NNHS ROUND 5

TOSS-UP

1) Physics – *Short Answer* Kirchhoff's loop rule is based on the conservation of what quantity?

ANSWER: ENERGY

BONUS

1) Physics – *Short Answer* What elementary particle mediates the electromagnetic force?

ANSWER: PHOTON

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TOSS-UP

2) Biology – *Short Answer* What cells, found in the seminiferous tubules, provide nutrients for cells undergoing spermatogenesis?

ANSWER: SERTOLI CELLS

BONUS

2) Biology – *Multiple Choice* Which of the following statements is FALSE regarding the menstrual cycle in humans?

W) A peak in estradiol causes the LH surge
X) The follicle develops into the corpus luteum after ovulation
Y) Low levels of estradiol stimulate the hypothalamus to secrete gonadotropin-releasing hormone
Z) The luteal phase of the ovarian cycle is coordinated with the secretory phase of the uterine cycle

ANSWER: Y) LOW LEVELS OF ESTRADIOL STIMULATE THE HYPOTHALAMUS TO SECRETE GONADOTROPIN-RELEASING HORMONE
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TOSS-UP

3) Earth and Space – *Short Answer* Which scientist first proposed the heliocentric model of the solar system?

ANSWER: NICOLAS COPERNICUS (ACCEPT: COPERNICUS)

BONUS

3) Earth and Space – *Short Answer* What sequence, which resembles a tuning fork, is used as a morphological classification scheme for galaxies?

ANSWER: HUBBLE SEQUENCE (ACCEPT: HUBBLE TUNING FORK DIAGRAM)

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TOSS-UP

4) Math – *Short Answer* If a fair coin is flipped 7 times, what is the probability that all 7 flips are heads?

ANSWER: 1/128

BONUS

4) Math – *Short Answer* How many sides does a regular polygon with 20 diagonals have?

ANSWER: 8 (ACCEPT: OCTAGON)
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TOSS-UP

5) Chemistry – *Short Answer* Indicating sign, what is the oxidation state of oxygen in hydrogen peroxide?

ANSWER: -1 (DO NOT ACCEPT: 1)

BONUS

5) Chemistry – *Multiple Choice* Which of the following statements is true?

W) Both CCl_4 and CCl_2F_2 are polar
X) Both CCl_4 and CCl_2F_2 are nonpolar
Y) CCl_4 is polar, but CCl_2F_2 is nonpolar
Z) CCl_4 is nonpolar, but CCl_2F_2 is polar

ANSWER: Z) CCl_4 IS NONPOLAR, BUT CCl_2F_2 IS POLAR

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TOSS-UP

6) Energy – *Short Answer* Researchers at SLAC are testing a new form of cancer radiation therapy that reduces bombardment duration from minutes to under a second. Cancer is often caused by mutations to tumor suppressor genes and what other class of genes?

ANSWER: PROTO-ONCOGENES (DO NOT ACCEPT: ONCOGENES)

BONUS

6) Energy – *Multiple Choice* Researchers at SLAC are testing a new form of cancer radiation therapy that greatly reduces bombardment duration. Which of the following types of radiation is the most penetrating?

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

ANSWER: Y) GAMMA
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TOSS-UP

7) Physics – *Short Answer* A truck moving at a constant velocity suddenly breaks with a constant 5000-newton force. If the brakes do 25 kilojoules of work, then how far does the truck travel while braking before it comes to a complete stop?

ANSWER: 5 METERS

BONUS

7) Physics – *Multiple Choice* A 12-volt battery is connected to three parallel resistors, with resistances of 3, 24, and x ohms. The current through the battery is 6 amps. What is the resistance, x, of the third resistor?

W) 4
X) 8
Y) 12
Z) 16

ANSWER: X) 8

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TOSS-UP

8) Biology – *Multiple Choice* In eukaryotic messenger RNA, which of the following is always the first codon to be translated?

W) AAA
X) AUG
Y) GGG
Z) TAC

ANSWER: X) AUG

BONUS

8) Biology – *Short Answer* What type of horizontal gene transfer involves the transfer of DNA through bacteriophages?

ANSWER: TRANSDUCTION
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TOSS-UP

9) Earth and Space – *Short Answer* What term describes the small, asteroid sized bodies that are involved in the creation of planets?

ANSWER: PLANETESIMALS

BONUS

9) Earth and Space – *Short Answer* Order the following three epochs of the Cenozoic era from oldest to youngest: 1) Oligocene; 2) Eocene; 3) Pliocene.

ANSWER: 2, 1, 3

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TOSS-UP

10) Math – *Multiple Choice* Which of the following numbers has the most positive integer factors?

W) 28
X) 44
Y) 49
Z) 72

ANSWER: Z) 72

BONUS

10) Math – *Short Answer* What is the length of the major axis of the ellipse with equation $x^2 - 10x + 4y^2 - 8y = 7$?

ANSWER: 12
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TOSS-UP

11) Chemistry – *Multiple Choice* Which of the following compounds has the shortest bond length?

W) H_2
X) Br_2
Y) Cl_2
Z) F_2

ANSWER: W) H_2

BONUS

11) Chemistry – *Short Answer* How many sigma and pi bonds, respectively, are present in one molecule of benzene?

ANSWER: 12 SIGMA AND 3 PI (ACCEPT: 12 AND 3)

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TOSS-UP

12) Energy – *Short Answer* Researchers at Fermilab are using magnetic fields to study the interactions of muons in the Muon g-2 experiment. Muons are part of what class of spin-1/2 elementary particles?

ANSWER: FERMIONS

BONUS

12) Energy – *Short Answer* Researchers at Fermilab are using magnetic fields to study muons in the Muon g-2 experiment. They are studying the interaction of muons with what particles that pop in and out of existence for incredibly short amounts of time?

ANSWER: VIRTUAL PARTICLES
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TOSS-UP

13) Physics – *Multiple Choice* Which of the following is NOT considered an electrical control device?

W) Relay
X) Switch
Y) Transformer
Z) Transistor

ANSWER: Y) TRANSFORMER

BONUS

13) Physics – *Short Answer* Planck's law resolved what problem in physics, which predicted that a blackbody should emit an infinite amount of energy at very short wavelengths?

ANSWER: ULTRAVIOLET CATASTROPHE (ACCEPT: RAYLEIGH–JEANS CATASTROPHE)

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TOSS-UP

14) Biology – *Multiple Choice* What type of cell junction is found exclusively in plants?

W) Gap junction
X) Tight junction
Y) Desmosome
Z) Plasmodesmata

ANSWER: Z) PLASMODESMATA

BONUS

14) Biology – *Short Answer* Identify all of the following four amino acids that are essential for adult humans: 1) Glycine; 2) Isoleucine; 3) Leucine; 4) Proline.

ANSWER: 2 AND 3
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TOSS-UP

15) Earth and Space – *Short Answer* What term describes the process by which sediment is turned into solid sedimentary rock?

ANSWER: LITHIFICATION

BONUS

15) Earth and Space – *Multiple Choice* What type of unconformity is characterized by a break between a strata of igneous rock and a strata of sedimentary rock?

W) Angular unconformity
X) Disconformity
Y) Nonconformity
Z) Paraconformity

ANSWER: Y) NONCONFORMITY

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TOSS-UP

16) Math – *Short Answer* A triangle has integer side lengths. If two of the sides have lengths of 4 and 5, then what is the largest possible length of the third side?

ANSWER: 8

BONUS

16) Math – *Short Answer* How many ways can 7 committee members sit in a row, if the president must sit next to the vice president?

ANSWER: 1440
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TOSS-UP

17) Chemistry – *Short Answer* The hormone testosterone has 6 chiral centers. How many enantiomers does testosterone have?

ANSWER: 64

BONUS

17) Chemistry – *Multiple Choice* Which of the following compounds does NOT have the molecular formula C_6H_{14}?

W) Hexane
X) 2-ethyl propane
Y) 1,3-methyl butane
Z) 2-methyl pentane

ANSWER: X) 2-ETHYL PROPANE

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TOSS-UP

18) Energy – *Multiple Choice* Researchers at Argonne National Laboratory are studying bird feathers. Bird feathers are typically made of which of the following proteins?

W) Chitin
X) Collagen
Y) Elastin
Z) Keratin

ANSWER: Z) KERATIN

BONUS

18) Energy – *Short Answer* Researchers at Argonne National Laboratory are studying new and alternative ways to recycle lithium-ion batteries. What material is typically used for the anode of a lithium-ion battery?

ANSWER: GRAPHITE
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TOSS-UP

19) Physics – *Short Answer* A block slides across a surface in the presence of friction. Identify all of the following three factors that affect the acceleration of the block due to friction: 1) Contact area; 2) Mass of the block; 3) Coefficient of static friction.

ANSWER: NONE

BONUS

19) Physics – *Multiple Choice* A cube with uniform density is allowed to float in water, and it is observed that 80% of the cube's volume is submerged. If a force of 10 newtons is applied to the top of the cube, then it becomes completely submerged in the water. In newtons, what is the weight of the cube?

W) 10
X) 40
Y) 50
Z) 100

ANSWER: Y) 50

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TOSS-UP

20) Biology – *Short Answer* What special type of peroxisome is found in fat-storing tissues within plant seeds?

ANSWER: GLYOXYSOMES

BONUS

20) Biology – *Short Answer* What laser-based technique stains cells suspended in fluid with fluorescently labeled antibodies to study their properties?

ANSWER: FLOW CYTOMETRY
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TOSS-UP

21) Earth and Space – *Multiple Choice* Which spectral class of star is the hottest?

W) O
X) A
Y) B
Z) M

ANSWER: W) O

BONUS

21) Earth and Space – *Short Answer* What is the term for the plane of Earth's orbit around the Sun?

ANSWER: ECLIPTIC

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TOSS-UP

22) Math – *Multiple Choice* A function has a second derivative given by $f''(x)$ ***[f double prime of x]*** $= 36x^2$. How many points of inflection does f have?

W) 0
X) 1
Y) 2
Z) 3

ANSWER: W) 0

BONUS

22) Math – *Short Answer* Regular hexagon ABCDEF has an area of 60. What is the area of triangle ACE?

ANSWER: 30
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TOSS-UP

23) Chemistry – *Multiple Choice* Which of the following mixtures would make an effective buffer solution?

W) 0.05 molar hydrofluoric acid and 0.05 molar sodium fluoride
X) 0.50 molar hydrochloric acid and 0.50 molar sodium chloride
Y) 0.30 molar methylamine and 0.30 molar ammonium
Z) 0.25 molar acetic acid and 0.25 molar sodium bicarbonate

ANSWER: W) 0.05 MOLAR HYDROFLUORIC ACID AND 0.05 MOLAR SODIUM FLUORIDE

BONUS

23) Chemistry – *Short Answer* Rank the following four acids in terms of increasing K_a: 1) HClO; 2) HBrO; 3) HIO; 4) $HClO_2$

ANSWER: 3, 2, 1, 4