

NSI2 SE1

TOSS-UP

1) BIOLOGY – *Multiple Choice* Which of the following is not a type of RNA

- W) tRNA
- X) miRNA
- Y) snRNA
- Z) mrRNA

ANSWER: Z) mrRNA

BONUS

1) BIOLOGY – *Multiple Choice* An unnamed friend of Mihir has cystic fibrosis although none of his family exhibits the disease. This is possible because cystic fibrosis follows what type of hereditary pattern?

- W) Autosomal dominant
- X) Autosomal recessive
- Y) X-linked recessive
- Z) Y-linked

ANSWER: X) Autosomal recessive

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TOSS-UP

2) CHEMISTRY – *Multiple Choice* If the activation energy of a reaction is 800 kJ, which of the following is closest to the factor by which the reaction rate increases when the temperature increases from 100 K to 200 K.

- W) 1.5 times faster
- X) 2 times faster
- Y) 2.5 times faster
- Z) 3 times faster

ANSWER: W) 1.5 times faster

BONUS

2) CHEMISTRY – *Multiple Choice* Mihir is trying to identify a white solid powder he found inside a dollar bill in a parking lot. He makes a solution with the powder and discovers that in a flame test, there is no burn color. When a sample of the powder is placed in HCl, it fizzes violently. Which of the following could be Mihir's compound?

- W) Sodium Nitrate
- X) Potassium Carbonate
- Y) Magnesium Chloride
- Z) Calcium Carbonate

ANSWER: Z) Calcium Carbonate

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### TOSS-UP

3) EARTH AND SPACE – *Multiple Choice* A spiral galaxy with minimally defined spiral arms is known by what other name?

- W) multi-arm
- X) grand design
- Y) irregular
- Z) flocculent

ANSWER: Z) Flocculent

### BONUS

3) EARTH AND SPACE – *Short Answer* What term defines a sandy ridge formed by glacial melt flowing through tunnels beneath the glacier?

ANSWER: Esker

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### TOSS-UP

4) PHYSICS – *Short Answer* 3600 joules of heat are added to a 100 mL styrofoam cup filled with liquid water at 100 degrees Celsius. Given that the heat of vaporization for water is 300 joules per gram, to the nearest mL, how much liquid water is remaining in the cup after this process?

ANSWER: 88

### BONUS

4) PHYSICS – *Short Answer* By name or number, identify which of the following quantities are conserved in a parallel circuit: 1) Voltage, 2) Resistance, 3) Current

ANSWER: 1 ONLY

### TOSS-UP

5) MATH – *Short Answer* Oscar is doing a codeforces contest with 20 problems. However, on each problem, he is only allowed one submission. If, on the first 5 problems, he has a 90% chance of submitting correctly, 70% on problems 6-12, 40% on problems 13-16, and 20% on problems 17-20 (all inclusive), how many problems can Oscar expect to solve?

ANSWER: 11.8

### BONUS

5) MATH – *Short Answer* What is the equation of the slant asymptote of  $f(x) = \frac{x^3 - x^2 + x + 1}{x^2 + 3x - 1}$

(Read as Numerator is open parentheses  $x^3 - x^2 + x + 1$  close parenthesis, and denominator is open parenthesis  $x^2 + 3x - 1$  close parenthesis)

ANSWER:  $y = x - 4$

**TOSS-UP**

6) ENERGY – *Multiple Choice* In a photovoltaic cell, the generation of electricity involves the absorption of photons that create electron-hole pairs. Which of the following materials is most commonly used as the semiconductor in commercial photovoltaic cells?

- W) Cadmium telluride
- X) Silicon
- Y) Gallium arsenide
- Z) Copper indium gallium selenide

ANSWER: X) Silicon

**BONUS**

6) ENERGY – *Short Answer* Based on the Pauli Exclusion Principle, the Chandrasekhar Limit defines the maximum mass of a white dwarf before its electron degeneracy pressure is overcome and the white dwarf collapses into a neutron star. What is the term that defines the similar upper mass limit in neutron stars, above which its neutron degeneracy pressure is overcome?

ANSWER: Tolman-Oppenheimer-Volkoff limit

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TOSS-UP

7) Biology – *Short Answer* A species of insects is characterized by forming comb-like nests, having two pairs of membranous wings with an abdomen narrowly attached to the thorax. To which insect order does this species belong?

ANSWER: HYMENOPTERA

BONUS

7) Biology – *Multiple Choice* Which of the following is the closest to the lifespan of erythrocytes once they enter the bloodstream?

- W) 60 Days
- X) 80 Days
- Y) 120 Days
- Z) 140 Days

ANSWER: Y) 120 DAYS

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TOSS-UP

8) CHEMISTRY – *Short Answer* Identify all of the following organic compounds that are considered aromatic: 1) Pyridine, 2) Thiophene, 3) Cyclobutadiene, 4) Pyrrol

ANSWER: 1, 2, 4

BONUS

8) CHEMISTRY – *Short Answer* If the standard reduction potential of 2Hg^{2+} to Hg_2^{2+} is 0.90 V and Hg_2^{2+} to Hg is 0.80 V, what is the standard reduction potential of Hg^{2+} to Hg?

ANSWER: 0.85 VOLTS

TOSS-UP

9) EARTH AND SPACE – *Multiple Choice* Fern (pronounced: feern) has what percentage of its composition made up of air?

W) 49%

X) 25%

Y) 20%

Z) 5%

ANSWER: X) 25%

BONUS

9) EARTH AND SPACE – *Short Answer* The erosion of suspended sediments in water by other suspended sediments is known as what?

ANSWER: attrition (do not accept abrasion)

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TOSS-UP

10) PHYSICS – *Short Answer* In optics, what is the name for the unit equivalent to inverse meters (1/m)?

ANSWER: Diopter

BONUS

10) PHYSICS – *Short Answer* An electron with charge -1.6×10^{-19} C traveling with a velocity of 4×10^4 m/s enters a uniform magnetic field with a strength of 1.5 teslas. What is the magnitude of the force, in Newtons, experienced by the electron? Assume the electron enters perpendicular to the magnetic field.

ANSWER: 9.6×10^{-15} N

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### TOSS-UP

11) MATH – *Short Answer* A circle is inscribed into a square of side length 8. What is the area inside the square but outside of the circle?

ANSWER:  $64 - 16\pi$

### BONUS

11) MATH – *Short Answer* What is the value of  $(\sqrt{2} + i\sqrt{2})^3$ ?

ANSWER:  $-4\sqrt{2} + 4\sqrt{2}i$

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TOSS-UP

12) ENERGY – *Multiple Choice* Researchers are studying automated program repair, a method for computers to solve bugs itself. One approach is through the usage of generative pre-trained transformers. Which of the following are generative pre-trained transformers commonly used for?

- W) Natural Language Processing
- X) Memory Leak Management
- Y) Version Control Management
- Z) Code Refactoring

ANSWER: W) Natural Language Processing

BONUS

12) ENERGY – *Short Answer* Methane emissions are a significant concern due to their high global warming potential. What is the primary biochemical pathway through which methane-producing archaea create methane in anaerobic conditions?

ANSWER: HYDROGENOTROPHIC METHANOGENESIS

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### TOSS-UP

13) Biology – *Short Answer* The mechanism of Myotonic dystrophy type 1 is the repeated base sequence CTG along the DMPK gene. What is the name for these small sequences that are estimated to make up 5% of the human genome?

ANSWER: Short tandem repeats (STRs) (ACCEPT: microsatellite expansions)

### BONUS

13) Biology – *Short Answer* A landscaper prunes bushes so as to give them a thicker appearance. This is due to the phenomenon of apical dominance, in which axillary buds break dormancy when apical buds are removed. Which plant hormone controls this phenomenon?

ANSWER: AUXIN

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### TOSS-UP

14) CHEMISTRY – *Multiple Choice* Which of the following indicators would be most useful for a titration between Sodium Hydroxide and Hydrochloric Acid?

- W) Phenolphthalein
- X) Thymol Blue
- Y) Bromescerol Green
- Z) Bromothymol Blue

ANSWER: Z) Bromothymol Blue

### BONUS

14) CHEMISTRY – *Multiple Choice* Which of the following changes would increase the voltage of a voltaic cell with copper anode and platinum cathode?

- W) Increase the concentration of  $\text{Cu}^{2+}$
- X) Increase the concentration of Cu
- Y) Increase the concentration of  $\text{Pt}^{2+}$
- Z) Increase the concentration of Pt

ANSWER: W) INCREASE THE CONCENTRATION OF  $\text{Cu}^{2+}$

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TOSS-UP

15) EARTH AND SPACE – *Short Answer* What name is given to glacial striations caused by large clasts leaving indentations of shattered rocks?

ANSWER: chatter marks

BONUS

15) EARTH AND SPACE – *Short Answer* Howe Caverns in New York is a solutional cave lying 156 feet underground which began forming in the Cretaceous period. Among the things to see within the cave are glossy deposits of carbonate materials along the walls, often beside the flowing water that deposited them. What are these sheetlike speleothems known as?

ANSWER: flowstone

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TOSS-UP

16) PHYSICS – *Short Answer* During a thunderstorm, a great place to hide is in your car because it acts as what type of physical structure that acts as a shield against some electromagnetic fields?

ANSWER: Faraday's cage

BONUS

16) PHYSICS – *Short Answer* What is the 7th overtone of a string with 3rd overtone 99 Hz?

ANSWER: 231 Hz

TOSS-UP

17) MATH – *Multiple Choice* A convex polyhedron with some sides as quadrilaterals and others as triangles has 11 edges and 7 vertices. Which of the following best describes the number and kind of sides of this polyhedron?

W) 2 triangles and 4 quadrilaterals

X) 3 triangles and 4 quadrilaterals

Y) 4 triangles and 3 quadrilaterals

Z) 4 triangles and 2 quadrilaterals

ANSWER: W) 2 TRIANGLES AND 4 QUADRILATERALS

BONUS

17) MATH – *Short Answer* A cheetah's position as a function of time can be represented by the function $x(t) = 3t^2\sin(t)$. What is the cheetah's acceleration in terms of trigonometric functions at $t = 5$ seconds.

ANSWER: $60\cos(5) - 69\sin(5)$

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TOSS-UP

18) ENERGY – *Short Answer* Scientists at Niskayuna Newtons Lab are studying different types of vaccines. By name or number, identify all of the following 4 vaccines that are live attenuated vaccines:

- 1) Measles, mumps, rubella vaccine
- 2) Human papillomavirus vaccine
- 3) Chickenpox vaccine
- 4) Yellow fever vaccine

ANSWER: 1, 3, 4

BONUS

18) ENERGY – *Short Answer* Researchers are studying per- and polyfluoroalkyl substances to attempt to find a way to remove them from the environment. One promising method involves applying an electrical current to contaminated water in order to drive chemical reactions which will break down PFAS. What is the name of this method?

ANSWER: electrochemical oxidation