ROUND 2

TOSS-UP

1) Physics – *Short Answer* An object is dropped from a cliff and hits the ground at t = 27 seconds. Using g = 10, what is the velocity of the object when it lands?

ANSWER: 270 m/s

BONUS

1) Physics – *Multiple Choice* What is the universal gravitational constant in terms of little g and constants?

W) g*(Radius of the Earth)/(Mass of the Earth)
X) (Mass of the Earth)2/(Radius of the Earth)
Y) g*(Radius of the Earth)/(Weight of the Earth)2
Z) g*(Radius of the Earth)2/(Mass of the Earth)

ANSWER: Z) g*(RADIUS OF THE EARTH)/(MASS OF THE EARTH)2

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TOSS-UP

2) Energy – *Short Answer* Researchers at the Oak Ridge National Laboratory are studying why beta decay of atomic nuclei are slower than what's expected based on the beta decay of free neutrons. The process of beta decay occurs due to what fundamental force?

ANSWER: WEAK FORCE

BONUS

2) Energy – *Multiple Choice* Which of the following does NOT hold true for the process of beta decay?

W) Conservation of Angular Momentum
X) Conservation of Lepton Number
Y) Number of Protons is Conserved
Z) Conservation of Baryon Number

ANSWER: Y) NUMBER OF PROTONS IS CONSERVED
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ROUND 2

TOSS-UP

3) Chemistry – *Multiple Choice* Which of the following is closest to the bond angle of ammonia in degrees?

W) 70
X) 90
Y) 110
Z) 130

ANSWER: Y) 110

BONUS

3) Chemistry – *Short Answer* What is the electron pair geometry of ammonia?

ANSWER: TETRAHEDRAL

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TOSS-UP

4) Biology - *Multiple Choice* Which cavity are the lungs found in?

W) Pelvic
X) Pericardial
Y) Abdominal
Z) Pleural

ANSWER: Z) PLEURAL

BONUS

4) Biology - *Short Answer* Which organ in the abdominal cavity stores bile?

ANSWER: GALLBLADDER
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ROUND 2

TOSS-UP

5) Math – *Short Answer* Given that all roots are distinct, What is the sum of the solutions to the equation $12x^4 + 5x^3 - 9x^2 + x - 6 = 0$?

ANSWER: -5/12

BONUS

5) Math – *Short Answer* What value of x maximizes y in the equation $y = x^2 - 8x + 7$?

ANSWER: 4

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TOSS-UP

6) Earth and Space - *Multiple Choice* Acid rain, caused when pollutants released into the air react with water and other chemicals and then fall onto the ground, has the greatest effect on which region of the U.S.?

W) the Midwest
X) the East Coast
Y) the West Coast
Z) the Great Plains

ANSWER: X) THE EAST COAST

BONUS

6) Earth and Space - *Short Answer* By name or number, identify all of the following 4 choices that cause acid rain: 1) Climate change, 2) Decomposing vegetation, 3) Volcanoes, 4) Cars and other vehicles.

ANSWER: CLIMATE CHANGE, DECOMPOSING VEGETATION, VOLCANOES, CARS AND OTHER VEHICLES (ACCEPT: 1, 2, 3, 4 or ALL)
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ROUND 2

TOSS-UP

7) Energy – *Multiple Choice* Researchers at the Pacific Northwest National Laboratory are researching graphene and its properties. Graphene is a thin sheet of what element?

W) Nitrogen
X) Oxygen
Y) Carbon
Z) Tin

ANSWER: Y) CARBON

BONUS

7) Energy – *Short Answer* Graphene when used as an air electrode delivers an exceptionally high capacity of 15,000 mAh/g in lithium-air batteries, the highest value ever reported. In a lithium-air battery, what element is reduced, and what element is oxidized, respectively?

ANSWER: OXYGEN:REDUCED; LITHIUM:OXIDIZED

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TOSS-UP

8) Biology - *Short Answer* What type of fat is characterized by no carbon double bonds and increases LDL levels in the bloodstream?

ANSWER: SATURATED FAT

BONUS

8) Biology - *Multiple Choice* How many carbon rings do steroids have?

W) 2
X) 3
Y) 4
Z) 5

ANSWER: Y) 4
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ROUND 2

TOSS-UP

9) Physics – *Multiple Choice* A sphere and cylinder is rolled down a ramp. A block is slid down the ramp. If the ramp has no friction which object takes the longest to reach the bottom of the ramp?

W) Sphere
X) Cylinder
Y) Block
Z) All are the same

ANSWER: Z) ALL ARE THE SAME

BONUS

9) Physics – *Short Answer* What theorem states that all points inside a spherically symmetric ball will never be affected by the ball's gravitational field?

ANSWER: SHELL THEOREM

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TOSS-UP

10) Chemistry – *Multiple Choice* In the reaction $PCl_5 \rightarrow PCl_3 + Cl_2$, there is a measured decrease in the temperature of the surroundings. Which of the following best describes the signs of ΔH and ΔS?

W) ΔH positive, ΔS positive
X) ΔH positive, ΔS negative
Y) ΔH negative, ΔS positive
Z) ΔH negative, ΔS negative

ANSWER: W) ΔH positive, ΔS positive

BONUS

10) Chemistry – *Multiple Choice* If a reaction has ΔH positive and ΔS positive, when is it spontaneous?

W) Only at high temperatures
X) Only at low temperatures
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Y) Spontaneous at all temperatures
Z) Nonspontaneous at all temperatures

ANSWER: W) ONLY AT HIGH TEMPERATURES

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TOSS-UP

11) Math – *Short Answer* What is the value of $(1+i)^8$?

ANSWER: 16

BONUS

11) Math – *Short Answer* What is the absolute value of $\frac{5}{13} - \frac{12}{13}i$?

ANSWER: 1

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TOSS-UP

12) Earth and Space - *Short Answer* Over 90% of rock forming minerals are found in which mineral group?

ANSWER: SILICATES

BONUS

12) Earth and Space - *Multiple Choice* Which of the following minerals has basal cleavage?
W) fluorite
X) mica
Y) calcite
Z) galena

ANSWER: X) MICA

TOSS-UP

13) Biology - *Multiple Choice* Which is not a biological effect of taking a stimulant?

W) Increased respiration
X) Increased appetite
Y) Increased blood pressure
Z) Increased heart rate

ANSWER: X) INCREASED APPETITE

BONUS

13) Biology - *Short Answer* Which division of the nervous system would promote the emptying of the bladder?

ANSWER: PARASYMPATHETIC

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TOSS-UP

14) Energy – *Multiple Choice* Researchers at the Oak Ridge National Laboratory are researching methods to accelerate the screening process of drugs in order to develop more successful drugs for cheaper costs. Which of the following is a molecule that binds to an enzyme in a similar way to how pharmaceuticals bind to certain cellular receptors?

W) Receptor
X) Ligand
Y) Substrate
Z) DNA

ANSWER: Y) SUBSTRATE

BONUS

14) Energy – *Short Answer* Selective Serotonin Reuptake Inhibitors, or SSRIs, are able to increase serotonin levels by blocking reuptake and increasing the amount of serotonin binding to receptors on what neuron?

ANSWER: POST-SYNAPTIC NEURON (ACCEPT: RECEIVING NEURON/CELL)
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ROUND 2

TOSS-UP

15) Physics – *Multiple Choice* The buoyant force is a result of which of the following principles?

W) Bernoulli's Principle
X) Newton's Principle
Y) Archimedes' Principle
Z) Descartes' Principle

ANSWER: Y) ARCHIMEDES' PRINCIPLE

BONUS

15) Physics – *Short Answer* An object of uniform density floats in a cup of water such that 20% of the object's volume is above the water's surface. Which of the following is the density of the object in kilograms per cubic meter?

ANSWER: 800

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TOSS-UP

16) Earth and Space - *Short Answer* Give the name for the largest canyon in the Solar System, found on Mars.

ANSWER: VALLES MARINERIS

BONUS

16) Earth and Space - *Short Answer* Created as part of the NASA Mars Exploration Program, what rover was launched from Cape Canaveral on November 26th, 2011 and aimed to discover whether or not microbial life could have ever existed on Mars?

ANSWER: CURIOSITY
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ROUND 2

TOSS-UP

17) Chemistry – *Short Answer* What is the molecular geometry around a carbon in ethene?

ANSWER: TRIGONAL PLANAR

BONUS

17) Chemistry – *Short Answer* Identify all of the following three elements that are in the same group as carbon: 1) Silicon, 2) Indium, 3) Lead.

ANSWER: 1 AND 3

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TOSS-UP

18) Math – *Multiple Choice* What is the derivative of x?

W) ½ x^2 (READ one half x squared)
X) x
Y) ½ x
Z) 1

ANSWER: Z) 1

BONUS

18) Math – *Multiple Choice* Arcane and Ramses are both running in a 1 kilometer race on a circular track with circumference 100 meters. If Arcane runs just over three times as fast as Ramses, which of the following is true about their relative or absolute position in the race?

W) Ramses will be ahead in the race after running 1 lap
X) Arcane will have lapped Ramses once by the time Ramses has finished a lap
Y) Arcane will have lapped Ramses twice by the time Ramses has finished a lap
Z) Arcane will have lapped Ramses three times by the time Ramses has finished a lap

ANSWER: Y) ARCANE WILL HAVE LAPPED RAMSES TWICE BY THE TIME RAMSES HAS FINISHED A LAP
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ROUND 2

TOSS-UP

19) Chemistry – *Multiple Choice* In what reaction order is the rate of reaction directly proportional to the concentration of a reactant?

W) Zeroth
X) First
Y) Second
Z) Third

ANSWER: X) FIRST

BONUS

19) Chemistry – *Short Answer* In the reaction A + B → C + D, doubling the concentration of B quadruples the reaction rate. Doubling the concentration of A and halving the concentration of B halves the reaction rate. What is the reaction order of the overall reaction?

ANSWER: THIRD ORDER

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TOSS-UP

20) Physics – *Multiple Choice* Moving charges do not exert a net electromagnetic force on which of the following?

W) Magnets
X) Other moving charges
Y) Stationary charges
Z) Isolated neutrons

ANSWER: Z) ISOLATED NEUTRONS

BONUS

20) Physics – *Short Answer* A 4 kg point mass is located at the origin in 3-dimensional space. If Henry applies a 5 N force in the positive x direction, a 4 N force in the positive y direction, a 7 N force in the positive z direction, and a 1 N force in the negative x direction, then to the nearest hundredth, what is the magnitude of the mass's acceleration with SI units?
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ANSWER: 2.25 METERS PER SECOND SQUARED

ROUND 2

TOSS-UP

21) Earth and Space - *Short Answer* What is the name for the effect that occurs when light of different wavelengths focuses at different places, creating an issue specific to refractive telescopes?

ANSWER: CHROMATIC ABERRATION

BONUS

21) Earth and Space - *Multiple Choice* Assuming that there was a new moon on March 11, where in the sky would the moon be at sunset three days later on March 14?

W) slightly above the eastern horizon
X) slightly below the eastern horizon
Y) slightly above the western horizon
Z) slightly below the western horizon

ANSWER: Y) SLIGHTLY ABOVE THE WESTERN HORIZON

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TOSS-UP

22) Biology - *Short Answer* What is the waxy coating on the epidermal surface of leaves that helps to prevent water loss?

ANSWER: CUTICLE

BONUS

22) Biology - *Multiple Choice* Which is not one of the main floral organs?

W) Carpels
X) Stamens
Y) Sepals
Z) Receptacles

ANSWER: Z) RECEPTACLES
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ROUND 2

TOSS-UP

23) Math – *Short Answer* How many platonic solids are there?

ANSWER: 5

BONUS

23) Math – *Short Answer* What is the height of an equilateral triangle with side length 4?

ANSWER: $2\sqrt{3}$