

NSI2 Quarterfinals

TOSS-UP

1) BIOLOGY – *Short Answer* By name or number, identify all of the following three ion channels used during an action potential that use active transport: 1) Sodium Potassium pump, 2) Sodium channel, 3) Potassium channel

ANSWER: 1 ONLY

BONUS

1) BIOLOGY – *Short Answer* After a period of heavy blood loss, baroreceptors in the aortic arch detect a decrease in blood pressure. Subsequently, identify all of the following three centers in the medulla oblongata that will be activated: 1) vasomotor center, 2) cardiac accelerator center, 3) cardiac decelerator center

ANSWER: 1 AND 2

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### TOSS-UP

2) CHEMISTRY – *Multiple Choice* Which of the following is a property of benzene

W) tends to undergo substitution reactions rather than addition reactions

X) low boiling point compared to most hydrocarbons

Y) negative enthalpy change of formation

Z) high electrical conductivity

ANSWER: W) TENDS TO UNDERGO SUBSTITUTION REACTIONS RATHER THAN ADDITION REACTIONS

### BONUS

2) CHEMISTRY – *Short Answer* Identify all of the following four solvents that are ethereal, and that Grignard reactions are commonly conducted in: 1) Tetrahydrofuran, 2) Dichloromethane, 3) Diethyl ether, 4) Cyclohexane

ANSWER: 1 AND 3

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### TOSS-UP

3) EARTH AND SPACE – *Multiple Choice* A body of water in which freshwater runs into oceanic saltwater with even distribution of salinity throughout is known as which of the following?

- W) brackish lake
- X) salt wedge estuary
- Y) stratified estuary
- Z) vertically mixed estuary

ANSWER: Z) vertically mixed estuary

### BONUS

3) EARTH AND SPACE – *Multiple Choice* The phenomenon that causes water currents on the eastern shores of landmasses to be stronger is known as what?

- W) Western intensification
- X) Eckman effect
- Y) Eastern current strengthening
- Z) There is no such phenomenon

ANSWER: W) Western intensification

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### TOSS-UP

4) PHYSICS – *Short Answer* A laser moves from a material with index of refraction 2 into one with index of refraction 1.7. Which of the following is closest to the critical angle, in degrees?

- W) 30
- X) 45
- Y) 60
- Z) 90

ANSWER: Y) 60

### BONUS

4) PHYSICS – *Short Answer* The maximum kinetic energy of a photoelectrically expelled electron is equivalent to the energy of the absorbed photon minus what quantity?

ANSWER: Work Function (Accept: Ionization Energy)

### TOSS-UP

5) MATH – *Short Answer* Oscar negged a question against empty seats and now has to recite every digit of  $7^{2024}$ . Unfortunately, he forgot the last two digits. What are the last two digits of  $7^{2024}$ ?

ANSWER: 01

### BONUS

5) MATH – *Short Answer* How many ways are there for a team of 8 people with one president, vice president, secretary, and treasurer to sit in a row of chairs if the president and vice president must sit together, the secretary and treasurer must sit together, and the president cannot be seated on the edge of the seats?

ANSWER: 2400

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### TOSS-UP

6) ENERGY – *Short Answer* In 2020, researchers discovered well-preserved fossils of ancient marine life in Antarctica's Transantarctic Mountains, which were once covered by glaciers. These fossils provide insights into the prehistoric environment of Antarctica. What phylum of fossils, which could be categorized as articulate or inarticulate, are these?

ANSWER: BRACHIOPODS

### BONUS

6) ENERGY – *Short Answer* What is the name of the square matrix of second order partial derivatives used to analyze local curvature of a multivariable scalar function?

ANSWER: HESSIAN MATRIX

### TOSS-UP

7) BIOLOGY – *Short Answer* While Schwann cells are glial cells that are responsible for myelinating axons in the peripheral nervous system, what glial cells are responsible for this same function in the central nervous system?

ANSWER: OLIGODENDROCYTES

### BONUS

7) BIOLOGY – *Multiple Choice* What assay should be used to analyze levels of post translational glycosylation of proteins?

- W) Northern Blot
- X) Southern Blot
- Y) Eastern Blot
- Z) Western Blot

ANSWER: Y) Eastern Blot

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### TOSS-UP

8) CHEMISTRY – *Short Answer* - What is the name given to the effect where, upon expansion of a real gas, it cools?

ANSWER: JOULES-THOMSON EFFECT

### BONUS

8) CHEMISTRY – *Short Answer* What is the average oxidation state of Cobalt in Cobalt (II) hexafluorocobaltate(III)?

ANSWER: 2.4

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TOSS-UP

9) EARTH AND SPACE – What term describes high-density, gravity-driven winds coming off higher elevations which can open up polynyas in ice shelves?

ANSWER: KATABATIC WINDS

BONUS

9) EARTH AND SPACE – *Short Answer* A glacier lake connected in series to others like it by a single stream is known by what name?

ANSWER: paternoster lake

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TOSS-UP

10) PHYSICS – *Short Answer* How much energy in joules is used by a series circuit with a 4 ohm resistor and current 1.5 amps over a period of 6 seconds.

Answer: 54

BONUS

10) PHYSICS – *Short Answer* What law states that the magnetic field created by an electric current is defined by the permeability of free space multiplied by the current strength.

ANSWER: Ampere's Law

TOSS-UP

11) MATH – *Multiple Choice* Let the function $f(x)$ be the sum of cubes from 1 to x . For how many values of x from 1 to 22, inclusive, is $f(x)$ divisible by 25?

- W) 6
- X) 7
- Y) 8
- Z) 9

ANSWER: Y) 8

BONUS

11) MATH – *Multiple Choice* A wedge of cheese shaped like a triangular prism is sublimating in layers such that the area of the prism's 3in by 4in right triangular base remains unchanged, while its length decreases. If, when the cheese's length is 7in, it is sublimating at a rate of 10 in^3/min , at what rate is the surface area of the cheese decreasing?

- W) $7\text{in}^2/\text{min}$
- X) $10\text{in}^2/\text{min}$
- Y) $20\text{in}^2/\text{min}$
- Z) $70\text{in}^2/\text{min}$

ANSWER: Y) $20\text{in}^2/\text{min}$

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TOSS-UP

12) ENERGY – *Multiple Choice* Which of the following parameters is not commonly used to rank coal by grade?

- W) Calorific content
- X) Vitrinite reflectance
- Y) Total organic carbon
- Z) Density

ANSWER: Z) DENSITY

BONUS

12) ENERGY – *Short Answer* A recent development in the coal industry has raised hopes for cleaner energy production. What advanced technology, which stores carbon emissions underground, has been developed to reduce carbon emissions from coal-fired power plants?

ANSWER: Carbon Capture and Storage (CCS) technology



TOSS-UP

13) BIOLOGY – *Short Answer* A mutant flower has only sepals and carpels. According to the ABC hypothesis, by name or number, identify all of the following three genes that would be suppressed: 1) A, 2) B, 3) C

ANSWER: 2 ONLY

BONUS

13) BIOLOGY – *Short Answer* What term describes a body cavity, commonly found in roundworms, that is lined by endoderm and mesoderm and filled with hemolymph?

ANSWER: HEMOCOEL

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TOSS-UP

14) CHEMISTRY – *Short Answer* Rank the following four compounds by decreasing magnitude of the b coefficient in the van der Waals equation at 400 Kelvin: 1) H_2O , 2) NH_3 , 3) CCl_4 , 4) SiCl_4

ANSWER: 4, 3, 1, 2

BONUS

14) CHEMISTRY – *Short Answer* By name or number, identify all of the following 3 statements that are true regarding $\text{S}_\text{N}1$ reactions.

- 1 The rate law is bimolecular
- 2 The nucleophile attacks before the leaving group separates
- 3 The mechanism is fastest for tertiary alkyl halides

ANSWER: 3 Only

TOSS-UP

15) EARTH AND SPACE – *Short Answer* What is the smallest angle measure of Earth's seismic wave shadow zone?

ANSWER: 105°

BONUS

15) EARTH AND SPACE – *Multiple Choice* A layer of ash is discovered through radiometric dating to be 468 million years old. Which of the following periods of time would this layer fall into?

- W) Ordovician
- X) Cretaceous
- Y) Devonian
- Z) Cambrian

ANSWER: W) Ordovician

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TOSS-UP

16) PHYSICS – *Multiple Choice* What is the strangeness number of a particle containing quarks strange, strange, bottom?

- W) -1
- X) 0
- Y) -2
- Z) $+\frac{3}{4}$

ANSWER: Y) -2

BONUS

16) PHYSICS – *Short Answer* Rounded to the nearest ten, what is the fundamental frequency of a 24 cm long organ pipe at 20 degrees celsius?

ANSWER: 710 Hz

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### TOSS-UP

17) MATH – *Short Answer* In a standard deck of 52 cards, what is the probability that if I randomly choose 2 cards with replacement, they are of different suits AND different values?

ANSWER: 9/13

### BONUS

17) MATH – *Short Answer* Arjun is opening rocket league drops in the hopes of acquiring a Fennec. Each drop can give you a Rare, Import, Exotic, or Black Market item, each with equal probability. The Fennec appears 50% of the time if the item is of Import rarity. Arjun opens drops until he gets a Fennec, a Black Market item, or opens 3 drops. What is the probability that he has a Fennec once he stops opening drops?

ANSWER: 129/512

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### TOSS-UP

18) ENERGY – *Multiple Choice* Scientists at Brown's Zaslavsky Lab are using silicon and silicon germanium to create what type of device that is capable of amplifying or switching electrical signals?

- W) Capacitor
- X) Transistor
- Y) Inductor
- Z) Resistor

ANSWER: X) Transistor

### BONUS

18) ENERGY – *Short Answer* In Mr. Edgar's class of 40 students, 3 students used ChatGPT. Of those 3 students, all 3 were detected by Mr. Edgar's AI detector tool. 5 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