ROUND 4

TOSS-UP

1) Earth and Space – *Short Answer* At which of the following 4 locations are Population II Stars found: 1) Spiral Arms; 2) Central Bulge; 3) Halo; 4) Thin Disk

ANSWER: 2, 3 [SP]

BONUS

1) Earth and Space – *Multiple Choice* Which of the following are the temperature and salinity changes you will observe if you go down a column of subtropical water?

W) Temperature decreases; Salinity decreases
X) Temperature decreases; Salinity increases
Y) Temperature increases; Salinity decreases
Z) Temperature increases; Salinity increases

ANSWER:W) TEMPERATURE DECREASES; SALINITY DECREASES [SP]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

2) Physics – *Short Answer* A block is resting on a slope that has an angle of elevation of 30 degrees. Identify all of the following four choices that could be possible static coefficients of friction between the block and slope: 1) 0.4, 2) 0.5, 3) 0.6, 4) 0.7

ANSWER: 3 and 4 only, 0.6 and 0.7

BONUS

2) Physics – *Multiple Choice* Surface tension occurs due to intermolecular bonds between molecules in a liquid. Which of the following quantities share the same units as surface tension?

W) Acceleration
X) Force
Y) Spring Constant
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Z) Pressure

ANSWER: Y) Spring Constant

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS UP

3) Math – *Short Answer* How many ways can the letters in the word "DASTBOWL" be arranged if "DAST" must appear together in that order?

ANSWER: 120

BONUS

3) Math – *Multiple Choice* How many unit cubes does the space diagonal of a 12 by 15 by 18 rectangular prism pass through?
W) 36
X) 40
Y) 44
Z) 48

ANSWER: W) 36

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

4) Biology – *Short Answer* What inherited blood disorder is the result of reduced or absent synthesis of the beta chains of hemoglobin, which may result in anemia?

ANSWER: BETA THALASSEMIA

BONUS

4) Biology – *Short Answer* Order the following stomach chambers in order of digestion for a ruminant?

1) Rumen
2) Abomasum
3) Omasum
4) Reticulum

ANSWER: RUMEN, RETICULUM, OMASUM, ABOMASUM (1, 4, 3, 2)

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

5) Chemistry – *Short Answer* In nuclear chemistry, what type of decay emits an electron and antineutrino?

Answer: Beta Minus Decay

BONUS

5) Chemistry -- *Short Answer* What is the resulting atom when Uranium-235 undergoes alpha decay, beta minus decay, then alpha decay again?

Answer: Actinium-227

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

6) Chemistry – *Multiple Choice* What type of strain contributes most to the instability of cyclopropane?

W) Steric strain
X) Transannular strain
Y) Torsional strain
Z) Angle strain

ANSWER: Z) Angle Strain

BONUS

6) Chemistry – *Short Answer* What type of strain contributes most to the instability of the half-chair conformation of cyclohexane?

ANSWER: Torsional Strain

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

7) Biology – *Short Answer* Which of the following four chromosomal disorders are accurately matched?

1) Edward's Syndrome - Monosomy 18
2) Patau's Syndrome - Trisomy 13
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

3) Klinefelter's Syndrome - XXY
4) Cri du Chat Syndrome - Insertion on chromosome 5

ANSWER: 2 AND 3

BONUS

7) Biology – *Short Answer* What eating disorder is characterized by regular bouts of overeating often followed by self-induced vomiting and is associated with persistent and excessive concern with body weight?

ANSWER: BULIMIA NERVOSA

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

8) Earth and Space Science – *Short Answer* Shlok breaks open a granite boulder with his bare hands and finds a fragment of gabbro engulfed in the larger granite rock. What is the term used to refer to igneous inclusions inside of larger rocks such as the piece of gabbro?

ANSWER: XENOLITH [SW]

BONUS

8) Earth and Space Science – *Multiple Choice* All of the following terms correctly apply to rock Obsidian, except: [difficulty]

W) Conchoidal
X) Mafic
Y) Vitreous
Z) Amorphous

ANSWER: X) Mafic [SW]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

9) Physics – *Multiple Choice* Bernoulli's principle is a restatement of the conservation of what physical quantity?

W) Energy

X) Momentum
Y) Mass
Z) Angular Momentum

ANSWER: W) Energy

BONUS

9) Physics – *Short Answer* There is a hard physical limit on the fraction of energy that can be extracted from a Newtonian fluid, limiting the amount of energy extracted from wind turbines. The existence of this limit is an implication of what law?

ANSWER: Betz's Law

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

10) Math – *Short Answer* How many squares of integer side length with all four vertices on a vertex of a 4 by 4 grid of unit squares exist?

ANSWER: 30

BONUS

10) Math – *Short Answer* With a plethora of afterschool clubs at their high school, Alice attends a club on any 3 days of a given week whereas Bob attends a club on any 2 days the same week. How many ways can Alice and Bob attend clubs so that they both attend a club on at least one day this week?

ANSWER: 90

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

11) Physics – *Multiple Choice* The electron volt is a measure of:

W) Charge
X) Field Strength
Y) Voltage
Z) Energy

ANSWER: Z) Energy

BONUS

11) Physics – *Multiple Choice* Two parallel conducting wires lying in the xy-plane carry current in the positive x direction. In what plane does the magnetic force of one wire on the other lie in?

W) xy-plane
X) yz-plane
Y) zx-plane
Z) No magnetic force occurs

ANSWER: W) xy-plane

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

12) Math – *Short Answer* If a fair 20-sided die is rolled three times, what is the probability that a prime number is rolled on all three rolls?

ANSWER: 8/125 or 0.064

BONUS

12) Math – *Short Answer* Suppose *n* is a positive integer less than 81 such that n squared minus two is a multiple of seven. How many possible values of n are there?

ANSWER: 23

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

13) Earth and Space – *Short Answer* Earthquakes in areas with water-saturated soil can cause what phenomenon where the soil behave according to fluid dynamics?

ANSWER: SOIL LIQUEFACTION [SW]

BONUS

13) Earth and Space – *Multiple Choice* During an earthquake at Dulles High School, Siddarth sees a cone-shaped formation bubbling liquified soil. What formation is Siddarth most likely observing?

W) Sand boil
X) Mud volcano
Y) Dirt geyser
Z) Soil blow

ANSWER:W) SAND BOIL [SW]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

14) Chemistry – *Multiple Choice* If R-2-chlorobutane were to undergo an SN2 reaction with hydroiodic acid, what would be the distribution of products in terms of absolute configuration?

W) Completely R
X) Completely S
Y) Half R, half S
Z) R as the major product and S as the minor product

ANSWER: X) COMPLETELY S

BONUS

14) Chemistry – *Short Answer* If R-2-chlorobutane were to undergo an SN1 reaction with hydroiodic acid, what type of solution would result?

Answer: Racemic

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

15) Biology – *Short Answer* What highly soluble unfolded protein accumulates in Lewy bodies and Lewy neurites in Parkinson's disease and is also sometimes found in other neurodegenerative diseases?

ANSWER: ALPHA-SYNUCLEIN

BONUS

15) Biology – *Short Answer* Ravi is gram-staining bacteria, but the bacteria resists decolorization during staining due to presence of wax-like cell walls containing mycolic acid and large amounts of fatty acids and complex lipids? What physical property are these bacteria said to have?

ANSWER: ACID FASTNESS

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

16) Biology – *Multiple Choice* Ravi has insulted one too many people online, and in response someone sent him a League of Legends gift card in the mail. Unfortunately, the card was found to be contaminated with sarin, an organophosphate poison. What system does the poison directly affect?

W) Endocrine
X) Circulatory
Y) Nervous
Z) Respiratory

ANSWER: Y) NERVOUS

BONUS

16) Biology – *Multiple Choice* Steve boycotted all sugar to stop the exploitation of sugar beets by those cursed sugar farmers. After a week of eating no sugar, he is not feeling that good and his body has started burning his fat deposits. Which of the following is likely NOT true?

W) His liver is performing glycogenolysis
X) Lipogenesis is occuring
Y) He is not performing photosynthesis
Z) His hepatocytes are performing the process of gluconeogenesis
ANSWER: X) Lipogenesis is occurring

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

17) Earth and Space – *Multiple Choice* Which of the following greenhouse gasses traps the greatest amount of heat?

W) Carbon Dioxide

X) Methane
Y) Sulfur Hexafluoride
Z) Perfluorocarbon

ANSWER: Y) SULFUR HEXAFLUORIDE [SP]

BONUS

17) Earth and Space – *Multiple Choice* Which of the following represents a gap in the rock records caused by a period of nondeposition and erosion?

W) Nonconformity
X) Angular Unconformity
Y) Intrusion
Z) Disconformity

ANSWER: Z) DISCONFORMITY [SP]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

18) Chemistry – *Short Answer* How many degrees of unsaturation does a molecule of benzene have?

Answer: 4

BONUS

18) Chemistry – *Short Answer* How many degrees of unsaturation are present in one molecule of 5-nitro-2-propoxyaniline?

ANSWER: 5

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

19) Math – *Short Answer* Identify all of the following four integers that are congruent to 5 modulo 14:
1) -23
2) 90
3) -9

4) 50

ANSWER: 1 and 3 ONLY

BONUS

19) Math – *Short Answer* Dylan lists the first 10 positive integers and draws a line between two distinct integers if their absolute difference is at most 5. How many lines does he draw?

ANSWER: 35

~~~~~~

TOSS-UP

20) Physics – *Short Answer* Engineers must consider the physical aspects of materials when designing buildings or machines. One internal reaction ensures that the torque sums to zero everywhere within the system, whilst providing zero net force. What is this concept called?

ANSWER: Bending moment or Bend

BONUS

20) Physics – *Short Answer* In a universe where the speed of light is 25 meters per second, what would the Lorentz factor be for a reference frame moving at 7 meters per second?

ANSWER: 25/24
~~~~~~