freezing point depression constant of 1.9° Celsius per molal. What is the freezing point of a 1 liter solution of water that contains 3 moles of sodium chloride?

ANSWER: -11.4 CELSIUS

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TOSS-UP

6) Energy – *Short Answer* Scientists at Oak Ridge National Lab have created a model to analyze future global climates. In particular, this model focused on the effect of greenhouse gases on seasonal changes in wind direction that typically provide consistent reliable rainfall each year. What term describes these seasonal shifts in wind direction?

ANSWER: MONSOONS

BONUS

6) Energy – *Short Answer* Scientists at Oak Ridge National Lab have discovered a methanogen that can convert mercury into methylmercury, a toxic compound that is more easily taken up by fish and other wildlife. Methanogens are prominent members of what domain of life?

ANSWER: ARCHAEA
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TOSS-UP

7) Physics – *Short Answer* A 20-kilogram block is launched from the ground at an angle of 45° at a speed of 10 meters per second. What is the speed of the block when it reaches its highest point?

ANSWER: $5\sqrt{2}$ METERS PER SECOND

BONUS

7) Physics – *Short Answer* Identify all of the following three particles that obey the Pauli Exclusion Principle: 1) Neutrino; 2) Photon; 3) Electron.

ANSWER: 1 AND 3

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TOSS-UP

8) Biology – *Multiple Choice* What is the term for the contraction phase of the cardiac cycle?

W) Systole
X) Diastole
Y) Monostole
Z) Hyperstole

ANSWER: W) SYSTOLE

BONUS

8) Biology – *Short Answer* What term describes a dormant state, induced by drought, in which an organism becomes almost completely dehydrated and reduces its metabolic activity to an imperceptible level?

ANSWER: ANHYDROBIOSIS
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TOSS-UP

9) Earth and Space – *Multiple Choice* The layers of the atmosphere are primarily divided based on which of the following factors?

W) Altitude
X) Temperature
Y) Air pressure
Z) Composition

ANSWER: X) TEMPERATURE

BONUS

9) Earth and Space – *Multiple Choice* Which of the following processes most likely formed the lunar maria?

W) Drying of ancient oceans
X) Asteroid impacts
Y) Plate tectonics
Z) Volcanic eruptions

ANSWER: Z) VOLCANIC ERUPTIONS

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TOSS-UP

10) Math – *Short Answer* Evaluate $11^2 - 8^2$.

ANSWER: 57

BONUS

10) Math – *Short Answer* Define the binary operation a*b ***[a star b]*** = 2a + b. What is the value of 4*(3*2) ***[4 star the quantity 3 star 2]***?

ANSWER: 16
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TOSS-UP

11) Chemistry – *Short Answer* Identify all of the following four compounds that are found in diatomic form at standard temperature and pressure: 1) Hydrogen; 2) Helium; 3) Argon; 4) Bromine.

ANSWER: 1 AND 4

BONUS

11) Chemistry – *Multiple Choice* A compound contains 86% carbon and 14% hydrogen by mass. Which of the following is the empirical formula of the compound?

W) CH
X) CH_2
Y) C_2H_3
Z) CH_3

ANSWER: X) CH_2

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TOSS-UP

12) Energy – *Short Answer* Researchers at Pacific Northwest National Lab are researching the infection mechanism of the Zika virus, which is primarily mediated by mosquitoes. What term describes organisms, like mosquitoes, that transmit disease from one animal to another?

ANSWER: VECTOR

BONUS

12) Energy – *Multiple Choice* Researchers at Pacific Northwest National Lab found that the removal of ceramides from the membranes of liver cells significantly reduces viral replication in those cells. Ceramides are also found in the myelin sheath of neurons. In what class of macromolecules do ceramides belong?

W) Proteins
X) Carbohydrates
Y) Lipids
Z) Nucleic acids

ANSWER: Y) LIPIDS
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TOSS-UP

13) Physics – *Multiple Choice* A positively charged plastic rod is brought close to, but does not touch, a neutrally charged pith ball. The pith ball is grounded, and then the rod is removed. What is the final charge of the pith ball?

W) Positive
X) Negative
Y) Neutral
Z) Cannot be determined

ANSWER: X) NEGATIVE

BONUS

13) Physics – *Multiple Choice* Which of the following does NOT occur at relativistic speeds?

W) Time dilates
X) Length contracts
Y) The speed of light remains constant
Z) Rest mass increases

ANSWER: Z) REST MASS INCREASES

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TOSS-UP

14) Biology – *Short Answer* What term describes a single gene that has multiple phenotypic effects?

ANSWER: PLEIOTROPIC (ACCEPT: PLEIOTROPY)

BONUS

14) Biology – *Short Answer* In the Hershey–Chase experiment, what element was radioactively labeled in the proteins?

ANSWER: SULFUR
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TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following best characterizes the San Andreas fault?

W) Normal
X) Transverse
Y) Reverse
Z) Convergent

ANSWER: X) TRANSVERSE

BONUS

15) Earth and Space – *Short Answer* What is the name of the area where the northeast and southwest trade winds converge?

ANSWER: INTERTROPICAL CONVERGENCE ZONE (ACCEPT: ITCZ)

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TOSS-UP

16) Math – *Short Answer* In a survey of 25 people, 20 people said that they liked dogs, 16 people said that they liked cats, and 12 people said that they liked both dogs and cats. How many people liked neither cats nor dogs?

ANSWER: 1

BONUS

16) Math – *Short Answer* What is the magnitude of $(1 + 2i)^8$ ***[the quantity 1 plus 2i to the eighth power]***?

ANSWER: 625
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TOSS-UP

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

W) The molar solubility of a salt is equal to the concentration of any ion that occurs at a 1:1 ratio with the salt
X) Insoluble salts do not dissociate in solution
Y) Most salts become more soluble in liquid when temperature is increased
Z) The higher the K_{sp} for a salt, the more soluble the salt is

ANSWER: X) INSOLUBLE SALTS DO NOT DISSOCIATE IN SOLUTION

BONUS

17) Chemistry – *Short Answer* Consider the endothermic decomposition of dinitrogen pentoxide, $2N_2O_{5\,(g)} \leftrightarrow 4NO_{2\,(g)} + O_{2\,(g)}$. Identify all of the following three changes that would shift the equilibrium of the reaction towards the products: 1) Increasing pressure; 2) Increasing temperature; 3) Adding a catalyst.

ANSWER: 2 ONLY

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TOSS-UP

18) Energy – *Short Answer* Researchers at the Joint Genome Institute have discovered specialized subsidiary cells that surround stomata in grasses. These cells are adjacent to what kidney-shaped cells that regulate stomatal opening?

ANSWER: GUARD CELLS

BONUS

18) Energy – *Short Answer* Researchers at Pacific Northwest National Lab have discovered an iron oxide catalyst for the conversion of carbon dioxide to what toxic triple-bond containing molecule?

ANSWER: CARBON MONOXIDE
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TOSS-UP

19) Physics – *Short Answer* A parallel-plate capacitor consists of two square plates separated by a thin dielectric. By what factor will the capacitance increase if the side length of both square plates is doubled?

ANSWER: 4

BONUS

19) Physics – *Multiple Choice* Which of the following fluid equations is used to calculate the pressure difference between two static fluids due to surface tension?

W) Young–Laplace
X) Archimedes
Y) Bernoulli
Z) Continuity

ANSWER: Y) YOUNG-LAPLACE

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TOSS-UP

20) Biology – *Short Answer* What taxonomic division, which includes mosses and liverworts, encompasses nonvascular plants?

ANSWER: BRYOPHYTES

BONUS

20) Biology – *Short Answer* Order the following four events in the order in which they occur in mitosis: 1) Formation of cleavage furrow; 2) Disappearance of nucleoli; 3) Formation of kinetochores; 4) Separation of sister chromatids.

ANSWER: 2, 3, 4, 1
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TOSS-UP

21) Earth and Space – *Short Answer* What general process, which occurred shortly after the Big Bang, forms heavier nuclei from lighter, pre-existing ones?

ANSWER: NUCLEOSYNTHESIS

BONUS

21) Earth and Space – *Short Answer* What type of spiral galaxy has a well-defined spiral arm structure?

ANSWER: GRAND DESIGN

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TOSS-UP

22) Math – *Multiple Choice* Which of the following statements is true about the graph of the equation $y = x^2$?

W) Always increasing
X) Intersects the x-axis at exactly one point
Y) Intersects the y-axis at exactly two points
Z) Has a vertex at (0,1)

ANSWER: X) INTERSECTS THE X-AXIS AT EXACTLY ONE POINT

BONUS

22) Math – *Short Answer* What is the dot product of the two vectors 2i + 3j + 4k and i - j - k?

ANSWER: -5
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TOSS-UP

23) Chemistry – *Multiple Choice* Which of the following sets of quantum numbers n, l, m_l, m_s, is NOT possible?

W) 2, 1, -1, 1/2
X) 3, 2, 1, -1/2
Y) 4, 4, 0, 1/2
Z) 5, 3, -3, -1/2

ANSWER: Y) 4, 4, 0, 1/2

BONUS

23) Chemistry – *Short Answer* Identify all of the following three compounds that are soluble in water under standard conditions: 1) Silver chloride; 2) Lead (II) iodide; 3) Ammonium sulfate.

ANSWER: 3 ONLY