ROUND 5

TOSS-UP

1) Biology – *Multiple Choice* Which of the following would cause a left-shift on the Oxyhemoglobin dissociation curve?

W) Increased temperature
X) Increase H+ concentration
Y) Increased CO_2 concentration
Z) Switch to fetal hemoglobin from adult hemoglobin

ANSWER: Z) SWITCH TO FETAL HEMOGLOBIN FROM ADULT HEMOGLOBIN

BONUS

1) Biology – *Short Answer* Which key enzyme in the melanin cycle catalyzes the synthesis of DOPA from an amino acid in mammalian melanogenesis?

ANSWER: TYROSINASE

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TOSS-UP

2) Earth and Space – *Multiple Choice* Chrons refer to periods in which what property of the Earth remains stable?

W) Number of continents
X) Direction of mantle convection
Y) Direction of Earth's rotation
Z) Direction of the magnetic field

ANSWER: Z) DIRECTION OF MAGNETIC FIELD [SW]

BONUS

2) Earth and Space – *Short Answer* What effect, predicted by Einstein's general theory of relativity, explains why objects within the ergosphere cannot appear stationary when observed externally due to the twisting of spacetime?
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ANSWER: LENSE-THIRRING EFFECT (ACCEPT: FRAME DRAGGING) [SP]

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TOSS-UP

3) Chemistry – *Multiple Choice* What is the highest possible ratio of ortho to para hydrogen in earth's atmosphere?

W) 1:1 (one to one)
X) 2:1 (two to one)
Y) 3:1 (three to one)
Z) 4:1 (four to one)

Answer: Y) 3:1

BONUS→
3) Chemistry -- *Multiple Choice* Under what conditions is Ortho hydrogen more stable than Para hydrogen

W) Higher temperature atmosphere
X) Lower temperature atmosphere
Y) More humid atmosphere
Z) Less humid atmosphere

Answer: W) Higher temperature atmosphere

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TOSS-UP

4) Physics – *Short Answer* Macroscopic quantum effects can be observed when two superconducting plates are separated by a nonconductor. What is this set up known as?

ANSWER: Josephson Junction

BONUS

4) Physics – *Multiple Choice* A mass of 60 kilograms with uncertainty of 5 kilograms is moving at a speed of 133 m/s. What is the uncertainty of the position of the mass to one significant digit?

W) 3 times 10 raised to the power of negative 38 meters
X) 7 times 10 raised to the power of negative 38 meters
Y) 8 times 10 raised to the power of negative 38 meters
Z) 10 times 10 raised to the power of negative 38 meters

ANSWER: Y) 8 times 10 raised to the power of negative 38 meters

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TOSS-UP

5) Math – *Short Answer* A parallelogram has side lengths 4 and 6 and one diagonal of length 8. What is the length of the other diagonal?

ANSWER: 2sqrt10

BONUS

5) Math – *Short Answer* A Platonic solid is a polyhedron with faces that are only congruent regular polygons and at each vertex, the same number of faces meet. How many different Platonic solids are there?

ANSWER: 5

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TOSS-UP

6) Math – *Short Answer* How many of the first 210 positive integers are not divisible by 3, 5, or 7?

ANSWER: 96

BONUS

6) Math – *Short Answer* Find the sum of all positive integers less than 30 that are relatively prime to 30.

ANSWER: 120

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TOSS-UP

7) Earth and Space – *Multiple Choice* In which era of Earths history did mammals replace reptiles as the dominant land animals?

W) Cenozoic
X) Mesozoic
Y) Proterozoic
Z) Paleozoic

ANSWER: W) CENOZOIC [SP]

BONUS

7) Earth and Space – *Short Answer* What is the term for concentrated movements of water that flow in the opposite direction of breaking waves?

ANSWER: RIP CURRENTS (ACCEPT: RIP TIDE)[SP]

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TOSS-UP

8) Physics – *Multiple Choice* Kevin is doing a lab experiment and he needs to measure the length of a wire. However, his meterstick is only accurate to the nearest millimeter. What distribution model will he most likely assume for the uncertainty in the measurement of the length of the wire?

W) Binomial
X) Geometric
Y) Student's T
Z) Normal

ANSWER: Z) Normal

BONUS

8) Physics – *Short Answer* Suppose that in 2024, the average number of transistors in an integrated circuit is 4 billion. According to Moore's Law, what would the average number of transistors in an integrated circuit be in 2032 to the nearest billion?
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ANSWER: 64 billion

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TOSS-UP

9) Biology – *Short Answer* What are the two main types of DNA polymerase in *E. coli*?

ANSWER: DNA POLYMERASE III AND I

BONUS

9) Biology – *Short Answer* Which of the following four statements is true about diabetes insipidus?

1) It is commonly referred to as type 2 diabetes
2) It is an autoimmune disorder
3) It is due to failure of secretion of ADH
4) Hyperglycemia is not present

ANSWER: 3 AND 4

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TOSS-UP

10) Chemistry – *Short Answer* Identify all of the following three compounds matched with their correct molecular geometry: 1) Chlorine Trifluoride — T-shaped 2) Boron Trifluoride — trigonal pyramidal 3) Tellurium Tetrafluoride — seesaw

Answer: 1 & 3 Only

BONUS

10) Chemistry – *Multiple Choice* Which of the following does not have seesaw molecular geometry?

W) Sulfur Tetrafluoride
X) Tellurium Tetrachloride
Y) Xenon Dioxydiflouride
Z) Xenon Tetrafluoride

Answer: Z) Xenon Tetrafluoride

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TOSS-UP

11) Physics – *Multiple Choice* Fictitious forces occur when a non-inertial frame is being considered. Which of the following is a fictitious force?

W) Drag Force
X) Centripetal Force
Y) Coriolis Force
Z) Lorentz Force

ANSWER: Y) Coriolis Force

BONUS

11) Physics – *Multiple Choice* In modern times, physicists are trying to create a Grand Unified Theory, seeking to solve the disagreements between General Relativity and Quantum Physics. Which of the following theories do not have any experimental evidence backing them?

W) Gravitational Wave Theory
X) String Theory
Y) Quantum Field Theory
Z) General Theory of Relativity

ANSWER: X) String Theory

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TOSS-UP

12) Chemistry – *Short Answer* What is the bond order of carbon monoxide, which has 10 bonding electrons and 4 antibonding electrons?

Answer: 3

BONUS

12) Chemistry -- *Multiple Choice* Which statement regarding stable heteronuclear diatomic molecules is false?

W) All have bond orders greater than zero.
X) The antibonding molecular orbitals have more of the character of the more electropositive element than of the more electronegative element.

Y) Their molecular orbital diagrams are more symmetrical than those of homonuclear diatomic molecules.
Z) The bonding molecular orbitals have more of the character of the more electronegative element than of the less electronegative element.

Y) Their molecular orbital diagrams are more symmetrical than those of homonuclear diatomic molecules.

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TOSS-UP

13) Earth and Space – *Multiple Choice* Which of the following geological formations formed when a glacier moves over a solid rock and smooths the upstream side while plucking off of the downstream side?

W) Crag and tail
X) Roche moutonnée
Y) Cirque
Z) Arête

ANSWER: X) ROCHE MOUTONNÉE [SW]

BONUS

13) Earth and Space – *Short Answer* What term refers to landforms that are formed through processes mediated by glacial meltwater such as eskers?

ANSWER: FLUVIOGLACIAL (ACCEPT: GLACIOFLUVIAL) [SW]

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TOSS-UP

14) Math – *Multiple Choice* Which of the following trigonometric functions are non-integrable over the interval zero to two times pi:
W) Hyperbolic cosine
X) Tangent
Y) Cosine
Z) Sine

ANSWER: X) Tangent

BONUS

14) Math – *Short Answer* Evaluate the integral of sine of x times cosine of x minus 1 from zero to pi over 2 to the nearest integer.

ANSWER: -1

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TOSS-UP

15) Biology – *Short Answer* Ronuk's friends suspect that his body is producing too much estradiol. They perform a test and confirm that their suspicions were correct. What is the enzyme that is causing this condition?

ANSWER: AROMATASE

BONUS

15) Biology – *Short Answer* While we all know that aromatase converts testosterone, which Ronuk sadly lacks, to estradiol, all hormones of that type are derived from one precursor biomolecule. This molecule is synthesized in the liver. What is this molecule?

ANSWER: CHOLESTEROL

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TOSS-UP

16) Earth and Space – *Multiple Choice* Which of the following provided evidence of a liquid outer core?

W) P-wave shadow zone
X) S-wave shadow zone
Y) Transition Zone
Z) Low Velocity Zone

ANSWER: X) S-WAVE SHADOW ZONE [SP]

BONUS

16) Earth and Space – *Short Answer* During the grand unification epoch, the only two forces present in the universe were the electronuclear force and what other force?

ANSWER: GRAVITY [SP]

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TOSS-UP

17) Physics – *Multiple Choice* A common technique employed when solving physics problems is dimensional analysis. However, this technique fails when there are many dimensionless quantities involved in the problem. Which of the following dimensionless quantities can never be less than one?

W) Coefficient of Friction
X) Coefficient of Restitution
Y) Refractive Index
Z) Lorentz Factor

ANSWER: Z) Lorentz Factor

BONUS

17) Physics – *Short Answer* The majority of matter is made up of what two quarks?

ANSWER: up and down

TOSS-UP

18) Math – *Short Answer* The cross product of the two vectors <u>open parenthesis, a comma 2 comma 0, close parenthesis and open parenthesis, 8 comma a comma 0 close parenthesis</u> is the null vector. What is the product of all possible values of a?

ANSWER: -16

BONUS

18) Math – *Short Answer* How many trailing zeros does <u>144 factorial</u> have when it is represented in base 12?

ANSWER: 70

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TOSS-UP

19) Chemistry – *Short Answer* Identify all of the following changes that would increase the production of ammonia in the haber process assuming the reactants and products are at equilibrium in a piston 1) Depressing the piston 2) Increasing the temperature 3) Adding argon gas to the piston

Answer: 1 Only

BONUS

19) Chemistry – *Short Answer* Arsenic acid is being titrated with sodium hydroxide and reaches the first equivalence point at a pH of 8 when 30 mL of NaOH is used. If the first pKa of arsenic acid is 2.2, what is the pH of the solution at the half equivalence point?

ANSWER: 2.2

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TOSS-UP

20) Biology – *Short Answer* Which of the following four krebs cycle intermediates have 4 carbons?

1) Succinyl-CoA
2) Isocitrate
3) Oxaloacetate
4) Alpha-ketoglutarate

ANSWER: 1 AND 3 (SUCCINYL-COA AND OXALOACETATE)

BONUS

20) Biology – *Short Answer* What is the FIRST rate limiting enzyme in glycolysis?

ANSWER: HEXOKINASE

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