ROUND 1

TOSS-UP

1) Math – *Short Answer* What is the total number of positive factors in the product of the first 5 positive odd numbers?

ANSWER: 16

BONUS

1) Math – *Short Answer* The roots of the function f of x are –9, -4, and 4. How many imaginary roots does f of x squared have?

ANSWER: 4

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TOSS-UP

2) Earth and Space – *Multiple Choice* Which of the following is NOT a mafic igneous rock?

W) Rhyolite
X) Basalt
Y) Gabbro
Z) Scoria

ANSWER: W) RHYOLITE [SP]

BONUS

2) Earth and Space – *Multiple Choice* Which of the following is the correct silicate structure for micas?

W) Single Chains
X) Double Chains
Y) Sheets
Z) Three-dimensional Networks

ANSWER: Y) SHEETS [SP]
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TOSS-UP

3) Chemistry – *Short Answer* Identify all of the following three acids that are diprotic 1) Sulfurous acid; 2) Sulfuric acid; 3) Arsenic acid

ANSWER: 1, 2

BONUS

3) Chemistry -- *Short Answer* Fats are esters of long carbon chain acids of which molecule?

Answer: Glycerol

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TOSS-UP

4) Physics – *Multiple Choice* Which of the following systems are Feynman Diagrams used to describe?

W) Harmonic Oscillations
X) Rocket Motion
Y) Subatomic Particles
Z) Fluid Mechanics

ANSWER: Y) Subatomic Particles

BONUS

4) Physics – *Short Answer* What is the name of the principle in quantum mechanics which states that both the position and momentum of a particle cannot be known simultaneously?

ANSWER: Heisenberg Uncertainty Principle

TOSS-UP

5) Biology – *Multiple Choice* Which of the following is not a negative feedback mechanism?

W) Insulin facilitating cellular glucose uptake in response to hyperglycemia

X) Parathyroid hormone stimulates Calcium release from bones during hypocalcemia
Y) Oxytocin stimulates uterine contractions, intensifying until birth
Z) Dermal arteries vasoconstrict in response to a low body temperature

ANSWER: Y) OXYTOCIN STIMULATES UTERINE CONTRACTIONS, INTENSIFYING UNTIL BIRTH

BONUS

5) Biology – *Short Answer* Assuming 100% yield, how many moles of Glucose would be produced via photosynthesis provided unlimited H2O and 18 moles CO2?

ANSWER: 3

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TOSS-UP

6) Earth and Space – *Short Answer* What is the name of the massive release of energy where stars within a certain mass range begin helium fusion?

ANSWER: HELIUM FLASH [SP]

BONUS

6) Earth and Space – *Short Answer* What diagram is used to display areas of sunspot occurrence and shows that sunspot concentration fluctuates over an 11-year period?

ANSWER: MAUNDER BUTTERFLY DIAGRAM (ACCEPT: BUTTERFLY DIAGRAM) [SP]

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TOSS-UP

7) Biology – *Short Answer* What is the name given to substances which minimize changes in H+ and OH- concentrations within a solution?

ANSWER: BUFFER

BONUS

7) Biology – *Short Answer* Which rare granulocyte is responsible for the immune response and possesses a bi-lobed or tri-lobed nucleus?

ANSWER: BASOPHILS

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TOSS-UP

8) Physics – *Short Answer* Ice skaters start spinning slowly by twisting with their arms extended. As the skater places their arms closer towards their body, the skater starts rotating faster. This happens due to the conservation of what quantity?

ANSWER: Angular Momentum

BONUS

8) Physics – *Multiple Choice* In special relativity, which of the following values in classical physics is conserved in all reference frames?

W) Electric Charge
X) Energy
Y) Relativistic Mass
Z) Momentum

ANSWER: W) Electric Charge

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TOSS-UP

9) Math – *Multiple Choice* What is the quantity negative four times nine modulo 13?
W) 7
X) 10
Y) 3
Z) 5

ANSWER: Y) 3

BONUS

9) Math – *Short Answer* How many trailing zeroes does 70 factorial have in base 10?

ANSWER: 16

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TOSS-UP

10) Chemistry – *Multiple Choice* If a reaction has a negative ΔH (delta H) value and a negative ΔS (delta S) value, which of the following is true?

W) The reaction is always spontaneous
X) The reaction is only spontaneous at high temperatures
Y) The reaction is only spontaneous at low temperatures
Z) The reaction is never spontaneous

Answer: Y) The reaction is only spontaneous at low temperatures

BONUS

10) Chemistry -- *Multiple Choice* Which of the following reactions is generally only spontaneous at low temperatures?

W) Dissolution of solids into liquids
X) Dissolution of gasses into liquids
Y) Barium Sulfate and Calcium Chloride
Z) Evaporation

Answer: X) Dissolution of gasses into liquids

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TOSS-UP

11) Math – *Multiple Choice* There are many cross-sectional circles that can be drawn which lie entirely on the surface of a sphere. What is the name of the family of circles that have the greatest possible diameter among all such families of cross-sectional circles?
W) Maximal Circles
X) Great Circles
Y) Diametral Circles
Z) Equatorial Circles

ANSWER: X) Great Circles

BONUS

11) Math – *Short Answer* What is the sum of the positive integer factors of 2024?

ANSWER: 4,320

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TOSS-UP

12) Chemistry – *Multiple Choice* Which of the following compounds cannot be found as a network solid?

W) Silicon dioxide
X) Boron trifluoride
Y) Boron nitride
Z) Silicon carbide
Answer: X) BORON TRIFLUORIDE

BONUS

12) Chemistry – *Short Answer* Identify the techniques that can be used to determine the chirality of a given solution sample 1) Thin-layer chromatography; 2) Band-line analysis; 3) Polarimetry

ANSWER: 3 Only

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TOSS-UP

13) Biology – *Short Answer* If a species' phenotype of a heterozygote is an intermediate of the phenotypes of both recessive and dominant homozygotes, then which form of selection would heterozygote advantage display in this species?

ANSWER: STABILIZING SELECTION

BONUS

13) Biology – *Multiple Choice* Which of the following is true regarding the digestion of wood by termites?

W) They have glands which produce acid, used to digest the wood
X) Their gut contains protists capable of digesting wood
Y) They mechanically breakdown wood, but not chemically
Z) They possess specialized enzymes which break down cellulose and lignin

ANSWER: X) THEIR GUT CONTAINS PROTISTS CAPABLE OF DIGESTING WOOD

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TOSS-UP

14) Earth and Space – *Multiple Choice* Which of the following surfaces has the highest albedo?

W) Soil
X) Desert Sand
Y) Oceans
Z) Sea Ice

ANSWER: Z) SEA ICE [SP]

BONUS

14) Earth and Space – *Multiple Choice* Which of the following best describes how the concentration of tropospheric ozone has changed since the implementation of the Montreal Protocol?

W) It has stayed the same
X) It has increased
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Y) It has decreased
Z) Ozone only exists in the stratosphere not the troposphere

ANSWER: X) IT HAS INCREASED [SP]

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TOSS-UP

15) Physics – *Multiple Choice* How many degrees of freedom does chlorine gas, Cl2, have?

W) 3
X) 4
Y) 5
Z) 6

ANSWER:
Z) 6

BONUS

15) Physics – *Short Answer* The heat capacity ratio is the ratio of the heat capacity at constant pressure and heat capacity at constant volume. What is the heat capacity ratio for a diatomic gas?
ANSWER: 7/5 or 1.4

TOSS-UP

16) Biology – *Short Answer* What specialized mode of carbon fixation allows plants to perform gas exchange at night, storing CO2 as malic acid, and photosynthesize during the day, using CO2 derived from malate?

ANSWER: CRASSULACEAN ACID METABOLISM (ACCEPT: CAM)

BONUS

16) Biology – *Short Answer* A population in Hardy-Weinberg equilibrium where 32% of the population is codominant for a trait and the dominant allele has a frequency of 0.8. What is the frequency of the recessive phenotype?

ANSWER: 0.04, 4%
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TOSS-UP

17) Chemistry – *Short Answer* Identify all of the following three compounds matched with their correct hybridization at the central atom: 1) Ethyne — sp2 2) Sulfur Tetrafluoride — sp3d 3) Hydrazine — sp2

Answer: 1 & 2 Only

BONUS

17) Chemistry -- *Short Answer* From which shell does d orbital in sulfur tetrafluoride originate?

Answer: 3

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TOSS-UP

18) Math – *Short Answer* A solid has 9 faces, 7 rectangular and 2 heptagonal faces. How many edges does this solid have?

ANSWER: 21

BONUS

18) Math – *Short Answer* There are two solids that can be formed by rotating a right triangle with leg lengths of 6 and 8 around one of its legs. What is the absolute difference in the volumes of the two solids?

ANSWER: 32pi

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TOSS-UP

19) Earth and Space – *Multiple Choice* Which of the following properties would least likely be used to differentiate between calcite and halite?

W) Birefringence
X) Taste
Y) Hardness
Z) Crystal habit

ANSWER: Y) Hardness [SW]

BONUS

19) Earth and Space – *Short Answer* The air temperature in a room is 25 degrees C, and the dew point is 15 degrees C. Approximate the relative humidity in the room.

ANSWER: 50% [SW]

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TOSS-UP

20) Physics – *Multiple Choice* In what family of particles would a subatomic particle composed of a quark and an antiquark belong to?

W) Photon
X) Lepton
Y) Mesons
Z) Baryons

ANSWER: Y) Mesons

BONUS

20) Physics – *Short Answer* Cameras are intricate devices with many parts that need to be precisely made in order to create a clear picture. To measure how good a camera is at

distinguishing small objects, engineers calculate what value given a certain wavelength and aperture width?

ANSWER: Angular Resolution or Rayleigh Criterion