**TOSS UP**

1. BIOLOGY *Short Answer* Denote by name or number all of the following 4 insect orders which are known to be eusocial.  
   1. Dermaptera  
   2. Hymenoptera  
   3. Odonata  
   4. Isoptera  
     
   ANSWER: 2 and 4

**BONUS**

1. BIOLOGY *Short Answer* What is the name of the molecule, derived from linolenic acid, which functions in plants as a response to wounding, systemic acquired resistance to pathogens, and the activation of protease inhibitors?ANSWER: jasmonic acid

**TOSS UP**

1. PHYSICS *Short Answer* A rock is thrown horizontally off of a cliff at 15 m/s. The cliff is 200 m above a river. About how long, in seconds to the nearest integer, will it take the rock to land in the river?ANSWER: 6 seconds

**BONUS**

1. PHYSICS *Multiple Choice* For an Ohmic resistor, which of the following accurately represents the slope of the line, on a graph where the x axis represents Voltage, and the y axis represents Current?  
   W) R  
   X) 1/R  
   Y) 1  
   Z) 1/R^2ANSWER: X

**TOSS UP**

1. CHEMISTRY *Short Answer* Equal moles of the 4 different gases are placed in a closed container with a small pinhole opening in its side; they are: propane, methane, ethane, and chloromethane. After a short period has passed, which gas would have the lowest mole fraction?  
     
   ANSWER: methane

**BONUS**

1. CHEMISTRY *Multiple Choice* What is the major intermolecular force in the following compound, given that the difference in boiling point between its two stereoisomers is less than 3%: CH3CH double bonded to CHCH2CH3  
   W) Dipole Dipole  
   X) Hydrogen Bonding  
   Y) London dispersion  
   Z) IonicANSWER: Y

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* Denote by name or number all of the following 3 phenomena which do not contribute to the emergence of protostars from their cocoons.  
   1. Stellar Wind  
   2. Radiation Pressure  
   3. High Energy JetsANSWER: 3 only

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What is the name of the region outside the event horizon of a black hole in which space time rotates with the rotating black hole so powerfully that nothing could avoid being dragged along?ANSWER: ergosphere

**TOSS UP**

1. MATH *Multiple Choice* For what value of k will the function x + k/x have a relative maximum at x= -2?  
   W) 2  
   X) -2  
   Y) 4  
   Z) -4  
     
   ANSWER: Y

**BONUS**

1. MATH *Multiple Choice* The point on the curve x^2 +2y=0 which is nearest to the point (0, -0.5) occurs when y= ?  
   W) -1  
   X) 0  
   Y) - ½  
   Z) ½ ANSWER: X

**TOSS UP**

1. ENERGY *Short Answer* What ore is the main source of aluminum?ANSWER: bauxite

**BONUS**

1. ENERGY *Short Answer* What more efficient and safer underground mining method uses a specially shielded machine that allows a mined-out area to collapse in a controlled manner.ANSWER: longwall mining

**TOSS UP**

1. BIOLOGY *Multiple Choice* Which of the following animals would use the ZW/ZZ sex determination system?  
   W) Honeybees   
   X) Fruit flies  
    Y) Anaconda  
   Z) Sparrow  
     
   ANSWER: Z

**BONUS**

1. BIOLOGY *Short Answer* What procedure for prenatal diagnosis would a doctor elect to use if a pregnant woman desired genetic counseling only 4 weeks into her pregnancy?ANSWER: cvs

**TOSS UP**

1. PHYSICS *Multiple Choice* A vibrating string is behaving like a standing wave with nodes at the ends and 3 antinodes. The string is 150 cm long and the wave travels at 20 m/s. What is the string vibration wavelength and frequency?  
   W) 0.75 m, 26.6 Hz  
   X) 1.5 m, 15 Hz  
   Y) 2 m, 20 Hz  
   Z) 1 m, 10 HzANSWER: Z

**BONUS**

1. PHYSICS *Short Answer* Denote by name or number all of the following 4 statements which is or are true of commutators.  
   1. It is a rotary electrical switch which periodically reverses the current direction between the rotor and the external circuit.  
   2. It is a common feature of devices which use alternating current.   
   3. It works by producing a rotating force, or torque.   
   4. It has a very short lifetime, considering the number of circuit makes and breaks that occur in normal operation.ANSWER: 1 and 3

**TOSS UP**

1. CHEMISTRY *Short Answer* Rank the following elements in increasing order of their reactivity with fluorine: Carbon, Lithium, Cesium, Oxygen  
     
   ANSWER: 4, 1, 2, 3

**BONUS**

1. CHEMISTRY *Multiple Choice* Which conformational isomer of butane has the highest potential energy?  
   W) Anti-staggered  
   X) Gauche  
   Y) Eclipsed  
   Z) Fully eclipsedANSWER: Z

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What sudden burst of impacts from 4.1 to 3.8 billion years ago lead to many of the craters we see on the moon today?ANSWER: late heavy bombaRdment

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* Place the following 4 periods of the geologic time scale in order from oldest to newest: Devonian, Cretaceous, Cambrian, PermianANSWER: cambrian, devonian, permian, cretaceous

**TOSS UP**

1. MATH *Multiple Choice* If f’(x) and g’(x) exist, and f’(x) > g’(x) for all real x, the the graph of y = f(x) and the graph of y = g(x):  
   W) Intersect exactly once  
   X) Intersect no more than once  
   Y) Do not intersect  
   Z) Could intersect more than once  
     
   ANSWER: X

**BONUS**

1. MATH *Short Answer* If sinx= e^y, 0<x<pi, then what is dy/dx in terms of x?ANSWER: cot (x)

**TOSS UP**

1. ENERGY *Multiple Choice* Which of the following percentages most accurately represents the amount of U-235 in reactor grade, and weapons grade enriched uranium, respectively?  
   W) 1%, 50%  
   X) 50%, 1%  
   Y) 4%, 90%  
   Z) 90%, 4%ANSWER: Y

**BONUS**

1. ENERGY *Short Answer* What gaseous element is the naturally occurring decay product of Uranium and Thorium?ANSWER: radon

**TOSS UP**

1. BIOLOGY *Short Answer* What naturally occurring psychedelic compound produced by more than 200 species of mushrooms is currently being used in research for obsessive-compulsive disorder, cluster headaches, and anxiety related to terminal cancer, due to its mind-altering effects similar to those of LSD?  
     
   ANSWER: psilocybin

**BONUS**

1. BIOLOGY *Short Answer* Match each of the following 4 statements with the neurotransmitter it is describing:  
   1. Crosses the synapse between a motor neuron and a muscle fiber.  
   2. Major excitatory neurotransmitter in the vertebrate CNS, producing EPSPs and stimulating action potentials in the postsynaptic neurons.  
   3. Involved in the regulation of sleep and is also implicated in various emotional states.  
   4. First gas known to act as a regulatory molecule in the body.ANSWER: acetylcholine, glutamate, serotonin, nitric oxide

**TOSS UP**

1. PHYSICS *Short Answer* A particular radioisotope decays in the following order: alpha, beta, beta, alpha, gamma. How many neutrons have been emitted during the series of decays?ANSWER: 4

**BONUS**

1. PHYSICS *Short Answer* In x-ray emission, some electrons are slowed down or stopped by the target, and part or all of their kinetic energy is converted directly to a continuous spectrum of photons, including x rays. What is the name of this phenomenon, known as braking radiation? ANSWER: Bremsstrahlung

**TOSS UP**

1. CHEMISTRY *Short Answer* Rank the following compounds in order of the most acidic to the least acidic: I. p-chlorobenzoic acid, II. benzoic acid, III. p-methylbenzoic acid, IV. p-nitrobenzoic acid  
     
   ANSWER: 4, 1, 2, 3

**BONUS**

1. CHEMISTRY *Multiple Choice* Replacing a methyl group on a 3° carbon with a phenyl group would most likely have which of the following effects?  
   W) Increase the likelihood of a reaction via the SN1 mechanism rather than the SN2 mechanism.  
   X) Decrease the boiling point of the molecule.  
   Y) Increase the solubility of the molecule in water.  
   Z) Decrease the toxicity of the molecule to mice.ANSWER: W

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What 1.4 billion light year long object is currently the largest known structure in the universe?ANSWER: sloan great wall

**BONUS**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following statements most accurately describes the solution to Olber’s Paradox?  
   W) The universe is infinitely large.  
   X) The universe is infinitely old.  
   Y) The universe’s size is finite.  
   Z) The universe’s age is finite. ANSWER: Z

**TOSS UP**

1. MATH *Short Answer* What is the average value of 3t^3 – t^2over the interval -1 LTOET t LTOET 2? Give your answer as a fraction in simplest form.  
     
   ANSWER: 11/4

**BONUS**

1. MATH *Short Answer* If f(x) = 2x^3+Ax^2+Bx-5 and if f(2)=3 and f(-2) = -37, what is the value of A+B?ANSWER: -1

**TOSS UP**

1. ENERGY *Short Answer* Denote by name or number all of the following 4 alternative fuels which bioreactors would be used to create?  
   1. Syngas  
   2. Ethanol  
   3. Algae Fuel  
   4. Biochar ANSWER: 1, 2, and 3

**BONUS**

1. ENERGY *Short Answer* What is the name of the process that used bacterial fermentation to produce acetone, n-Butanol, and ethanol from starch?ANSWER: abe fermentation

**TOSS UP**

1. BIOLOGY *Multiple Choice* The Asian pitcher plant, Nepenthes, is an example of which of the following types of plants?   
   W) Parasitic  
   X) Epiphytic  
   Y) Carnivorous  
   Z) Xerophytic  
     
   ANSWER: Y

**BONUS**

1. BIOLOGY *Short Answer* Match the type of soil bacteria which functions to perform one of the four following actions:  
   1. Release ammonia (NH3) by breaking down proteins and other organic compounds in humus  
   2. Oxidation of NH3 to nitrite(N02 -), followed by oxidation of nitrite to nitrate (N03-).  
   3. Convert NO3- to N2  
   4. Convert gaseous nitrogen (N2) into NH3ANSWER: ammonifying, nitrifying, denitrifying, nitrogen fixing

**TOSS UP**

1. PHYSICS *Multiple Choice* You are given three capacitors, each of capacitance 5 farads. Which of the following capacitances could not be derived through placing the capacitors in any permutation in a circuit, assuming a constant voltage?  
   W) 15 F  
   X) 7.5 F  
   Y) 3.5 F  
   Z) 1.7 FANSWER: Y

**BONUS**

1. PHYSICS *Short Answer* Denote by name or number all of the following 4 charge distributions in which the electric field magnitude is equal to 0 at the given point.  
   1. Any point on an infinite sheet of charge with uniform charge per unit area  
   2. Inside a cylinder, when the cylinder is infinitely conducting with a radius R and charge per unit length lambda.  
   3. A point which is a distance R from an infinite wire, with charge per unit length lambda.   
   4. A point inside a conducting sphere of radius R, with charge q on the surface. ANSWER: 2 and 4

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Solid NaOH is hygroscopic, meaning it absorbs moisture from the air. A student places solid NaOH into a weighing dish and leaves the sample out for too long before weighing it. The student then dissolves the NaOH and uses the solution in a titration of an acid. The measured amount of the acid will therefore be:  
   W) less than the actual amount of acid  
   X) greater than the actual amount of acid  
   Y) equal to the actual amount of acid  
   Z) Not enough information  
     
   ANSWER: X

**BONUS**

1. CHEMISTRY *Short Answer* A double replacement reaction occurs in a beaker between reagent X and reagent Y. It is found that water is formed in the reaction. Denote by name or number all of the following 3 compounds which can be a potential reagent in the reaction.  
   1. HCl  
   2. NaOH  
   3. MgCl2ANSWER: 1 and 2

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* Denote by name or number all of the following 4 statements which is or are true of earthquakes.  
   1. P- waves propagate in such a way that the particles in the earth travel parallel to the direction of the wave energy  
   2. The elastic rebound theory is an explanation for how energy is spread during earthquakes.  
   3. Surface waves are more destructive that body waves  
   4. Love waves are vertically polarized shear waves.ANSWER: 1, 2, and 3

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* To the nearest integer, about how many times more energy is released in an earthquake the measures 5.0 on the Richter scale when compared to an earthquake of magnitude 4.0?ANSWER: 32

**TOSS UP**

1. MATH *Multiple Choice* Find the integral, from 0 to pi over 4, of tan^2(x) dx.  
   W) 1- pi over 4  
   X) pi over 4 – 1  
   Y) 1/3  
   Z) pi over 4 +1  
     
   ANSWER: W

**BONUS**

1. MATH *Multiple Choice* If the solutions to f(x) = 0 are -1 and 2, then the solutions of f(x/2)= 0 are:  
   W) – ½ and 1  
   X) -1 and 2  
   Y) -3/2 and 3/2  
   Z) -2 and 4ANSWER: Z

**TOSS UP**

1. ENERGY *Multiple Choice* Which of the following types of fuel cells is the one most commonly used in vehicles?W) Alkaline   
   X) Polymer Electrolyte Membrane  
   Y) Solid Oxide  
   Z) Phosphoric Acid  
   ANSWER: X

**BONUS**

1. ENERGY *Short Answer* Denote by name or number all of the following 4 heat engines which have working fluids which are always liquids.   
   1. Diesel  
   2. Stirling  
   3. Rankine  
   4. OttoANSWER: 2 only

**TOSS UP**

1. PHYSICS *Short Answer* What type of decay is known to occur only when the mass of the original neutral atom is at least 2 electron masses larger than that of the final atom?  
     
   ANSWER: BETA PLUS

**BONUS**

1. PHYSICS *Short Answer* Denote by name or number all of the following 4 statements which is or are true of the Zeeman effect.  
   1. The dot product of the magnetic moment and magnetic field vectors results in the potential energy of the dipole interaction.  
   2. It is based entirely on the orbital angular momentum of the electron.  
   3. The Zeeman effect holds for both weak and strong magnetic fields.   
   4. The Bohr magneton is the natural unit for expressing an electron magnetic dipole moment.ANSWER: 1,2 and 4