

Niskayuna Winter Invitational Round Robin 3

TOSS-UP

1) PHYSICS – *Short Answer*—In a cyclic process, a heat engine absorbs 800 J of heat energy from a high-temperature reservoir and exhausts 500 J to a low temperature reservoir in each cycle. To the nearest whole number percentage, what is the efficiency of the heat engine?

ANSWER: 38

BONUS

1) PHYSICS – *Short Answer*—Two 3 ohm resistors connected in parallel are connected in series to a 1 ohm resistor and the circuit is connected to a 2 volt battery. What is the power, in watts, dissipated by this circuit?

ANSWER: 1.6

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### TOSS-UP

2) CHEMISTRY – *Short Answer*—What is the value of the orbital angular momentum quantum number of an electron in the 5s (read as: 5-S) orbital of Cesium?

ANSWER: 0

### BONUS

2) CHEMISTRY – *Multiple Choice*— Given that the standard reduction potential of  $\text{Cr}^{2+} + 2\text{e}^- \rightarrow \text{Cr}$  (read as: C-R 2-plus plus 2 e-minus yields C-R) is -0.90 V and the standard reduction potential of  $\text{Cr}^{3+} + \text{e}^- \rightarrow \text{Cr}^{2+}$  (read as: C-R 3-plus plus e-minus yields C-R 2-plus) is -0.42 V, which of the following is closest to the standard reduction potential of  $\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr}$  in volts?

W) -1.32

X) -0.74

Y) -0.48

Z) +0.48

ANSWER: X) -0.74

### TOSS-UP

3) ENERGY – *Short Answer*—Researchers at the Pacific Northwest National Lab are able to measure physical and hydraulic properties of sediments in the layer beneath the land surface and above the water table. What term is given to this layer?

ANSWER: VADOSE ZONE (ACCEPT: UNSATURATED ZONE)

### BONUS

3) ENERGY – *Short Answer*—Despite its name, Doppler radars do not use radio waves because of the low precision that comes with its longer wavelength. Instead, Doppler radars work by sending out pulses in what part of the electromagnetic spectrum?

ANSWER: MICROWAVE

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TOSS-UP

4) EARTH AND SPACE – *Multiple Choice*—A river bed is characterized by having large sediments and easily erodible, weak bank material. Which of the following types of rivers would be most likely to form on this river bed?

W) Anastamosing (read as: ah-nas-ta-mohs-ing)

X) Meandering

Y) Wandering

Z) Braided

ANSWER: Z) BRAIDED

BONUS

4) EARTH AND SPACE – *Short Answer*—Rank the following three water reservoirs in order of least to most volume: 1) groundwater, 2) rivers and streams, 3) oceans

ANSWER: 2, 1, 3

TOSS-UP

5) MATH – *Short Answer*—What is the circumference of a circle whose area and radius are the same?

ANSWER: 2

BONUS

5) MATH – *Multiple Choice*—Daniel is already preparing for the Niskayuna Summer Invitational. If on the n th day, Daniel asks his team to write questions n more times than the previous day, starting with 1 time on the first day, after which of the following days will the total number of times Daniel has asked his team to write questions exceed 1000 times?

W) 17

X) 18

Y) 19

Z) 20

ANSWER: X) 18

TOSS-UP

6) BIOLOGY – *Multiple Choice*—Which of the following is not true regarding epinephrine?

W) Epinephrine binds to alpha adrenergic receptors, but not beta adrenergic receptors

X) Epinephrine is produced in the adrenal medulla

Y) Epinephrine is derived from tyrosine

Z) Epinephrine's solubility in water is dependent on its pH

ANSWER: W) EPINEPHRINE BINDS TO ALPHA ADRENERGIC RECEPTORS, BUT NOT BETA ADRENERGIC RECEPTORS

BONUS

6) BIOLOGY – *Short Answer*—Epinephrine is synthesized in the adrenal medulla. By name or number, order the following four intermediates in the synthesis of epinephrine from first to last:

1) dopamine, 2) L-DOPA, 3) tyrosine, 4) norepinephrine

ANSWER: 3, 2, 1, 4

TOSS-UP

7) PHYSICS – *Short Answer*—By name or number, identify all of the following three mirrors that always create virtual images: 1) plane mirror, 2) concave mirror, 3) convex mirror

ANSWER: 1 AND 3

BONUS

7) PHYSICS – *Multiple Choice*—Which of the following angles is closest to the greatest angle that a ray of light passing from water, with an index of refraction of $4/3$, to air, with an index of refraction of 1, will not undergo total internal reflection?

- W) 15
- X) 30
- Y) 45
- Z) 60

ANSWER: Y) 45

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### TOSS-UP

8) CHEMISTRY – *Short Answer*—What type of molecular geometry is exhibited by the molecule chlorine trifluoride?

ANSWER: T-SHAPED

### BONUS

8) CHEMISTRY – *Short Answer*—What is the general name for chemical compounds containing a five membered aromatic ring with 4 carbon atoms and one oxygen atom?

ANSWER: FURANS

### TOSS-UP

9) ENERGY – *Short Answer*—Diseases such as rabies and salmonella are similar in that they are transmitted to humans by an infected animal. What is the adjective given to this type of disease?

ANSWER: ZOONOTIC

### BONUS

9) ENERGY – *Multiple Choice*—The  $R_0$  (read as: R-naught) value of an infectious disease is a measure of which of the following?

- W) The proportion of a community that needs to be immune to the disease in order for there to be herd immunity.
- X) The number of individuals that are infected by contact with an infected person.
- Y) The time it would take for an infected population to double its size.
- Z) The incidence of the infectious disease divided by the size of the community.

ANSWER: X) THE NUMBER OF INDIVIDUALS THAT ARE INFECTED BY CONTACT WITH AN INFECTED PERSON.

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TOSS-UP

10) EARTH AND SPACE – *Multiple Choice*—Which of the following metamorphic rocks is not paired correctly with one of its protoliths?

- W) Gneiss; shale
- X) Sandstone; quartzite
- Y) Schist; shale
- Z) Phyllite; limestone

ANSWER: Z) PHYLLITE; LIMESTONE

BONUS

10) EARTH AND SPACE – *Multiple Choice*—Which of the following plate boundaries is an example of a convergent boundary?

- W) Cocos plate and Caribbean plate
- X) Pacific plate and Nazca plate
- Y) Scotia plate and Antarctic plate
- Z) African plate and Arabian plate

ANSWER: W) COCOS PLATE AND CARIBBEAN PLATE

TOSS-UP

11) MATH – *Short Answer*—Daniel and Aarush are at opposite ends of a 150 mile long road. If Daniel bikes at 20 miles/hour, and Aarush drives at 50 miles per hour, at what time will they meet if Daniel leaves at 12:00pm and Aarush leaves at 12:30pm?

ANSWER: 2:30 PM

BONUS

11) MATH – *Multiple Choice*—If $x^{x^2} = 216$, (read as: x to the x to the second) what is x^4 ?

- W) 6
- X) 18
- Y) 36
- Z) 72

ANSWER: Y) 36

TOSS-UP

12) BIOLOGY – *Multiple Choices*—Which of the following is not a difference between monocots and dicots?

- W) Monocots have fibrous roots and dicots have tap roots
- X) Monocot stems typically lack piths while dicot stems have piths
- Y) Monocots have a scattered vascular structure while dicots have a ringed vascular structure
- Z) Monocots usually have net-like veins while dicots usually have parallel veins

ANSWER: Z) MONOCOTS USUALLY HAVE NET-LIKE VEINS WHILE DICOTS HAVE PARALLEL VEIN

BONUS

12) BIOLOGY – *Short Answer*—By name or number, order the following layers of a deciduous forest from top to bottom: 1) ground level 2) understory 3) herb level, 4) canopy

ANSWER: 4, 2, 3, 1

TOSS-UP

13) PHYSICS – *Multiple Choice*—If I am riding my bike forward, in which of the following directions does the bike wheel's angular momentum vector point?

- W) Left
- X) Right
- Y) Forward
- Z) Upward

ANSWER: W) LEFT

BONUS

13) PHYSICS – *Short Answer*—By name or number, identify all of the following three properties that are path functions: 1) pressure, 2) heat, 3) temperature

ANSWER: 2 ONLY

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### TOSS-UP

14) CHEMISTRY – *Multiple Choice*—Which of the following molecules have the same molecular geometry and electron geometry?

- W)  $I_3^-$
- X)  $PCl_5$
- Y)  $H_2O$
- Z)  $SO_2$

ANSWER: X)  $PCl_5$

### BONUS

14) CHEMISTRY – *Short Answer*—Rank the following 3 ions by increasing degree of deflection in a mass spectrometer: 1) Carbon-12  $1+$ , 2) Carbon-12  $2+$ , 3) Carbon-13  $1+$

ANSWER: 3, 1, 2

### TOSS-UP

15) ENERGY – *Short Answer*—What mineral primarily constitutes the anodes of lithium-ion batteries?

ANSWER: GRAPHITE

### BONUS

15) ENERGY – *Multiple Choice*—In high-temperature gas cooled reactors, which of the following is the primary gas used to cool the reactors?

W) Hydrogen

X) Helium

Y) Nitrogen

Z) Argon

ANSWER: X) HELIUM

### TOSS-UP

16) EARTH AND SPACE – *Multiple Choice*—Which of the following phases in the Wilson cycle is not paired correctly with its description?

W) embryonic; uplifting and formation of valleys and rifts

X) juvenile; extension and widening due to divergent forces, typically characterized by narrow seas with matching coasts

Y) mature; a proper ocean with continental margins

Z) suturing; the edges of the oceanic plate begins to subduct under continental plate

ANSWER: Z) SUTURING; THE EDGES OF THE OCEANIC PLATE BEGINS TO SUBDUCT UNDER CONTINENTAL PLATE

### BONUS

16) EARTH AND SPACE – *Short Answer*—Rank the following four bodies of water in order of their stage in the Wilson cycle: 1) Mediterranean, 2) Pacific, 3) Red Sea, 4) Atlantic.

ANSWER: 3, 4, 2, 1



### TOSS-UP

17) MATH – *Short Answer*—What is the sum of the first 52 terms of an arithmetic sequence whose first three terms are -2, 0, and 2?

ANSWER: 2548

### BONUS

17) MATH – *Short Answer*—If it takes Arjun and Daniel 10 hours to compile a round, Daniel and Mihir 12 hours to compile a round, and Arjun and Mihir 15 hours to compile a round, how long, in hours, will it take Arjun to compile a round by himself?

ANSWER: 24 HOURS

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TOSS-UP

18) BIOLOGY – *Multiple Choice*—A deficiency in which of the following amino acids, which is responsible for producing melatonin and serotonin, would cause symptoms like impaired motor activity and increased aggressiveness?

- W) Tyrosine
- X) Serine
- Y) Methionine
- Z) Tryptophan

ANSWER: Z) TRYPTOPHAN

BONUS

18) BIOLOGY – *Short Answer*—Prolyl isomerase is an enzyme that accelerates the cis- and trans- isomerization of peptide bonds preceding proline residues, thus regulating the folding and unfolding of proteins at site of the proline residues. What is the name of the class of proteins to which prolyl isomerase belongs, responsible for regulating the folding and unfolding of proteins?

ANSWER: MOLECULAR CHAPERONES (ACCEPT: CHAPERONINS, CHAPERONES)

TOSS-UP

19) MATH – *Short Answer*—What is the perimeter of a rhombus with diagonals of length 6 and 8?

ANSWER: 20

BONUS

19) MATH – *Short Answer*—How many ways are there to seat the 7 members of the tournament board in a line of chairs, if the President and Secretary must sit next to each other, and the President cannot sit next to the Vice President?

ANSWER: 1200



TOSS-UP

20) BIOLOGY – *Short Answer*—What term is used to describe the form of asexual reproduction, commonly occurring in invertebrates but also occurring in vertebrates when populations are low, where an egg develops without being fertilized?

ANSWER: PARTHENOGENESIS

BONUS

20) BIOLOGY – *Multiple Choice*—Which of the following statements is true regarding the difference between the Z-W sex system and the X-Y sex system?

- W) The Z-W system applies strictly to avians while the X-Y system applies to mammals
- X) In the Z-W system, the ovum determines the sex of the offspring, while in the X-Y system, the sperm determines the sex of the offspring
- Y) The Z-W system is an intermediate of the X-Y system and is caused by a mutation in the SRY gene, leading to intersex offspring
- Z) The Z-W system uses two sets of sex chromosomes while the X-Y system uses one set of sex chromosomes

ANSWER: X) IN THE Z-W SYSTEM, THE OVUM DETERMINES THE SEX OF THE OFFSPRING, WHILE IN THE X-Y SYSTEM, THE SPERM DETERMINES THE SEX OF THE OFFSPRING