

Niskayuna Summer Invitational Single Elimination 1 aka Super Biology Round

TOSS-UP

- 1) Physics – *Multiple Choice* A charged particle is placed in a region where both an electric field and a magnetic field are present. If the particle experiences a force perpendicular to its velocity, what can be said about the direction of the magnetic field?
- W) The magnetic field is parallel to the particle's velocity.
X) The magnetic field is antiparallel to the particle's velocity.
Y) The magnetic field is perpendicular to the plane formed by the electric field and the velocity.
Z) The magnetic field is zero.

ANSWER: Y) THE MAGNETIC FIELD IS PERPENDICULAR TO THE PLANE FORMED BY THE ELECTRIC FIELD AND THE VELOCITY

BONUS

- 1) Physics – *Short Answer*
Which effect describes the deformation of a material when subjected to a force or stress and states that a material will experience a proportional contraction or expansion in the perpendicular direction? (AI)

ANSWER: POISSON EFFECT (ACCEPT: POISSON)

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### TOSS-UP

- 2) Chemistry – *Short Answer* The Hill Coefficient is related to what quality of a quaternary protein?

ANSWER: COOPERATIVITY

### BONUS

- 2) Chemistry – *Short Answer* Given a closed system with isothermic internal energy change 16 joules, temperature 8 kelvin, and change in entropy 1 joule per kelvin, in joules, what is the helmholtz free energy?

ANSWER: 8

### TOSS-UP

3) Energy – *Short Answer* Despite constantly evolving and adapting, species have had a relatively constant chance for extinction. What is the hypothesis that explains this fact by stating that species must constantly evolve and adapt simply to remain on equal footing with competing species? (DY)

ANSWER: RED QUEEN HYPOTHESIS

### BONUS

3) Energy – *Short Answer* Researchers at Indiana University developed a “minimal cell”, stripping a cell down to its genetic bare minimum. Despite the evolutionary challenges associated with a bare minimum genome, the minimal cell was able to recoup the loss of fitness compared to non-minimal cells within 2,000 generations. Organisms from what genus of bacteria were used to develop these minimal cells?

ANSWER: MYCOPLASMA

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### TOSS-UP

4) Earth and Space – *Short Answer* What physical process, occurring during the evolution of massive stars, involves the synthesis of new nuclei from earlier nuclei and nucleons? (TJ)

ANSWER: NUCLEOSYNTHESIS

### BONUS

4) Earth and Space – *Multiple Choice* Which of the following is not an effect of El Niño?

- W) weakening of trade winds
- X) increased Equatorial Pacific water temperature
- Y) increased rainfall in the Western Pacific
- Z) decrease of ocean upwelling

ANSWER: Y) INCREASED RAINFALL IN THE WESTERN PACIFIC

### TOSS-UP

5) Math – *Multiple Choice* Given a differentiable function that only outputs a single value, what is the arc length of the function on bounds 8.8 to 11.3? (MK)

- W) 1
- X) 1.5
- Y) 2
- Z) 2.5

ANSWER: Z) 2.5

### BONUS

5) Math – *Short Answer* What is the partial derivative, with respect to x, of the multivariable function  $x^2y + 2x + 3y^7 + 9xy^2 + 8x^4y^7$ ? (READ AS x squared y plus 2x plus 3 y to the power 7 plus 9xy squared plus 8x to the fourth y to the seventh)

ANSWER: (ALLOWING COMMUTATIVE PROPERTY)  $2xy + 2 + 9y^2 + 32x^3y^7$

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TOSS-UP

6) Chemistry – *Short Answer* What is the name given to a redox reaction where one compound converts to two compounds through simultaneous oxidation and reduction?

ANSWER: DISPROPORTIONATION (ACCEPT: DISMUTATION)

BONUS

6) Chemistry – *Short Answer* The standard reduction potential of Zinc 2 plus is -0.76 and the standard reduction potential of Lead two plus is -0.13. In volts, what is the standard reduction potential of the reaction Zinc plus Lead 2 plus yields Lead plus Zinc 2 plus?

ANSWER: 0.63

TOSS-UP

7) Physics – *Short Answer* What is the acceleration of a cat with mass 4 kg thrown off of a building which has reached its terminal velocity of 100 km/hour to the nearest integer? (AI)

ANSWER: 0

BONUS

7) Physics – *Short Answer* In milliliters per minute, what is the flow rate of blood through an artery with a pressure difference of 90 mmHg (millimeters of mercury) and a resistance of 30 peripheral resistance units?

ANSWER: 3

TOSS-UP

8) Biology – *Multiple Choice* What is the name of the product when a vesicle containing a phagocytized pathogen fuses with a lysosome? (MK)

- W) phagosome (READ AS: fay-go-soam)
- X) phagolysosome (READ AS: fay-go-lie-so-soam)
- Y) lytosome (READ AS: lit-oh-some)
- Z) peroxisome

ANSWER: X) PHAGOLYSOSOME

BONUS

8) Biology – *Multiple Choice* Which of the following vesicle coats is most commonly used in cellular phagocytosis?

- W) COP1 (READ AS: cop one) -> as in a police officer
- X) COP2 (READ AS: cop two)
- Y) clathrin
- Z) tubulin

ANSWER: Y) CLATHRIN

TOSS-UP

9) Earth and Space – *Short Answer* By name or number, identify all of the following three types of moraines that run parallel to the direction of movement of glaciers:

- 1) lateral moraine
- 2) medial moraine
- 3) terminal moraine (AI)

ANSWER: 1 AND 2

BONUS

9) Earth and Space – *Multiple Choice* Which of the following processes is NOT a way in which air can be forced to rise?

- W) orographic lifting
- X) frontal wedging
- Y) evaporative cooling
- Z) convergence of air

ANSWER: Y) EVAPORATIVE COOLING

TOSS-UP

10) Math – *Multiple Choice* Given that 2 by 2 matrix A is singular, which of the following could be matrix A?

- W) Top row 3, -4, bottom row 2, 3
- X) Top row -2, -3, bottom row 1, 4
- Y) Top row 3, -4, bottom row 3, 4
- Z) Top row -2, -3, bottom row 4, 6

ANSWER: Z) Top row -2, -3, bottom row 4, 6

BONUS

10) Math – *Short Answer* What is the sum of the elements in the product of matrix A with first row 3, -2, 3, second row 1, 4, -5, and third row 2, -2, 3, and matrix B, with first row 3, second row -1, and third row 2?

ANSWER: 20

TOSS-UP

11) Physics – *Multiple Choice* Which of the following particles is not a gauge boson? (TJ)

- W) Photon
- X) Gluon
- Y) W boson
- Z) Higgs boson

ANSWER: Z) HIGGS BOSON

BONUS

11) Physics – *Short Answer* What is the term used for energy lost to expansion for no useful purpose as a conductor experiences a changing magnetic field? (MK)

ANSWER: EDDY CURRENT LOSS (ACCEPT: IRON LOSS)

TOSS-UP

12) Energy – *Short Answer* By name or number, identify all of the following 4 vaccines that are live attenuated vaccines: (DY)

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

ANSWER: 1, 3, 4

BONUS

12) Energy – *Short Answer* The latest advancements in an RSV vaccine involve identifying the structure of the prefusion form of an F protein. What type of synthetic protein, an artificial antibody-substitute, was used to identify the preF structure of the F protein?

ANSWER: MONOCLONAL ANTIBODY

TOSS-UP

13) Biology – *Multiple Choice* Which of the following is the best explanation as to why Gram-positive bacteria are generally more susceptible to antibiotics? (DY)

W) Gram-positive bacteria lack channel proteins that expel cytotoxic drugs that Gram-negative bacteria have.

X) Gram-positive bacteria lack an additional cell membrane that Gram-negative bacteria have.

Y) Gram-positive bacteria lack enzymes that hydrolyze foreign molecules that Gram-negative bacteria have.

Z) Gram-negative bacteria have a thicker cell wall that is more resistant to foreign molecules.

ANSWER: X) GRAM-POSITIVE BACTERIA LACK AN ADDITIONAL CELL MEMBRANE THAT GRAM NEGATIVE BACTERIA HAVE.

BONUS

13) Biology – *Short Answer* Identify all of the following 3 species of bacteria are Gram-negative?

1) Staphylococcus aureus, 2) Bacillus anthracis, 3) Escherichia coli

ANSWER: 3 ONLY

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### TOSS-UP

14) Earth and Space – *Multiple Choice* Chalk is which of the following types of sedimentary rock? (AI)

W) clastic

X) chemical

Y) biochemical

Z) organic

ANSWER: Y) BIOCHEMICAL

### BONUS

14) Earth and Space – *Short Answer* Identify the single-celled, autotrophic organism that produces scales of calcium carbonate that when fossilized are the primary constituent of chalk.

ANSWER: COCCOLITHOPHORE

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TOSS-UP

15) Math – *Short Answer* Given that one of the solutions to a quadratic equation is $3i+4$, what is the quadratic in standard form? (AR)

ANSWER: $x^2 - 8x + 25$

BONUS

15) Math – *Short Answer* The diagonal of a cube is $\sqrt{27}$. Let A be the volume of the cube and B be the surface area of the cube. Compute the product AB. (EC)

ANSWER: 1458

TOSS-UP

16) Chemistry – *Multiple Choice* Which of the following types of unit cells has the most atoms per unit cell? (AR)

- W) Face-centered cubic
- X) Body-centered cubic
- Y) Cubic closest packed
- Z) Hexagonal closest packed

ANSWER: Z) HEXAGONAL CLOSEST PACKED

BONUS

16) Chemistry – *Short Answer* Determine the geometry of the coordination complex around the Cobalt atom in $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$.

ANSWER: OCTAHEDRAL

TOSS-UP

17) Energy – *Short Answer* What is the name given to the form of hydroelectric energy storage in which energy is stored in the form of gravitational potential energy by pumping water from lower elevations to higher elevations in times of low demand and releasing the water to generate electricity in times of high demand?

ANSWER: PUMPED STORAGE HYDROELECTRICITY

BONUS

17) 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

TOSS-UP

18) Biology – *Short Answer* What is the most abundant protein on earth? (MK)

ANSWER: RUBISCO (ACCEPT: RUBP CARBOXYLASE, RIBULOSE BISPHTHOSPHATE CARBOXYLASE)

BONUS

18) Biology – *Multiple Choice* In C4 plants, what enzyme is used for carbon fixation in place of Rubisco?

- W) Crassulacean acid (READ AS: cra-sue-lay-shun acid)
- X) Phosphoenolpyruvate carboxylase (READ AS: fos-foe-ee-nole-pie-roo-vay-t car-box-ill-ace)
- Y) Inositol trisphosphate
- Z) Diacylglycerol (READ AS: die-ass-ill-gli-sir-all)

ANSWER: X) PHOSPHOENOLPYRUVATE CARBOXYLASE

TOSS-UP

19) Earth and Space – *Short Answer* What is the term for the closest distance from the center of a planet that a satellite can approach without being pulled apart by the planet's gravitational field? (TJ)

ANSWER: ROCHE LIMIT

BONUS

19) Earth and Space – *Short Answer* Of Earth's 5 Lagrange points in the Earth-Sun system, how many of those points lie on the axis running through Earth and the Sun?

ANSWER: 3



ESTIMATION

20) Estimation – *Short Answer* The average smoker is exposed to a certain amount of radiation from radioactive isotopes in cigarettes **each year** equivalent to eating how many standard Cavendish bananas?

ANSWER: 2520