TOSS-UP

1) Physics – *Multiple Choice* Which of the following effects is not predicted by general relativity? (TJ)

W) Gravitational waves
X) Frame-dragging
Y) Gravitational lensing
Z) Quantum entanglement

ANSWER: Z) QUANTUM ENTANGLEMENT

BONUS

1) Physics – *Multiple Choice* In which Hydrogen spectral line series does an electron transition to the energy level corresponding to principal quantum number 2? (AI)

W) Brackett
X) Paschen
Y) Pfund
Z) Balmer

ANSWER: Z) BALMER SERIES

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TOSS-UP

2) Chemistry – *Multiple Choice* What is the molecular geometry around each carbon atom in a molecule of ethylene? (MK)

W) Tetrahedral
X) Square planar
Y) Trigonal planar
Z) Trigonal bipyramidal

ANSWER: Y) TRIGONAL PLANAR

BONUS

2) Chemistry – *Short Answer* In milliliters, what is the volume of 1.00 molar Barium Hydroxide needed to neutralize a 50.0 milliliter solution of 0.400 molar Nitric acid?

ANSWER: 10

TOSS-UP

3) Energy – *Multiple Choice*   Approximately how many years does it take for commercial polystyrene to degrade? (MK)

W) 50
X) 500
Y) 5,000
Z) 50,000

ANSWER: X) 500

BONUS

3) 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

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TOSS-UP

4) Earth and Space – *Short Answer*   Which of the following statements are true about Type I supernovae?
1) Type I supernovae do not occur in binary or multiple-star systems
2) Type I supernovae only occur in smaller stars
3) Type I supernovae lack hydrogen spectral lines.

ANSWER: 3, ONLY

BONUS

4) Earth and Space – *Multiple Choice*   Which of the following is closest to the temperature of the sun's corona in Kelvins?

W) 10,000
X) 100,000
Y) 1,000,000
Z) 10,000,000

ANSWER: Y) 1,000,000

TOSS-UP

5) Math – *Short Answer*   What is the value of $_{-4}\int^4(-7x^3+15x)dx$ (READ AS the definite integral bounded from -4 to 4 of the quantity negative seven x cubed plus fifteen x) with respect to x? (MK)

ANSWER: 0

BONUS

5) Math – *Short Answer*   Given that Arjun only has 11 and 12 dollar bills, what is the maximum price of an item that he can't give the exact payment for, in dollars?

ANSWER: 109

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TOSS-UP

6) Chemistry – *Short Answer*   What phase of matter will most unsaturated fats be at room temperature? (MK)

ANSWER: LIQUID

BONUS

6) Chemistry – *Multiple Choice*   How many electrons are in the 5f orbitals of Uranium in its ground-state?

W) 1
X) 3
Y) 10
Z) 14

ANSWER: X) 3

7) Physics – *Multiple Choice*   For a free falling football dropped from a 180 m high tower, to the nearest integer in meters per second, what is its velocity at the time it hits the ground? (MK)

W) 20
X) 40
Y) 60
Z) 80

ANSWER: Y) 60

BONUS

7) Physics – *Short Answer*   Niskayuna Science Bowl B team members are conducting a slinky experiment. They are studying the possible effect of several variables upon the speed of a wave in a slinky. Slinky 1 has a wavelength of 1.75 meters and a frequency of 2.0 Hz. Slinky 2 has a wavelength of 0.5 meters and a frequency of 5.0 Hz. What is the difference in speed, in meters per second, between the two slinkies. (IL)

ANSWER: 1

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TOSS-UP

8) Biology – *Multiple Choice*   What is the most heavily concentrated cation in animal extracellular fluid? (MK)

W) Sodium
X) Potassium
Y) Calcium
Z) Magnesium

ANSWER: W) SODIUM

BONUS

8) Biology – *Short Answer*   What cardiovascular structures prevent proteins from plasma from entering interstitial fluid?

ANSWER: CAPILLARIES

TOSS-UP

9) Earth and Space – *Short Answer* Rank the following 3 Milankovitch cycles in terms of shortest to longest periodicity. 1) Precession, 2) Obliquity, 3) Eccentricity (DY)

ANSWER: PRECESSION, OBLIQUITY, ECCENTRICITY (ACCEPT: 1, 2, 3)

BONUS

9) Earth and Space – *Short Answer* What term is given to the effect on the climate by the gradual changes in the shape of Earth's orbit and tilt?

ANSWER: ORBITAL FORCING

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TOSS-UP

10) Math – *Short Answer*   What is the sum of the coefficients of the trinomial expansion of $2(a + b + c)^3$ (READ AS 2 times open parenthesis a plus b plus c close parenthesis cubed)? (AR)

ANSWER: 54

BONUS

10) Math – *Short Answer* Given triangle ABC, where angle A is 45 degrees, angle C is 105 degrees, and side A is 8 inches, what is the length of side B in inches? Express your answer in simplest radical form. (MK)

ANSWER: $4\sqrt{2}$

TOSS-UP

11) Physics – *Multiple Choice*   Which of the following is a baryon? (AI)

W) Proton
X) Electron
Y) Higgs Boson
Z) Photon

ANSWER: W) PROTON

BONUS

11) Physics – *Multiple Choice*   Which of the following forces is currently not accounted for by the Standard Model of particle physics?

W) Strong Force
X) Weak Force
Y) Gravity
Z) Electromagnetic Force

ANSWER: Y) GRAVITY

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TOSS-UP

12) Energy – *Short Answer* Which of the following 3 statements are true of Type I errors?
1) The probability of a Type I error is represented by the variable 'alpha'
2) Type I errors are known as false negatives
3) The significance level represents the probability of a Type I error occurring.

ANSWER: 1 AND 3

BONUS

12) Energy – *Short Answer*   The United States Geological Survey reported in a recent study that at least 45% of American tap water is contaminated with a particular group of fluorinated substances, characterized by having at least one fully fluorinated methyl or methylene carbon atom. What is the name of this group of substances?

ANSWER: PER- AND POLYFLUOROALKYL SUBSTANCES (ACCEPT: PFAS)

TOSS-UP

13) Biology – *Multiple Choice*   What protein is the main component of the spindle fibers in animal cells undergoing mitosis? (DY)

W) Albumin
X) Collagen
Y) Myosin
Z) Tubulin

ANSWER: Z) TUBULIN

BONUS

13) Biology – *Short Answer*   Which of the following statements are true of tubulin:
1) Tubulin polymers are generally smaller than actin filaments
2) The alpha and beta subunits of tubulin have significantly smaller mass than actin filaments
3) Tubulins are GTPases (READ AS: gee-tee-pee-ay-sis)

ANSWER: 3 ONLY

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TOSS-UP

14) Earth and Space – *Multiple Choice*   Which of the following is the predicted final fate of an O-type main sequence star, with mass 16 times that of the sun? (TJ)

W) Black Hole Formation
X) White Dwarf Formation
Y) Neutron Star Formation
Z) Planetary Nebula Formation

ANSWER: W) BLACK HOLE FORMATION

BONUS

14) Earth and Space – *Short Answer*   What is the proposed mechanism responsible for the observed excess of matter over antimatter in the universe?

ANSWER: BARYOGENESIS

TOSS-UP

15) Math – *Short Answer*   Given that a rectilinearly moving particle has position function 3t+4, what is its velocity at t = 7? (MK)

ANSWER: 3

BONUS

15) Math – *Short Answer* Which of the following 3 series converge as n approaches infinity? 1) Sum of 1 divided by n, 2) Sum of one divided by the quantity n squared, 3) Sum of the quantity n squared plus 1 divided by the quantity of n squared plus 2.

ANSWER: 2 ONLY

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TOSS-UP

16) Chemistry – *Multiple Choice*   Given that the electronegativity of bromine is 2.96 and the electronegativity of Hydrogen is 2.2, which of the following best describes the Br-H bond in a molecule of hydrogen bromide? (MK)

W) Ionic
X) Polar covalent
Y) Nonpolar covalent
Z) Metallic

ANSWER: X) POLAR COVALENT

BONUS

16) Chemistry – *Short Answer*   State the noble gas electron configuration for Chromium.

ANSWER: ARGON 4s1 3d5, (ACCEPT: Argon 3d5 4s1)

TOSS-UP

17) Energy – *Multiple Choice* Which type of radioactive decay would have the smallest effect on atomic mass? (DY)

W) Alpha decay
X) Beta decay
Y) Neutron emission
Z) Gamma decay

ANSWER: Z) GAMMA DECAY

BONUS

17) Energy – *Short Answer* Isotopes of what element are commonly used for treating disorders of the thyroid gland?

ANSWER: IODINE

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TOSS-UP

18) Biology – *Multiple Choice* Which of the following would be the most likely finding in a patient with hyperaldosteronism? (DY)

W) Low serum sodium and low serum potassium
X) High serum sodium and high serum potassium
Y) Low serum sodium and high serum potassium
Z) High serum sodium and low serum potassium

ANSWER: Z) HIGH SERUM SODIUM AND LOW SERUM POTASSIUM

BONUS

18) Biology – *Short Answer* Vasopressin is a medication and a natural hormone that increases water retention and increases blood pressure. Vasopressin acts in the kidneys by increasing osmolarity by stimulating the action of what group of channel proteins?

ANSWER: AQUAPORINS

TOSS-UP

19) Earth and Space – *Multiple Choice*   Valley networks on the surface of Mars are thought to have been formed by which of the following? (AP)

W) Wind
X) Tectonic activity
Y) Flowing water
Z) Volcanism

ANSWER: Y) FLOWING WATER

BONUS

19) Earth and Space – *Multiple Choice*   Which of the following could be the progenitor of a short gamma-ray burst?

W) Supernova
X) Hypernova
Y) Kilonova
Z) Tidal disruption event

ANSWER: Y) KILONOVA

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20) Estimation – *Short Answer*   Given that he was born the year after World War 2 ended, and died the year before Youtube was launched, in what year did Neil A. Campbell publish his first edition of 'Biology'?

ANSWER: 1987