

## Niskayuna Winter Invitational Single Elimination 1

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### TOSS-UP

1) PHYSICS – *Multiple Choice*—Which of the following occurs when you rub a cat’s fur around a glass tube?

- W) Electrons transfer from the air to the cat’s fur
- X) Electrons transfer from the glass to the cat’s fur
- Y) Electrons transfer from the air to the glass tube
- Z) Electrons transfer from the cat’s fur to the glass

ANSWER: X) ELECTRONS TRANSFER FROM THE GLASS TO THE CAT’S FUR

### BONUS

1) PHYSICS – *Short Answer*—A box is in the bed of a pickup truck that is accelerating forward. If the truck is said to be moving in the positive x-direction, what direction is the friction force on the box from the bed of the truck?

ANSWER: POSITIVE X-DIRECTION

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### TOSS-UP

2) CHEMISTRY – *Multiple Choice*— Which of the following molecules will have the highest average kinetic energy at 100 degrees Celsius?

- W) Helium
- X) Neon
- Y) Argon
- Z) They all have the same kinetic energy

ANSWER: Z) THEY ALL HAVE THE SAME KINETIC ENERGY

### BONUS

2) CHEMISTRY – *Short Answer*—Potassium superoxide is a yellow solid produced by burning molten potassium in an atmosphere of excess oxygen. When Potassium Superoxide reacts with water and carbon dioxide, oxygen gas is released, and a white solid is formed. Given that the chemical formula for Potassium superoxide is  $\text{KO}_2$ , what is the identity of the formed solid?

ANSWER: POTASSIUM BICARBONATE (ACCEPT:  $\text{KHCO}_3$ )

### TOSS-UP

3) ENERGY – *Short Answer*—A simple gear train consists of a first gear with 84 teeth, a second gear with 12 teeth, and a third gear with 84 teeth. If 1 newton meter of torque is used to turn the first gear, how much torque, in newton meters will be put out by the third gear?

ANSWER: 1

### BONUS

3) ENERGY – *Multiple Choice*—Antifreeze is a common additive in gasoline which lowers the freezing point of the water in the coolant pumped throughout the engine block. Which of the following is the active ingredient in antifreeze?

- W) Ethylene glycol
- X) Tert-butyl alcohol
- Y) Cyclohexanol
- Z) Cyclobutane

ANSWER: W) ETHYLENE GLYCOL

**TOSS-UP**

4) EARTH AND SPACE – *Short Answer*—Name all of the following four terms which are associated with a convergent plate boundary: 1) terrane (read as: **tur**-ayne), 2) fracture zone, 3) accretionary wedge, 4) Wadati-Benioff zone

ANSWER: 1, 3 AND 4

**BONUS**

4) EARTH AND SPACE – *Multiple Choice*—Which of the following is not a characteristic of Karst topography?

- W) Disappearing streams
- X) Collapse breccia
- Y) Saline intrusion in groundwater
- Z) Limestone caves

ANSWER: Y) SALINE INTRUSION IN GROUNDWATER

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**TOSS-UP**

5) MATH – *Multiple Choice*—Which of the following numbers is the sum of the unique prime factors of 2024?

- W) 30
- X) 36
- Y) 42
- Z) 45

ANSWER: X) 36

**BONUS**

5) MATH – *Short Answer*—What is the area of the region enclosed by the lines  $y=4$ ,  $x=3$ , and  $y= -1/2x$ ?

ANSWER:  $12\frac{1}{4}$   
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### TOSS-UP

6) BIOLOGY – *Short Answer*—By name or number, identify all of the following four hormones that are NOT released by the anterior pituitary gland: 1) oxytocin, 2) GRH, 3) vasopressin, 4) human growth hormone

ANSWER: 1 AND 3

### BONUS

6) BIOLOGY – *Multiple Choice*—In women undergoing labor, pressure exerted on the cervix by the baby's head is responsible for stimulating the release of oxytocin by the posterior pituitary gland, which causes further uterine contractions, causing further pressure on the cervix by the baby's head. What is the name given to this neuroendocrine positive feedback mechanism?

ANSWER: FERGUSON REFLEX (ACCEPT: FERGUSON)



### TOSS-UP

7) PHYSICS – *Short Answer*—What is the term for the process by which energy is emitted from a black hole due to quantum effects at its event horizon?

ANSWER: HAWKING RADIATION

### BONUS

7) PHYSICS – *Multiple Choice*—In the context of quantum electrodynamics, what is the term for the process in which a virtual particle-antiparticle pair is created near a real particle, affecting its properties momentarily?

W) Renormalization

X) Quantum tunneling

Y) Vacuum fluctuation

Z) Casimir effect

ANSWER: Y) VACUUM FLUCTUATION

### TOSS-UP

8) CHEMISTRY – *Multiple Choice*—Which of the following atomic subshells contains the highest energy electrons?

- W) 3s
- X) 3p
- Y) 3d
- Z) 4s

ANSWER: Y) 3d

### BONUS

8) CHEMISTRY – *Short Answer*—By name or number, identify all of the following three orbital hybridizations present in a molecule of urea: 1) sp, 2) sp<sup>2</sup>, 3) sp<sup>3</sup>.

ANSWER: 2 AND 3

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### TOSS-UP

9) ENERGY – *Multiple Choice*—The CERES instrument used on NASA satellites is designed to measure the Earth's radiative energy flux. Which of the following is an SI unit used to measure radiant energy flux?

- W) Lumens
- X) Candela
- Y) Ampere
- Z) Watt

ANSWER: Z) WATT

### BONUS

9) ENERGY – *Short Answer*—Scientists at the University of Pennsylvania's Gadue lab are studying endoderm and mesoderm specification. To do this, they are using what type of stem cells characterized by their ability to develop into any type of cell in the body?

ANSWER: PLURIPOTENT

### TOSS-UP

10) EARTH AND SPACE – *Short Answer*—By name or number, identify all of the following four faults that are associated with compressional forces: 1) normal, 2) reverse, 3) thrust fault, 4) strike slip

ANSWER: 2 AND 3

### BONUS

10) EARTH AND SPACE – *Multiple Choice*—The Basin and Range province in North America is characterized by horst and graben topography. Which of the following is not true regarding horst and graben topography?

- W) Horsts represent areas of uplift, while grabens are areas of subsidence
- X) They are characterized by normal faults
- Y) They are characterized by compressional forces
- Z) They are common in sedimentary basins

ANSWER: Y) THEY ARE CHARACTERIZED BY COMPRESSIONAL FORCES



### TOSS-UP

11) MATH – *Short Answer*—How many factors does  $202^4$  have?

ANSWER: 255

### BONUS

11) MATH – *Short Answer*—Josh is driving his Ferrari F8 a distance of 1200 miles. At first, he travels at a speed of 200 mph. After traveling  $\frac{1}{3}$  of the total distance, the windshield breaks, so he travels at 150 mph. After another  $\frac{1}{4}$  of the total distance, a wheel falls off, reducing his speed to 100 mph. How much time would Josh have saved, in hours, if he had taken his helicopter, which would have traveled at 200 mph the entire distance?

ANSWER: 3

**TOSS-UP**

- 12) BIOLOGY – *Multiple Choice*—Which of the following bulbs would not allow a plant to reproduce?  
W) True bulbs  
X) Corms  
Y) Tubers  
Z) Rhizomes

ANSWER: Y) TUBERS

**BONUS**

- 12) BIOLOGY – *Short Answer*—A plant's flower only produces sepals and carpals. According to the ABC hypothesis, which gene or genes are absent from the plant?

ANSWER: B

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**TOSS-UP**

- 13) PHYSICS – *Short Answer*—What is the name of the imaginary path created to calculate the circulation of a magnetic field?

ANSWER: AMPERIAN LOOP

**BONUS**

- 13) PHYSICS – *Multiple Choice*—A 6 centimeter long solenoid has 1800 turns of wire and carries a current of 9 Amps. Which of the following is closest to the strength, in teslas of the magnetic field at the center of the solenoid?  
W) 0.9  
X) 0.5  
Y) 0.3  
Z) 0.1

ANSWER: Y) 0.3

**TOSS-UP**

14) CHEMISTRY – *Short Answer*— Characterized by a loud popping noise, what gas is produced when solid Zinc is placed in Hydrochloric acid?

ANSWER: HYDROGEN GAS (ACCEPT: H<sub>2</sub>)

**BONUS**

14) CHEMISTRY – *Short Answer* — Given that a microwave has a wavelength of 30 cm, and assuming the speed of light to be 3 times 10 to the 8th meters per second, in gigahertz, what is the frequency of the wave?

ANSWER: 1 GHz

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**TOSS-UP**

15) ENERGY – *Short Answer*—Control rods are used in nuclear reactors to control the rate of nuclear fission. Which subatomic particle are they designed to absorb without themselves decaying?

ANSWER: NEUTRON

**BONUS**

15) ENERGY – *Multiple Choice*—Which of the following is an ore in which uranium is commonly found?

- W) pitchblende
- X) calamine
- Y) hematite
- Z) siderite

ANSWER: W) PITCHBLENDE



### TOSS-UP

- 16) EARTH AND SPACE – *Multiple Choice*—Which of the following is not true about Bowen’s reaction series?
- W) The first minerals in the reaction series are mafic while the later minerals are felsic
  - X) The first minerals in the continuous branch are sodium rich while the later minerals are calcium rich
  - Y) Quartz is the last mineral in the reaction series
  - Z) The first minerals in the reaction series tend to be darker in color while the later minerals tend to be lighter in color

ANSWER: X) THE FIRST MINERALS IN THE CONTINUOUS BRANCH ARE SODIUM RICH WHILE THE LATER MINERALS ARE CALCIUM RICH

### BONUS

- 16) EARTH AND SPACE – *Short Answer*—Rank the following four minerals in order from first to crystalize to last to crystalize according to Bowen’s reaction series: 1) muscovite, 2) quartz, 3) biotite, 4) olivine

ANSWER: 4, 3, 1, 2



### TOSS-UP

- 17) MATH – *Short Answer* — If two fair ten-sided dice are rolled, what is the probability that the sum of the sides facing up is greater than 11?

ANSWER: 9/20 (ACCEPT: 45%) (DO NOT ACCEPT 45/100)

### BONUS

- 17) MATH – *Multiple Choice* — If  $\log_5(2) = 0.43$  and  $\log_5(3) = 0.68$ , find  $\log_{12}(25)$ , as a fraction in simplest form?

ANSWER: 100/77

**TOSS-UP**

- 18) BIOLOGY – *Multiple Choice*—If you are given a urine sample of a person with proteinuria, which of the following assays should you run to analyze what proteins are present?
- W) Northern blot
  - X) Southern blot
  - Y) Eastern blot
  - Z) Western blot

ANSWER: Z) WESTERN BLOT

**BONUS**

- 18) BIOLOGY – *Short Answer*—What enzyme is used to convert glucose-6-phosphate to 6-phosphogluconate in the pentose phosphate pathway, also creating an NADPH molecule for cellular activities?

ANSWER: GLUCOSE-6-PHOSPHATE DEHYDROGENASE

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**TOSS-UP**

- 19) ENERGY – *Short Answer*—What term represents the maximum possible efficiency of an ideal heat engine operating between two temperature reservoirs?

ANSWER: CARNOT EFFICIENCY

**BONUS**

- 19) ENERGY – *Short Answer*—Researchers at Yale’s Addy lab are studying cue-induced cocaine-seeking behavior. Which part of the brain stem do they suspect to play a role in this cocaine-seeking behavior through cholinergic mechanisms, and is also responsible for motor functions in the eye, along with visual and auditory processing?

ANSWER: MIDBRAIN

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### TOSS-UP

20) PHYSICS – *Multiple Choice*—Which of the following phenomena describes the tendency of a material to decrease its electrical resistance when subjected to low temperatures?

- W) Photoelectric effect
- X) Superconductivity
- Y) Piezoresistivity
- Z) Seebeck effect

ANSWER: X) SUPERCONDUCTIVITY

### BONUS

20) PHYSICS – *Multiple Choice*—Which of the following resistive forces relates to the Reynolds Number, acting on an object in the direction of the relative fluid velocity?

- W) Surface tension
- X) Drag force
- Y) Pressure force
- Z) Gravitational force

ANSWER: X) DRAG FORCE