

## Niskayuna Summer Invitational Round Robin 3

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### TOSS-UP

1) Physics – *Multiple Choice* Which of the following factors does not affect the flow rate of a fluid through a horizontal pipe? (TJ)

- W) Diameter of the pipe
- X) Viscosity of the fluid
- Y) Pressure difference across the pipe
- Z) Length of the pipe

ANSWER: Z) LENGTH OF THE PIPE

### BONUS

1) Physics – *Short Answer* What principle explains the relationship between the velocity and pressure of a fluid in steady, incompressible flow?

ANSWER: BERNOULLI'S PRINCIPLE

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### TOSS-UP

2) Chemistry – *Multiple Choice* Which of the following quantities is **always** not unitless? (AR)

- W) Absorbance
- X) Turbidity
- Y) Specific Gravity
- Z) Equilibrium Constant

ANSWER: X) TURBIDITY

### BONUS

2) Chemistry – *Short Answer* What is the positive difference between the number of rotational and vibrational degrees of freedom of ammonia at 320 Kelvin?

ANSWER: 3

### TOSS-UP

3) Energy – *Multiple Choice* Mr. Edgar is using an AI detector tool to determine if students are using ChatGPT to write essays. His AI detector tool detects all students who are using ChatGPT, but also tends to label human-written essays as AI written. What terms best describe Mr. Edgar's AI detector tool? (DY)

- W) High sensitivity, high specificity
- X) High sensitivity, low specificity
- Y) Low sensitivity, high specificity
- Z) Low sensitivity, low specificity

ANSWER: X) HIGH SENSITIVITY, LOW SPECIFICITY

### BONUS

3) Energy – *Short Answer* In Mr. Edgar's class of 30 students, 5 students used ChatGPT. Of those 5 students, all 5 were detected by Mr. Edgar's AI detector tool. 3 students who didn't use ChatGPT were also flagged by Mr. Edgar's AI detector tool. What is the negative predictive value, to the nearest percent, of Mr. Edgar's AI detector tool?

ANSWER: 100

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### TOSS-UP

4) Earth and Space – *Multiple Choice* Olivine is best categorized as which of the following types of silicates?

- W) Nesosilicates
- X) Inosilicates (READ AS: ih-no-si-li-cates)
- Y) Tectosilicates
- Z) Phyllosilicates (READ AS: fi-llo-si-li-cates)

ANSWER: W) NESOSILICATES

### BONUS

4) Earth and Space – *Short Answer* What is the name of the region on the HR diagram where a combination of size and temperature causes stars to become unstable and pulsate?

ANSWER: INSTABILITY STRIP

### TOSS-UP

5) Math – *Multiple Choice* What is  $\int_0^1 (8x^3 - 6x^5) dx$  (READ AS the integral of the function  $8x$  cubed minus  $6x$  to the fifth on definite bounds 0 to 1)? (MK)

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

ANSWER: X) 1

### BONUS

5) Math – *Short Answer* Identify the carrying capacity of a population of deer,  $P$ , given the differential equation  $dP/dt = 4P(1 - P/24)$  (READ AS:  $dP$  over  $dT$  equals  $4P$  times open parentheses  $1$  minus the quantity  $P$  divided by  $24$  close parentheses)

ANSWER: 24

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### TOSS-UP

6) Chemistry – *Multiple Choice* Which of the following compounds burns purple in a flame test? (AR)

- W) Potassium
- X) Calcium
- Y) Sodium
- Z) Lithium

ANSWER: W) POTASSIUM

### BONUS

6) Chemistry – *Multiple Choice* In a given reaction, if  $\Delta H$  is negative, and  $\Delta S$  is positive, what does this indicate about the sign of  $\Delta G$  and the spontaneity of the reaction respectively?

- W) Negative, nonspontaneous
- X) Negative, spontaneous
- Y) Positive, nonspontaneous
- Z) Positive, spontaneous

ANSWER: X) NEGATIVE, SPONTANEOUS

### TOSS-UP

7) Physics – *Short Answer* What is the relationship between two different coordinate frames that move at a constant velocity relative to each other in spacetime? (AI)

ANSWER: LORENTZ TRANSFORMATION

### BONUS

7) Physics – *Multiple Choice* Approximately how much more intense is 50 decibels than 10 decibels?

- W) 4 times
- X) 8 times
- Y) 16 times
- Z) 32 times

ANSWER: Y) 16 TIMES

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### TOSS-UP

8) Biology – *Short Answer* Which of the following 3 cellular structures are involved in cyclic photosynthetic electron flow? 1) Photosystem 1, 2) Photosystem 2, 3) Plastocyanin (READ AS: Plas-to-sy-a-nin) (MK)

ANSWER: 1 and 3

### BONUS

8) Biology – *Multiple Choice* Which statement is true regarding the molecular structures of the active reaction centers of pigments P680 and P700?

- W) P680's is larger
- X) P700's is larger
- Y) They are identical molecules
- Z) P680's is nonpolar while P700's is polar

ANSWER: Y) THEY ARE IDENTICAL MOLECULES

### TOSS-UP

9) Earth and Space – *Multiple Choice* The upper limit for the mass of neutron stars is known as which of the following? (AP)

- W) Tolman-Oppenheimer-Volkoff limit
- X) Roche limit (READ AS: Roch limit)
- Y) Chandrasekhar limit
- Z) Eddington limit

ANSWER: W) TOLMAN-OPPENHEIMER-VOLKOFF LIMIT

### BONUS

9) Earth and Space – *Multiple Choice* What does the term “glitch” imply when used with neutron stars?

- W) Increase in size
- X) Increase in luminosity
- Y) Decrease in period
- Z) Decrease in mass

ANSWER: Y) DECREASE IN PERIOD



### TOSS-UP

10) Math – *Multiple Choice* Given a binomial distribution with 100 trials, what is the standard deviation for an event with probability 0.5? (MK)

- W) 5
- X) 10
- Y) 20
- Z) 25

ANSWER: W) 5

### BONUS

10) Math – *Short Answer* To the nearest tenth, what is the expected value of the total number of dots on the top faces when you roll 56,789 fair six sided dice?

ANSWER: 198761.5

### TOSS-UP

11) Physics – *Short Answer* A current of 7 amperes flows through a 10 ohm resistor for 60 seconds. How many coulombs have passed through the resistor?

ANSWER: 420

### BONUS

11) Physics – *Short Answer* A ball is thrown vertically upward with an initial velocity of 20 m/s. How high does it rise before falling back down? Give your answer in meters to the nearest tenth.

ANSWER: 20.4

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### TOSS-UP

12) Energy – *Short Answer* Control rods are neutron-absorbing objects used to control the rate of nuclear reactions in nuclear power plants. Which of the following elements is not commonly used to create control rods? (DY)

- W) Boron
- X) Gold
- Y) Cadmium
- Z) Hafnium

ANSWER: X) GOLD

### BONUS

12) Energy – *Short Answer* In December 2022, Lawrence Livermore National Lab became the first lab on Earth to produce a net energy gain from a fusion reaction. What is the name given to the torus-shaped plasma confinement device that was used for this fusion reaction?

ANSWER: TOKAMAK

### TOSS-UP

13) Biology – *Multiple Choice* What enzyme is considered the pacemaker of cellular respiration? (MK)

- W) Hexokinase
- X) Phosphoglucosomerase (READ AS: Phos-fo-glu-co-iso-mer-ase)
- Y) Phosphofructokinase
- Z) Enolase (READ AS: ee-nol-ase)

ANSWER: Y) PHOSPHOFRUCTOKINASE

### BONUS

13) Biology – *Short Answer* What is the only member of the mitochondrial electron transport chain that is not a protein?

ANSWER: UBIQUINONE (ACCEPT: UBIQUINONE-10, Q, COMPLEX Q, COENZYME Q, COENZYME Q-10)

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### TOSS-UP

14) Earth and Space – *Multiple Choice* To the nearest solar mass, what is the maximum possible mass of a nonrotating, stable neutron star? (TJ)

- W) 1
- X) 2
- Y) 3
- Z) 5

ANSWER: X) 2

### BONUS

14) Earth and Space – *Multiple Choice* Which cosmological model proposes that our observable universe is merely one of many parallel universes, forming a vast "multiverse" structure?

- W) Inflationary cosmology
- X) Ekpyrotic universe
- Y) Brane cosmology
- Z) String theory landscape

ANSWER: Z) STRING THEORY LANDSCAPE

### TOSS-UP

15) Math – *Multiple Choice* Which of the following polar coordinates has the greatest sum of the x and y values of its rectangular coordinates? (AR)

W)  $(3, \frac{\pi}{8})$  [Read as: three comma pi over eight]

X)  $(3, \frac{\pi}{6})$  [Read as: three comma pi over six]

Y)  $(3, \frac{\pi}{4})$  [Read as: three comma pi over four]

Z)  $(3, \frac{\pi}{2})$  [Read as: three comma pi over two]

ANSWER: Y)  $(3, \frac{\pi}{4})$

### BONUS

15) Math – *Short Answer* Given that angle A = 15 degrees and angle B = 30 degrees, find the value of  $\tan(A) + \tan(B) + \tan(A)\tan(B)$ .

ANSWER: 1



### TOSS-UP

16) Chemistry – *Multiple Choice* Niskayuna C Team conducts an NMR spectroscopy on a compound they found inside of Tarun's locker. Given that they find a single peak around a chemical shift value of 12 ppm, what is the number of neighboring protons, and what type of proton type is likely to be present? (MK)

W) 0 neighboring proton, alcohol

X) 0 neighboring proton, carboxylic acid

Y) 1 neighboring protons, alcohol

Z) 1 neighboring protons, carboxylic acid

ANSWER: X) 0 NEIGHBORING PROTONS, CARBOXYLIC ACID

### BONUS

16) Chemistry – *Short Answer* What is the bond order of the oxygen-oxygen bonds in ozone?

ANSWER: 1.5



**TOSS-UP**

17) Energy – *Multiple Choice* Approximately how much coal is needed to generate one kilowatt hour of electricity? (DY)

- W) ½ lb
- X) 1 lb
- Y) 4 lb
- Z) 8 lb

ANSWER: X) 1 LB

**BONUS**

17) Energy – *Short Answer* What is the most common grade of coal used in American coal-fired power stations? (DY)

ANSWER: BITUMINOUS (ACCEPT: SUB-BITUMINOUS)



**TOSS-UP**

18) Biology – *Short Answer* Yelling at Aarush until he starts drinking more sparkling water is an example of what type of learning? (MK)

ANSWER: OPERANT CONDITIONING (ACCEPT: INSTRUMENTAL CONDITIONING, NEGATIVE REINFORCEMENT)

**BONUS**

18) Biology – *Multiple Choice* What is the term for a species that lives on the border between two biomes?

- W) Ecotonic species
- X) Border species
- Y) Edge species
- Z) Dibiomal species

ANSWER: Y) EDGE SPECIES

### TOSS-UP

19) Earth and Space – *Short Answer* Which term refers to a proposed process to decrease ocean temperatures in which particles are injected into clouds to increase their albedo and ability to reflect sunlight? (DY)

ANSWER: MARINE CLOUD BRIGHTENING (ACCEPT: MARINE CLOUD SEEDING)

### BONUS

19) Earth and Space – *Short Answer* By name or number, rank the following three greenhouse gasses in terms of lowest to highest contribution to atmospheric energy flux. 1) methane, 2) carbon dioxide, 3) nitrous oxide.

ANSWER: 3, 1, 2

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### ESTIMATION

20) Estimation – *Short Answer* To two significant figures, what percent of the recommended daily allowance of Vitamin B12 is provided by a regular-strength 5-Hour Energy?

ANSWER: 21000%