

Niskayuna Winter Invitational Semifinals

TOSS-UP

1) PHYSICS – *Multiple Choice*—Unpolarized light is passed through two polarizing filters, the first directed vertically and the second directed 45 degrees with respect to the vertical. Which of the following is closest to the fraction of the intensity of the light that emerges from the filter?

W) 0.25

X) 0.5

Y) 0.75

Z) 0.9

ANSWER: W) 0.25

BONUS

1) PHYSICS – *Short Answer*—You are in a spaceship and you throw a tennis ball. It takes 2.4 seconds for the ball to hit a tennis racket from the instant you throw the ball and when it hits the tennis racket is 2.4 seconds. Another spaceship traveling at a speed $\frac{1}{2}$ of the speed of light from your frame of reference. From the frame of reference of the other ship, to the nearest tenth of a second, how long does it take for the ball to hit the racket?

ANSWER: 4.0

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### TOSS-UP

2) CHEMISTRY – *Multiple Choice*—Which of the following types of product would you expect when reacting an aldehyde with methyl magnesium bromide in the presence of a dissociated acid?

W) Primary Alcohol

X) Secondary Alcohol

Y) Tertiary Alcohol

Z) Ketone

ANSWER: X) SECONDARY ALCOHOL

### BONUS

2) CHEMISTRY – *Short Answer*—If the molar solubility of  $\text{Mg}(\text{OH})_2$  at  $20^\circ\text{C}$  is  $1.5 \times 10^{-4}$ , what is its solubility product constant?

ANSWER:  $1.35 \times 10^{-11}$

### TOSS-UP

3) ENERGY – *Short Answer*—What is the process through which biomass is converted into biofuels under high temperature and pressure without the presence of oxygen?

ANSWER: PYROLYSIS

### BONUS

3) ENERGY – *Multiple Choice*—Which of the following compounds, previously used as an anti-knocking agent in gasoline, was phased out due to environmental and health concerns?

- W) Methyl tert-butyl ether
- X) Ethanolamine
- Y) Toluene
- Z) Tetraethyl lead

ANSWER: Z) TETRAETHYL LEAD

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TOSS-UP

4) EARTH AND SPACE – *Multiple Choice*—Which of the following earthquakes is an example of an intraplate earthquake?

- W) 2001 Gujarat earthquake in India
- X) 1960 Valdivia earthquake in Chile
- Y) 1952 Severo-Kurilsk earthquake in the Kamchatka peninsula in Russia
- Z) 1989 Loma Prieta earthquake in California

ANSWER: W) 2001 GUJARAT EARTHQUAKE IN INDIA

BONUS

4) EARTH AND SPACE – *Short Answer*—By name or number, identify all of the following three statements that are true about soil liquefaction: 1) it is more likely to occur in denser soils, 2) it is more likely to occur in waterlogged soils, 3) it is more likely to occur in soils that compress when pressure is applied

ANSWER: 2 AND 3

TOSS-UP

5) MATH – *Short Answer*—In celebration of December, Arnold is writing the lyrics to his new Christmas song. If the amount of lyrics he writes on any given day is modeled by $\frac{x^3}{3} - 16x^2 + 192x + 25$ (READ AS: x cubed over 3 minus sixteen x squared plus one hundred ninety two x plus twenty five), with December 1st being $x=1$, on which day of December will Arnold write the most lyrics?

ANSWER: DECEMBER 8TH (DO NOT ACCEPT: 8) (ACCEPT: THE EIGHTH)

BONUS

5) MATH – *Short Answer* —What is the area of the ellipse with equation $4x^2 - 16x + 3 + 6y^2 + 12y - 2 = 3$ (READ AS: four x squared minus sixteen x plus three plus six y squared plus twelve y minus 2 equals 3.)

ANSWER: $6\sqrt{6}\pi$ (ACCEPT: $6\pi\sqrt{6}$)

TOSS-UP

6) BIOLOGY – *Short Answer*—TGF alpha is a protein that, when activated, is responsible for initiating cell migration and cell proliferation pathways, and has been associated with cancer progression. What type of protein is TGF alpha?

ANSWER: EPIDERMAL GROWTH FACTOR (ACCEPT: GROWTH FACTOR) (DO NOT ACCEPT: TRANSCRIPTION FACTOR)

BONUS

6) BIOLOGY – *Multiple Choice*—The G_1 phase of the cell cycle is initiated at which of the following events?

- W) The accumulation of a certain concentration of cyclin
- X) The accumulation of a certain concentration of MPF
- Y) When the activity of MPF peaks
- Z) When cyclin is degraded

ANSWER: Z) WHEN CYCLIN IS DEGRADED

TOSS-UP

7) PHYSICS – *Multiple Choice*—The postulated particle, the graviton, would be most similar to which of the following particles?

- W) W Boson
- X) Photon
- Y) Gluon
- Z) Tauon

ANSWER: X) PHOTON

BONUS

7) PHYSICS – *Short Answer*—What effect describes the relocation of an electron to a lower shell's vacancy through the release of another electron?

ANSWER: AUGER EFFECT (ACCEPT: AUGER-MEITNER EFFECT)

TOSS-UP

8) CHEMISTRY – *Short Answer*—What specific type of reaction occurs when KMnO_4 , MnSO_4 and H_2O are combined to form MnO_2 and other byproducts?

ANSWER: COMPROPORTIONATION (ACCEPT: SYNPROPORTIONATION) they are the same thing

BONUS

8) CHEMISTRY – *Short Answer*—In electrophilic aromatic substitution reactions, what group of elements act as ortho-para directors, but also as deactivators?

ANSWER: HALOGENS

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### TOSS-UP

9) ENERGY – *Multiple Choice*—In nuclear medicine, what radioactive isotope is commonly used in diagnostic imaging to visualize bone structure and detect certain medical conditions?

- W) Iodine-131
- X) Technetium-99m
- Y) Cobalt-60
- Z) Strontium-90

ANSWER: X) TECHNETIUM-99M

### BONUS

9) ENERGY – *Short Answer*—One of the many applications of technetium-99m is its usage in imaging conditions of the thyroid gland because uptake of technetium-99m is correlated with uptake of radioactive iodine. By name or number, identify all of the following three conditions in which uptake of radioactive iodine would increase: 1) Hashimoto's thyroiditis, 2) Grave's disease, 3) Jod-Basedow hyperthyroidism<sup>1</sup>

ANSWER: 2 ONLY

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<sup>1</sup> Radioactive iodine uptake in Jod-Basedow hyperthyroidism would decrease because the HPT axis still functions.

### TOSS-UP

10) EARTH AND SPACE – *Multiple Choice*—A Type Iax (one-a-x) supernova would have a progenitor and remnant of, respectively, which of the following?

- W) type K or lower main sequence star to black dwarf
- X) neutron star to black hole
- Y) type A or higher main sequence star to white dwarf
- Z) white dwarf to zombie star

ANSWER: Z) WHITE DWARF TO ZOMBIE STAR

### BONUS

10) EARTH AND SPACE – *Short Answer*—By name or number, identify all of the following characteristics that are common to all T Tauri stars: 1) spectral class less than or equal to F, 2) older than 10 million years, 3) spectra high in lithium

ANSWER: 1 AND 3

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### TOSS-UP

11) MATH – *Short Answer*—If the roots of the quadratic  $2x^2 - 9x + 5$  are all increased by 3, what is the sum of the coefficients of the old and new quadratic?

ANSWER: 29

### BONUS

11) MATH – *Multiple Choice*—How many trailing zeroes are in  $\binom{400}{130}$ ? (read as: 400 choose 130)

- W) 0
- X) 1
- Y) 24
- Z) 36

ANSWER: X) 1

### TOSS-UP

12) BIOLOGY – *Short Answer*—By name or number, identify all of the following four components that were not included in the Miller-Urey experiment: 1) ammonia, 2) methane, 3) oxygen gas, 4) hydrogen gas

ANSWER: 3 ONLY

### BONUS

12) BIOLOGY – *Multiple Choice*—In operant conditioning, which of the following would be an example of negative reinforcement?

W) Wearing earplugs so as to not hear your Science Bowl team's criticisms

X) Having to do push-ups when you get a toss-up wrong

Y) Getting yelled at when you fail to attend Science Bowl practice

Z) Getting your water privileges taken away when you can't answer questions correctly

ANSWER: W) WEARING EARPLUGS SO AS TO NOT HEAR YOUR SCIENCE BOWL TEAM'S CRITICISMS

### TOSS-UP

13) PHYSICS – *Multiple Choice*—Which of the following terms describes the hypothetical particles that are their own antiparticles, believed to play a crucial role in explaining the dominance of matter over antimatter in the universe?

- W) Axions
- X) Tachyons
- Y) Majorana fermions
- Z) Sterile neutrinos

ANSWER: Y) MAJORANA FERMIONS

### BONUS

13) PHYSICS – *Multiple Choice*—An electron moves perpendicular to a magnetic field of 1.5 milliteslas with a velocity of  $3 \times 10^7$  meters per second. If the electron has a charge of  $1.6 \times 10^{-19}$  coulombs and a mass of  $9.11 \times 10^{-31}$  kilograms, which of the following values is closest to the radius of the circular path, in centimeters, it follows due to the magnetic field?

- W) 11
- X) 27
- Y) 42
- Z) 58

ANSWER: W) 11



### TOSS-UP

14) CHEMISTRY – *Multiple Choice*—Given a system that receives 1000 kJ of energy at 500 Kelvin and discharges 600 kJ at 300 Kelvin, what can be said about the system:

W) Impossible

X) No irreversibilities present in the system

Y) Some irreversibilities present in the system

Z) None of the above

ANSWER: X) NO IRREVERSIBILITIES PRESENT IN THE SYSTEM

### BONUS

14) CHEMISTRY – *Short Answer*—Given that a sample of an incredibly heavy gas, and assuming the universal gas constant  $R$  is equal to 8 joules per mole kelvin, with molar mass 6,000 g/mol has root mean square velocity of 2.8 m/s, what is the temperature of the sample to the nearest Kelvin?

ANSWER: 2 K

### TOSS-UP

15) ENERGY – *Short Answer*—What term describes the maximum electrical current that can pass through a conductor before its material properties deteriorate, leading to excessive heat and potential failure?

ANSWER: AMPACITY

### BONUS

15) ENERGY – *Multiple Choice*—Which cutting-edge energy storage technology utilizes reversible chemical reactions involving the conversion between electrical and chemical energy for grid-scale storage?

W) Lithium-ion batteries

X) Flow batteries

Y) Supercapacitors

Z) Solid-state batteries

ANSWER: X) FLOW BATTERIES

### TOSS-UP

16) EARTH AND SPACE – *Multiple Choice*—Which of the following differentiates drumlins from moraines?

W) drumlins form only at the edges of glaciers while moraines form within

X) drumlins are composed of sorted sediments while moraines are unsorted

Y) moraines are formed perpendicular to glacial movement while drumlins are formed parallel

Z) moraines are teardrop shaped while drumlins have no distinct shape

Answer: Y) MORAINES ARE FORMED PERPENDICULAR TO GLACIAL MOVEMENT WHILE DRUMLINS ARE FORMED PARALLEL<sup>2</sup>

### BONUS

16) EARTH AND SPACE – *Multiple Choice*—Which of the following structures is formed as a moving glacier breaks away from the stagnant ice above it?

W) bergschrund

X) firn

Y) randkluft

Z) chatter marks

ANSWER: W) BERGSCHRUND

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<sup>2</sup> This question was replaced during the tournament.

### TOSS-UP

17) MATH – *Multiple Choice* — Which of the following shapes does the polar graph  $r=2+2\cos(\theta)$  (READ AS: r equals two plus two cosine of theta)?

- W) Vertical Cardioid
- X) Horizontal Cardioid
- Y) Spiral
- Z) Lemniscate (READ AS: Lem-Ni-Scit)

ANSWER: X) HORIZONTAL CARDIOID

### BONUS

17) MATH – *Short Answer* — In a standard deck of 52 cards, what is the probability that the sum of the first three cards drawn does not exceed 36, assuming Ace is 1, Jack is 11, Queen is 12, and King is 13?

ANSWER: 5506/5525

### **TOSS-UP**

18) BIOLOGY – Multiple Choice—The number of locules in the ovary of a flower are equivalent to the number of which of the following parts of the flower?

- W) Stamens
- X) Sepals
- Y) Pistils
- Z) Carpels

ANSWER: Z) CARPELS

### **BONUS**

18) BIOLOGY – Multiple Choice—Which of the following situations would not cause a short day plant to flower?

- W) Exposure to far-red light for 8 hours followed by 16 hours of darkness
- X) 18 hours of darkness followed by 6 hours of sunlight exposure
- Y) Exposure to sunlight for 8 hours followed by 16 hours of darkness
- Z) 18 hours of darkness with a flash of light at 13 hours, followed by 6 hours of sunlight exposure

ANSWER: Z) 18 HOURS OF DARKNESS WITH A FLASH OF LIGHT AT 13 HOURS, FOLLOWED BY 6 HOURS OF SUNLIGHT EXPOSURE

### TOSS-UP

19) EARTH AND SPACE – *Multiple Choice*—Which of the following positions is an inferior planet most likely in if it's seen just after sunset?

- W) Opposition
- X) Superior Conjunction
- Y) Greatest Eastern Elongation
- Z) Greatest Western Elongation

ANSWER: Y) GREATEST EASTERN ELONGATION

### BONUS

19) EARTH AND SPACE – *Multiple Choice*—Which of the following names an area of high stress on a transform boundary?

- W) asperity
- X) backstop
- Y) creep
- Z) seiche

ANSWER: W) ASPERITY

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**TOSS-UP**

20) BIOLOGY – *Multiple Choice*—The glomerular filtration rate is the measure of the flow rate of filtered blood through the kidneys. Which of the following would not increase the glomerular filtration rate in a healthy adult?

- W) Increased blood pressure
- X) Constriction of the afferent arteriole
- Y) Constriction of the efferent arteriole
- Z) Prostaglandins

ANSWER: X) CONSTRICTION OF THE AFFERENT ARTERIOLE

**BONUS**

20) BIOLOGY – *Short Answer*—Unfortunately, you wake up one day and your thyroid gland is missing. By name or number, identify all of the following four parameters that would be increased: 1) T3, 2) T4, 3) TSH, 4) TRH

ANSWER: 3 AND 4