

## Niskayuna Summer Invitational Single Elimination 2

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### TOSS-UP

1) Physics – *Short Answer* A wire of length 2m has a cross sectional area of  $0.05\text{m}^2$  and a resistance of 30 ohms. In ohm-meters, what is the resistivity of the wire? (AI)

ANSWER: 0.75

### BONUS

1) Physics – *Short Answer* ANdrey has a juicy balloon where the balloon itself is in the shape of a rigid hollow cylinder with mass  $m$  and radius  $r$ . His balloon is filled to the brim with juice of total mass 8kg. Assume that the outer surface of the balloon has friction while the inner surface is frictionless. If ANdrey releases the balloon from rest at the top of a slope with height 4m, in meters per second, what will be the speed of the balloon at the bottom of the slope? Express your answer as a fraction in simplest form and assume gravity to be 9.8 meters per second squared. (ANdrey)

ANSWER: 42/5

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### TOSS-UP

2) Chemistry – *Multiple Choice* Which of the following terms is used to describe stereoisomers produced by rotation around sigma bonds, whose interconversion, by rotation around a single bond, between conformations is restricted by an energy barrier? (MK)

- W) Atropisomers
- X) Enantiomers
- Y) Structural isomers
- Z) Cis-trans isomers

ANSWER: W) ATROPISOMERS

### BONUS

2) Chemistry – *Short Answer* What process, the oldest used in industrial electrolytics, involves the electrodeposition of metals from their ores in solution, often using acid?

ANSWER: LEACHING (ACCEPT: ELECTROEXTRACTION, ELECTROWINNING)

### TOSS-UP

3) Energy – *Multiple Choice* Approximately how much heat is produced by normal human resting metabolism in watts? (DY)

- W) 20
- X) 40
- Y) 80
- Z) 160

ANSWER: Y) 80

### BONUS

3) Energy – *Short Answer* What is the name given to the fusion energy process that initiates fusion by compressing fuel-filled targets—usually small pellets composed of deuterium and tritium?

ANSWER: INERTIAL CONFINEMENT FUSION

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### TOSS-UP

4) Earth and Space – *Short Answer* What is the term for when an exoplanet passes between its star and observer? (AI)

ANSWER: TRANSIT

### BONUS

4) Earth and Space – *Multiple Choice* Which of the following spectral classes is hotter than A-type stars?

- W) B
- X) C
- Y) G
- Z) K

ANSWER: W) B

**TOSS-UP**

5) Math – *Short Answer* How many inversions are present in the sequence 4, 5, 2, 1? (MK)

ANSWER: 5

**BONUS**

5) Math – *Short Answer* What is the value of the determinant of the 3x3 matrix with first row 3 4 5, second row 7 1 3, and third row 9 4 6?

ANSWER: 17

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**TOSS-UP**

6) Chemistry – *Multiple Choice* Given the reaction  $H_2 + F_2$  yields  $2HF$  at equilibrium, what could be expected to happen if the temperature of the system were to increase? (MK)

- W) The equilibrium would shift left
- X) The equilibrium would shift right
- Y) The concentration of  $H_2$  would decrease
- Z) The equilibrium would stay the same

ANSWER: W) THE EQUILIBRIUM WOULD SHIFT LEFT

**BONUS**

6) Chemistry – *Short Answer* When ferromagnetic materials are heated past their Curie point, what form of magnetism can they be predicted to exhibit?

ANSWER: PARAMAGNETISM

### TOSS-UP

7) Physics – *Short Answer* A converging lens with a focal length of 20 cm is used to form an image of an object placed 40 cm in front of the lens. What is the magnification of the image?  
(TJ)

ANSWER: -1

### BONUS

7) Physics – *Multiple Choice* In meters per second square, what is the magnitude of the maximum acceleration of a 2 kg block oscillating in simple harmonic motion on a horizontal table with an equation of motion of  $x(t)=4\cos(2.5t+3)$  (READ AS: x of t equals 4 times cosine of the quantity 2.5t plus 3)?

- W) 10
- X) 15
- Y) 20
- Z) 25

ANSWER: Z) 25

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### TOSS-UP

8) Biology – *Short Answer* Despite being termed a second messenger,  $\text{Ca}^{2+}$  ions actually function as a third cellular signal after its channels are activated by what molecule that results from the cleaving of phosphatidylinositol 4,5-bisphosphate? (MK)

ANSWER: INOSITOL TRISPHOSPHATE (ACCEPT: IP3,  $\text{C}_6\text{H}_{15}\text{O}_{15}\text{P}_3$ )

### BONUS

8) Biology – *Multiple Choice* The binding of a single molecule of epinephrine to a G-protein coupled receptor has the potential to convert approximately how many molecules of Glycogen to Glucose-1-Phosphate?

- W) 100
- X) 1,000
- Y) 1,000,000
- Z) 100,000,000

ANSWER: Z) 100,000,000

### TOSS-UP

9) Earth and Space – *Short Answer* By name or number, order the following three mountain ranges from youngest to oldest: (AP)

- 1) Adirondacks
- 2) Andes
- 3) Himalayas

ANSWER: 1, 2, 3

### BONUS

9) Earth and Space – *Multiple Choice* Which of the following minerals displays an orthorhombic crystal structure and is a polymorph of calcite? (AI)

- W) Aragonite
- X) Rhodonite
- Y) Actinolite
- Z) Celestite

ANSWER: W) ARAGONITE

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### TOSS-UP

10) Math – *Short Answer* Ephram has 6 beads labeled E,P,H,R,A,M. If he puts these 6 beads on a necklace, how many distinct arrangements can he get? Rotations or flips of the same sequence are not considered distinct arrangements. (EC)

ANSWER: 60

### BONUS

10) Math – *Short Answer* In the sequence 88, 24, 64, 40, 24, etc, each number after the second is obtained by finding the non-negative difference between the previous 2 numbers. What is the sum of the first 100 numbers in this sequence?

ANSWER: 760

### TOSS-UP

11) Physics – *Multiple Choice* A hollow sphere, solid sphere, and solid disk, all with mass  $m$  and radius  $r$  are released at the same time from the top of a frictionless plane of length  $l$ . Which of the following objects will have the fastest speed when they reach the bottom of the slope? (ANdrey)

- W) The hollow sphere
- X) The solid sphere
- Y) The solid disk
- Z) All objects will have the same speed

ANSWER: Z) ALL OBJECTS WILL HAVE THE SAME SPEED

### BONUS

11) Physics – *Multiple Choice* ANdrey can't do physics, so instead he asks astronomy questions in disguise. If ANdrey is in an orbit around the Earth with kinetic energy equal to twice the magnitude of ANdrey's potential energy due to Earth, which of the following paths will his orbit take?

- W) Circular
- X) Elliptical
- Y) Parabolic
- Z) Hyperbolic

ANSWER: Z) HYPERBOLIC

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### TOSS-UP

12) Energy – *Multiple Choice* Which of the following is closest to the percentage uranium-235 isotope must be enriched to in order to be used for nuclear fuel?

- W) 1
- X) 5
- Y) 15
- Z) 20

ANSWER: X) 5

### BONUS

12) Energy – *Short Answer* In gram staining, what biochemical counterstain is used to differentiate between gram positive and gram negative bacteria based on the thickness of their peptidoglycan layers? (AI)

ANSWER: RED SAFRANIN (ACCEPT: SAFRANIN)

**TOSS-UP**

13) Biology – *Multiple Choice* Which of the following amino acids does not exhibit chirality?  
(MK)

- W) Leucine
- X) Alanine
- Y) Isoleucine
- Z) Glycine

ANSWER: Z) GLYCINE

**BONUS**

13) Biology – *Short Answer* What is the most common class of enzyme-coupled receptors?

ANSWER: RECEPTOR TYROSINE KINASES (ACCEPT: RTKs, DO NOT ACCEPT: PTKs)

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**TOSS-UP**

14) Earth and Space – *Short Answer* The USDA soil texture triangle classification scheme uses the proportions of what 3 sediments to classify soil? (DY)

ANSWER: SAND, SILT, CLAY (IN ANY ORDER)

**BONUS**

14) Earth and Space – *Short Answer* What term is given to the ocean deposits formed mostly of calcium carbonate from the bodies of phytoplanktonic organisms?

ANSWER: CALCAREOUS OOZE

**TOSS-UP**

15) Math – *Short Answer* When performing a one sample t test on a sample of 45, how many degrees of freedom must you assume? (MK)

ANSWER: 44

**BONUS**

15) Math – *Short Answer* In terms of  $\pi$ , what is the perimeter of the polar curve  $r = 4\sin(\theta)$  (READ as r equals 4 sin of theta) between the radian angles of 0 to  $\pi/2$ ?

ANSWER:  $2\pi$



**TOSS-UP**

16) Chemistry – *Short Answer* Used in material science, what class of compounds solely consists of molecules made up of Carbon and Nitrogen atoms? (MK)

ANSWER: CARBON NITRIDES

**BONUS**

16) Chemistry – *Short Answer* To the nearest tenth, what is the ratio of the energy of a photon released when an electron transitions from  $n = 4$  to  $n = 2$  to the energy of a photon released when an electron transitions from  $n = 3$  to  $n = 2$  in a hydrogen atom?

ANSWER: 1.4



### TOSS-UP

17) Energy – *Multiple Choice* Which of the following is an example of a Class 3 Lever? (AI)

- W) Scissors
- X) Wheelbarrow
- Y) Tweezers
- Z) Pliers

ANSWER: Y) TWEEZERS

### BONUS

17) Energy – *Short Answer* In August of 1977, the Voyager 2 space probe launched and flew by Jupiter for reconnaissance. It employed the technique of using the energy of Jupiter's gravitational field and orbital velocity to build momentum -- similar to a slingshot -- to launch itself to Saturn. What technique did Voyager 2 utilize?

ANSWER: GRAVITY ASSIST

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### TOSS-UP

18) Biology – *Short Answer* How many generations of dichotomous branching are present in the respiratory tract? (MK)

ANSWER: 23 (ACCEPT: 24)

### BONUS

18) Biology – *Multiple Choice* Which of the following best describes the function of surfactant in the human respiratory system?

- W) Increases surface tension of epithelium to allow for lessened expansion of the lungs.
- X) Increases surface tension of basal cells to prevent infection in the lungs
- Y) Decreases surface tension of epithelium to prevent alveolar collapse
- Z) Surfactant only has cardiac function

ANSWER: Y) DECREASES SURFACE TENSION OF EPITHELIUM TO PREVENT ALVEOLAR COLLAPSE

### TOSS-UP

19) Earth and Space – *Short Answer* NASA’s James Webb Space Telescope has been taking deep space images of the early universe. Recently, in a young star system, d203-506, within a protoplanetary disk, they detected a carbon based cation, which has long been speculated to have been an important factor in the creation of planets, as it helps form more complex carbon compounds. What is the name of this cation? (MK)

ANSWER: METHYL CATION (ACCEPT:  $\text{CH}_3^+$ , METHYL, METHENIUM, DO NOT ACCEPT: METHANIUM)

### BONUS

19) Earth and Space – *Multiple Choice* Approximately how large is the Schwarzschild radius of the supermassive black hole at the center of the Milky Way galaxy?

- W) 1 million kilometers
- X) 10 million kilometers
- Y) 100 million kilometers
- Z) 1 billion kilometers

ANSWER: X) 10 MILLION KILOMETERS

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### ESTIMATION

20) Estimation - *Short Answer* To 2 significant figures, how long, in seconds, is the length of Taylor Swift’s full discography, or compilation of every song she’s ever written? (AI)

ANSWER: 75000