ROUND 5

TOSS-UP

1) Physics – *Short Answer* Find the moment of inertia about the vertical axis through the handle of a system consisting of a rope of negligible mass and length L hanging vertically from a handle, a point mass of mass m at the center of mass of the rope, and a point mass of mass 2m at the bottom of the rope. Express your answer in terms of m and L.

ANSWER: 0

BONUS

1) Physics – *Short Answer* A 9 meter rod in space of mass 2 kg is held fixed at its left end. A force of 10 N is being applied perpendicularly to the rod 2 meters away from the left end. What is the magnitude of the resulting angular acceleration of the rod, neglecting gravity.

ANSWER: 10/27

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TOSS-UP

2) Energy – *Short Answer* Scientists at Oak Ridge National Laboratory are developing a new memory storage device that mimics how the brain works to store information. This device will greatly increase the efficiency of memory systems by copying the connection between nerve cells in the brain. What is the name of these connections?

ANSWER: SYNAPSES

BONUS

2) Energy – *Short Answer* Which of the four biological macromolecules is used to create the soft membrane used in these neuromorphic computing systems?

ANSWER: LIPIDS
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ROUND 5

TOSS-UP

3) Chemistry – *Short Answer* What is the oxidation number of Cr in $Cr_2O_7^{2-}$ (read C R 2 O 7 2 minus)?

ANSWER: +6

BONUS

3) Chemistry – *Short Answer* How many oxygen-oxygen bonds are in the dichromate ion?

ANSWER: 0

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TOSS-UP

4) Biology – *Short Answer* What is the classification of neurotransmitters that prevent an action potential?

ANSWER: INHIBITORY NEUROTRANSMITTERS

BONUS

4) Biology – *Multiple Choice* Which of the following does NOT affect the membrane potential in a cell?

W) The concentration of ions in the interior and exterior of the cell
X) Activity of electrogenic pumps, which maintain the ion concentration across the membrane
Y) The concentration of taq polymerase within the cell
Z) Changes in ion conductance

ANSWER: Y) THE CONCENTRATION OF TAQ POLYMERASE WITHIN THE CELL
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ROUND 5

TOSS-UP

5) Math – *Multiple Choice* What is the eccentricity of a non-circular ellipse?

W) 0
X) Between 0 and 1 exclusive
Y) Equal to 1
Z) Greater than 1

ANSWER: X) BETWEEN 0 AND 1 EXCLUSIVE

BONUS

5) Math – *Short Answer* What is the term for the segment with endpoints on the ellipse, runs through one focus, and is parallel to the minor axis in an ellipse?

ANSWER: LATUS RECTUM

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TOSS-UP

6) Earth and Space – *Multiple Choice* Which of the following is not true about partial melting in the Earth's upper mantle?

W) It can occur when rocks move deeper into the Earth due to an increase in pressure.
X) It can occur when water is introduced into the Earth at a high enough temperature to lead to melting.
Y) It can lead to the creation of volcanoes on Earth's surface as molten material rises upwards.
Z) It primarily affects oceanic lithosphere at mid-ocean ridges and subduction zones.

ANSWER: W) IT CAN OCCUR WHEN ROCKS MOVE DEEPER INTO THE EARTH DUE TO AN INCREASE IN PRESSURE

BONUS

6) Earth and Space – *Short Answer* At what type of fault does the footwall move downward relative to the hanging wall?

ANSWER: REVERSE (DO NOT ACCEPT CONVERGENT)
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ROUND 5

TOSS-UP

7) Energy – *Short Answer* Scientists at Oak Ridge National Laboratory are developing synthetic trees, which could be used as passive water pumps. These trees utilize what process that occurs in the leaves of plants, causing water to travel upwards?

ANSWER: TRANSPIRATION

BONUS

7) Energy – *Short Answer* In the leaves of these synthetic trees, there are silicon microchambers that can open and close to regulate water loss. These microchambers mimic what part of a leaf that is the site of gas exchange?

ANSWER: STOMATA

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TOSS-UP

8) Biology – *Short Answer* Which of the five primary classes of immunoglobulins is responsible for an allergic reaction?

ANSWER: IGE

BONUS

8) Biology – *Short Answer* A flexible hinge is found within certain classes of immunoglobulins which allows the separation between the two antigen-binding sites to fluctuate. Of the five primary classes of immunoglobulins, which of them contain this hinge?

ANSWER: IGG, IGA, IGD
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ROUND 5

TOSS-UP

9) Physics – *Short Answer* A bug holds on to the edge of a wheel with a diameter of one meter. The wheel rolls without slipping and is accelerated constantly at 2 m/s^2. After 4 seconds, what is the centripetal acceleration the bug experiences?

ANSWER: 128

BONUS

9) Physics – *Short Answer* A pilot flies a jet at a constant speed of 1440 kilometers per hour. The pilot then follows a vertical circular path staying at the same speed. If the pilot experiences a maximum of 5 g's during its loop, what is the radius of the circular loop? Assume g is 10 m/s^2 and express your answer in kilometers.

ANSWER: 4 KILOMETERS (ACCEPT: 4)

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TOSS-UP

10) Chemistry – *Multiple Choice* To the nearest integer at what pH does the indicator phenolphthalein turn pink?

W) 4
X) 6
Y) 8
Z) 10

ANSWER: Y) 8

BONUS

10) Chemistry – *Short Answer* By name or number, Identify all of the following that are indicators: 1) Phenol Red, 2) Methyl Yellow, 3) Methyl Orange, 4) Thymol Blue

ANSWER: ALL (ACCEPT 1, 2, 3, 4 OR PHENOL RED, METHYL YELLOW, METHYL ORANGE, THYMOL BLUE IN ANY ORDER)
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ROUND 5

TOSS-UP

11) Math – *Short Answer* What is the name of the intersection of the altitudes of a triangle?

ANSWER: ORTHOCENTER

BONUS

11) Math – *Short Answer* In a base 6 number system, how many 3 digit numbers with nonzero digits are ascending or descending? For a number to be ascending it must have digits strictly increasing and it must have digits strictly decreasing to be descending.

ANSWER: 20 (Solution: $2 * \frac{5}{3}$)

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TOSS-UP

12) Earth and Space – *Short Answer* By name or number, identify all of the following 5 rocks that are variations of chert, a sedimentary rock made of microcrystalline quartz: 1) Flint, 2) Arkose, 3) Jasper, 4) Travertine, 5) Coquina

ANSWER: FLINT, AND JASPER (ACCEPT 1, 3)

BONUS

12) Earth and Space – *Short Answer* Metamorphic rocks are formed from other rocks through heat and pressure. The more different the resulting rock is from its parent rock, the higher the grade of metamorphism. By name or number, arrange the following 3 metamorphic rocks in order of lowest to highest grade metamorphism: 1) Schist, 2) Gneiss, 3) Slate

ANSWER: SLATE, SCHIST, GNEISS (ACCEPT 3, 1, 2)
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ROUND 5

TOSS-UP

13) Biology – *Multiple Choice* Which type of epithelium is found in areas of abuse and high friction?

W) Simple Squamous
X) Simple Columnar
Y) Stratified Squamous
Z) Stratified Columnar

ANSWER: Y) STRATIFIED SQUAMOUS

BONUS

13) Biology – *Short Answer* What is the name of the wavelike motion that keeps substances moving through tubular organs, which is produced by the contraction of smooth muscle?

ANSWER: PERISTALSIS

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TOSS-UP

14) Energy – *Short Answer* Researchers at Fermilab are studying interactions between fundamental particles at high energies, and they have conducted experiments demonstrating what process that causes neutrinos to change flavor as they travel?

ANSWER: NEUTRINO OSCILLATION

BONUS

14) Energy – *Multiple Choice* "Intense, high energy particles can also help the scientists at Fermilab search for new types of dark matter, including new dark particles. Dark matter is estimated to take up what approximate percent of the universe?
W) 5%
X) 25%
Y) 50%
Z) 95%

ANSWER: X) 25%
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ROUND 5

TOSS-UP

15) Physics – *Multiple Choice* Jimmy and Jamie are working together to test 2 springs named A and B. Through experimentation, they find that when Spring A is displaced half as much as Spring B, the two springs exert the same tension force. Then, they cut spring B in half and take one of the pieces, which they name Spring C. Assuming all springs work ideally, how much does spring C displace in comparison to Spring A for the same tension force?

W) Spring C displaces less than Spring A
X) Spring C displaces the same amount as Spring A
Y) Spring C displaces more than Spring A
Z) It is impossible to compare the two

ANSWER: X) SPRING C DISPLACES THE SAME AMOUNT AS SPRING A

BONUS

15) Physics – *Short Answer* Now, Jimmy and Jamie are trying to set up their springs to make an effective spring with spring constant k = 5 N/m. They have springs of k constant 1, 2 and 10. Assuming that all springs are ideal, of the same length, and are put only in series and parallel, what is the least amount of springs they must use?

ANSWER: 2

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TOSS-UP

16) Earth and Space – *Short Answer* What is the name for the celestial bodies that maintain the stability of Saturn's rings?

ANSWER: SHEPHERD MOONS

BONUS

16) Earth and Space – *Short Answer* What force is primarily responsible for IO, one of Jupiter’s moons, to be so volcanically active?

ANSWER: TIDAL FORCE (ACCEPT GRAVITY)
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ROUND 5

TOSS-UP

17) Chemistry – *Short Answer* What is the enthalpy of formation of O_2 (read O 2), to the nearest joule?

ANSWER: 0

BONUS

17) Chemistry – *Multiple Choice* Which of the following is true about a galvanic cell?

W) It has a negative E and a negative delta G
X) It has a positive E and a positive delta G
Y) It has a positive E and a negative delta G
Z) It has a negative E and a positive delta G

ANSWER: Y) IT HAS A POSITIVE E AND A NEGATIVE DELTA G

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TOSS-UP

18) Math – *Short Answer* What are the Cartesian coordinates of the polar coordinates (2, 240 degrees)?

ANSWER: $(-1, -\sqrt{3})$

BONUS

18) Math – *Short Answer* Evaluate in simplest radical form $e^{(\pi * i / 6)}$ (read e to the quantity pi i over 6) where i is the square root of negative 1.

ANSWER: $\sqrt{3}/2 + 1/2\ i$
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ROUND 5

TOSS-UP

19) Chemistry – *Short Answer* What is the common industrial procedure for the production of ammonia called?

ANSWER: HABER PROCESS

BONUS

19) Chemistry – *Short Answer* Balance the equation $P_4O_{10} + H_2O \rightarrow H_3PO_4$.

ANSWER: $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$

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TOSS-UP

20) Physics – *Short Answer* What was the first experiment to measure the charge of an electron?

ANSWER: MILLIKAN'S OIL DROP EXPERIMENT

BONUS

20) Physics – *Multiple Choice* Bob is swinging a yoyo in a vertical circle. The yoyo weighs five newtons and the length of the yoyo string is 0.5 meters. If Bob swings the yoyo at a rate of 5 meters per second, what is the magnitude of the tension in the rope at the top of the yoyo's path? Assume the path the yoyo takes is perfectly circular and that the string is massless.

W) 10 N
X) 15 N
Y) 20 N
Z) 25 N

ANSWER: Y) 20 N
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ROUND 5

TOSS-UP

21) Earth and Space – *Multiple Choice* Many streams carry and deposit sediment in their waters, resulting in the creation of various depositional landforms like deltas. The ability of a stream to carry sediments and other particles depends on what two terms used to define the maximum load a stream can carry in a given amount of time and the largest size of sediment a stream is able to move?

W) Capacity and Competence
X) Competence and Discharge
Y) Capacity and Discharge
Z) Discharge and Flow

ANSWER: W) CAPACITY AND COMPETENCE

BONUS

21) Earth and Space – *Short Answer* Many streams exhibit a series of bends known as meanders. Because velocity is greatest at the outer edge of a meander, erosion occurs and chips away at the stream bed in that area. Thus, the outer edge of a meander can also be referred to by what term?

ANSWER: CUT BANK

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TOSS-UP

22) Biology – *Short Answer* Where are erythrocytes initially formed?

ANSWER: BONE MARROW

BONUS

22) Biology – *Short Answer* What does the hormone erythropoietin regulate?

ANSWER: PRODUCTION OF RED BLOOD CELLS
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ROUND 5

TOSS-UP

23) Math – *Short Answer* What is the derivative with respect to x of $9x^2 + 6x + 2$?

ANSWER: 18x + 6

BONUS

23) Math – *Short Answer* What is the minimum slope of tangent of x?

ANSWER: 1