**TOSS UP**

1. BIOLOGY *Short Answer* In a flower, what structures correspond to the male and female reproductive organs in animals, respectively?  
     
   ANSWER: stamen and pistil

**BONUS**

1. BIOLOGY *Short Answer* In late 2006, Western honey bee colonies in North America saw a drastic decline in late 2006. European beekeepers have since observed similar phenomena in Belgium, France, the Netherlands, Greece, Italy, Portugal, and Spain. What phenomenon , significant due bees' large role in pollination, is seen when worker bees from a beehive or colony abruptly disappear and continues to have no identifiable cause?ANSWER: colony collapse disorder

**TOSS UP**

1. PHYSICS *Multiple Choice* In a stress-strain curve, beyond which of the following points will permanent deformation first occur?W) Hooke's limit

X) proportionality limit

Y) elastic limit

Z) yield pointANSWER: Y) elastic limit

**BONUS**

1. PHYSICS *Short Answer* A rock with density of 4 g/mL and mass 1kg is suspended by a string while submerged in a bucket of water. Taking acceleration due to gravity as 10 m/s, what is the tension in the string? Treat the string as infinitesimally thin. ANSWER: 7.5 N

**TOSS UP**

1. CHEMISTRY *Short Answer* You have an electrolytic cell set up to produce a metal with a reduction potential greater than that of hydrogen. At what portion of the cell will you be able to collect your produced metal?  
     
   ANSWER: cathode

**BONUS**

1. CHEMISTRY *Short Answer* You once again have an electrolytic cell set up in front of you, with the ions of gold, copper, and silver dissolved in an aqueous solution. Assuming the products are scraped off the cathode at the same rate they are produced, in what chronological order will the metals be produced?ANSWER: gold, silver, copper (1 3 2)

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following wavelengths of light would be absorbed in the greatest quantities by water?W) red

X) yellow

Y) green

Z) blueANSWER: W) red

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What is the name commonly given to the southernmost latitude in the Northern hemisphere where the sun can remain continuously above or below the horizon for 24 hours?ANSWER: arctic circle

**TOSS UP**

1. MATH *Short Answer* Three ants each sit at the corner of an equilateral triangle. Each any randomly picks a direction and starts to move along the edge, until it reaches a corner. What is the probability that none of the ants collide?  
     
   ANSWER: 1/4

**BONUS**

1. MATH *Short Answer* An ant starts at the lower-left corner of a 3 x 3 grid. It moves along the edges of the grid, and can choose either to move up or to move right until it encounters the upper right corner, or encounters an edge, in which case it will continuously move up or right until it reaches the aforementioned corner. How many possible paths exist for the ant to move through, and what is the probability that the ant chooses the shortest path?ANSWER: 20, 100%

**TOSS UP**

1. ENERGY *Short Answer* The Hall-Heroult process is the major industrial process by which aluminum is produced through electrolysis. Historically, previous attempts to electrolyze aluminum salts, due to the rapid oxidation of the produced aluminum in the aqueous solution. The use of what solvent to dissolve the aluminum oxides allowed for the overcoming of this problem?ANSWER: cryolite

**BONUS**

1. ENERGY *Short Answer* You are in a lab and have in front of you an electrolytic cell which is set up to electrolyze an aqueous solution of sodium hydroxide. You connect the cell to a power source, and collect the substance formed at the cathode. What is this substance. ANSWER: hydrogen

**TOSS UP**

1. BIOLOGY *Short Answer* In animal cells, cytokinesis occurs by the process of cleavage. What indentation in the cell surface near the old metaphase plate is the first sign of cleavage, and is produced by the interaction of actin and myosin causing the contraction of a ring of microfilaments?  
     
   ANSWER: cleavage furrow

**BONUS**

1. BIOLOGY *Multiple Choice* In which of the following groups of organisms does the nuclear envelope remain intact during cell division, with microtubules forming a spindle within the nucleus?W) bacteria

X) diatoms and yeasts

Y) dinoflagellates

Z) archaeaANSWER: X) diatoms and yeasts

**TOSS UP**

1. PHYSICS *Multiple Choice* In a Feynman diagram, a straight line with a right-pointing arrow embedded in it represents aW) particle

X) antiparticle

Y) gluon

Z) gauge bosonANSWER: W) particle

**BONUS**

1. PHYSICS *Short Answer* What gauge boson is responsible in mediating Beta Minus decay and is emitted when a down quark changes flavor into an up quark? ANSWER: W- BOSON

**TOSS UP**

1. CHEMISTRY *Short Answer* PVC's flame-retardant abilities come from the prescence of what element in its monomer?  
     
   ANSWER: chlorine

**BONUS**

1. CHEMISTRY *Short Answer* Which of the following is an example of a thermosetting polymer?W) polycarbonate

X) polyester

Y) polyvinyl chloride

Z) vulcanized rubberANSWER: Z) vulcanized rubber

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* When the dry adiabatic lapse rate is lower than the environmental lapse rate, but the wet adiabatic lapse rate is greater than the environmental lapse rate, what form of stability occurs?ANSWER: conditional instability

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What term describes changes in solar irradiance of the earth due to variations of the movement and orientation of earth that result in alteration of the amount and location of solar radiation reaching the earth; these variations are a major contributor to Milankovitch cycles in the earth's climateANSWER: solar forcing

**TOSS UP**

1. MATH *Short Answer* What is the limit as x approaches zero of the function with numerator sinx cosx and denominator x?  
     
   ANSWER: 1

**BONUS**

1. MATH *Multiple Choice* Consider the series from n = 1 to infinity of the fraction e to the n over n factorial. If the ratio test is applied to the series, which of the following resulting inequalities implies that the series converges? W) limit as n approaches infinity of n factorial over e is less than one

X) limit as n approaches infinity of e over n factorial is less than one

Y) limit as n approaches infinity of n + 1 over e is less than one

Z) limit as n approaches infinity of e over n + 1 is less than oneANSWER: Z) limit as n approaches infinity of e over n + 1 is less than one

**TOSS UP**

1. ENERGY *Multiple Choice* Helium is a gas which finds many uses, mostly in industry as a protective atmosphere for arc welding and growing crystals. Which of the following is the source of most terrestrial helium that is used? W) big bang nucleosynthesis and subsequent inclusion in Earth's atmosphere during planetary formation

X) outgassing from rocks during Earth's formation due to the extreme vacuum of space

Y) stellar nucleosynthesis and capture by earth via solar wind

Z) alpha decay of radioactive rocks and combination with electronsANSWER: Z) alpha decay of radioactive rocks and combination with electron

**BONUS**

1. ENERGY *Short Answer* The US Department of Energy gives estimates for total system levelized cost for various sources of electricity, which is the dollar cost per megawatt hour that must be charged over time in order to pay for the total cost. By name or number, order the following 4 electrical plant types by INCREASING average levelized cost for plants entering service in 2017: 1. offshore wind 2. conventional natural gas 3. conventional coal 4. advanced nuclearANSWER: 2, 3, 4, 1

**TOSS UP**

1. BIOLOGY *Multiple Choice* Which of the following codons is NOT a stop codon?  
   W) UAC

X) UAA

Y) UAG

Z) UGA  
ANSWER: W) UAC

**BONUS**

1. BIOLOGY *Short Answer* In addition to acting as the initiation codon, the codon AUG also codes for what amino acid?ANSWER: methaionine

**TOSS UP**

1. PHYSICS *Multiple Choice* A and B are two samples of different ideal gases. Sample A has double the molar mass and temperature of sample B. What is the relationship between their root mean square speeds?

W) A has two times the rms as B

X) A has half the rms as B

Y) A has the same rms as B

Z) there is not enough known information to answer the problemANSWER: Y) A has the same rms as B

**BONUS**

1. PHYSICS *Multiple Choice* A substance is at its critical temperature, but below its critical pressure. The pressure on it is then raised so that it is now at the critical point on a PT diagram. Which of the following statements describes the change in phase that has occurred? W) gas into liquid

X) liquid into gas

Y) gas into supercritical fluid

Z) liquid into supercritical fluidANSWER: Z) liquid into supercritical fluid

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Which of the following elements is never hypervalent in molecules?  
   W) phosphorus

X) xenon

Y) iodine

Z) lithium  
ANSWER: Z) lithium

**BONUS**

1. CHEMISTRY *Short Answer* By name or number, identify all of the following 5 compounds that are considered hypervalent1.PCL5

2. XeF2

3. XeF4

4. I3 -

5. ClF3ANSWER: all of them

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* Radio astronomers have found that between 1420 and 1666 megahertz, or 21 and 18 centimeters, there is a especially quiet zone in the electromagnetic radiation from outer space. What term, coined by Bernard Oliver in 1971 describes this band, which lies between the spectra of hydrogen and hydroxl radicals and so could be an obvious band for communication with extraterrestrial intelligence?ANSWER: water hole

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What cosmological structure consisting of 73 quasars and discovered in January 2013 is the current largest cosmological structure, beating out the Sloan Great Wall?ANSWER: Huge large quasar group

**TOSS UP**

1. MATH *Short Answer* Function A is cos(x), and function b is sin(x). But what quantity must function A be translated if the sum of the two functions is to be 2cosx?  
     
   ANSWER: pi/2

**BONUS**

1. MATH *Short Answer* Let R be the region between the graph of y = e to the negative 2 x and the x acis for x is greater than or equal to three. What is the area of R, giving your answer as a reduced fraction and in terms of e?ANSWER: 1/2e^6

**TOSS UP**

1. ENERGY *Short Answer* The International Nuclear Event Scale was introduced in 1990 by the International Atomic Energy Agency to quantify nuclear accidents, with 7 being the highest number and warranting classification as a "major accident". In history, how many nuclear accidents have been classified at their highest as a 7?ANSWER: two

**BONUS**

1. ENERGY *Multiple Choice* Of the thirty countries in which nuclear power plant operate, in which of the following countries is it NOT used as a primary source of electricity?W) Germany

X) Slovakia

Y) Belgium

Z) FranceANSWER: W) Germany

**TOSS UP**

1. BIOLOGY *Short Answer* Order the following three mammalian infraclasses in order from least to greatest adaptive radiation within the group

1. marsupials

2. monotremes

3. eutherians  
ANSWER: 2 1 3

**BONUS**

1. BIOLOGY *Short Answer* Among mollusks, there is a range of eye complexity that has often been used as an example against irreducible complexity. What primitive eye structure, found in the mollusk Pleurotomaria, consists of an indent in the epithelium in which pigmented cells are concentrated, and is intermediate between having patches of pigmented cells and the pinhole-camera-type eye in development. ANSWER: eyecup

**TOSS UP**

1. PHYSICS *Multiple Choice* Two satellites, A and B, are orbiting above the earth with the same velocity v. Which of the following statements about the satellites must be true?W) their masses are the same

X) their angular momenta are the same

Y) their orbits are the same

Z) their moments of inertia are the sameANSWER: Y) their orbits are the same

**BONUS**

1. PHYSICS *Multiple Choice* Two blocks, A and B are used to compress a horizontal spring on a frictionless table. The spring is sandwiched in between the two such that it will push on both the blocks when they are released, then fall to the table after it has reached its unstretched position. Block A has twice the mass of block B. Which of the following statements describing the blocks' kinetic energies after the spring has extended is correct?W) block A will have a greater kinetic energy than block B

X) block B will have a greater kinetic energy than block A

Y) both block A and B will have the same kinetic energies

Z) there is not enough information to determine what will occurANSWER: X) block B will have a greater kinetic energy than block A

**TOSS UP**

1. CHEMISTRY *Short Answer* In the Daniell cell, the ion of what element is drawn to the cathode?  
     
   ANSWER: copper

**BONUS**

1. CHEMISTRY *Short Answer* Give the two half-cell reactions that occur at the cathode and anode, respectively, of a Daniell cellANSWER: cathode: cu2+ and two electrons yields cu anode: zn yields zn2+ and two electrons

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What term describes open-ocean sediments, characterized by their great distance from continental margins, fine particle size, and slow-settling mode of deposition and include foraminniferal ooze, silicaceous ooze, and fin-grained terrigenous particles.ANSWER: pelagic sediments

**BONUS**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following statements best describes why formainiferal oozes are rare on parts of the seafloor deeper than 4 kmW) below 4 km the water is undersaturated with calcium carbonate, and so their shells dissolve before reaching the seafloor

X) formanifera are rare in the open ocean where depths deeper than 4 km are typical

Y) formanifera cannot live below 4 km due to the ocean conditions

Z) deep-sea currents that run below 4 km carry the shells away before they can be deposited on the seafloorANSWER: W) below 4 km the water is undersaturated with calcium carbonate, and so their shells dissolve before reaching the seafloor

**TOSS UP**

1. MATH *Short Answer* What is the y-intercept of the line which passes through the points (1, 2) and (3, 6)?  
     
   ANSWER: -1

**BONUS**

1. MATH *Short Answer* What hyperbolic function produces a graph with domain open interval negative infinity to infinity and range open interval negative infinity to infinity?ANSWER: hyperbolic sine

**TOSS UP**

1. ENERGY *Multiple Choice* In an electrochemical cell that is producing electrical energy from chemical reactions, free electrons spontaneously flow from theW) cathode to anode through the external circuit

X) anode to cathode through the external circuit

Y) cathode to anode through the salt bridge

Z) anode to cathode through the salt bridgeANSWER: X) anode to cathode through the external circuit

**BONUS**

1. ENERGY *Short Answer* In lithium ion batteries, what material is the most commercially popular choice for the negative electrode?ANSWER: Graphite

**TOSS UP**

1. PHYSICS *Short Answer* In room-temperature air, the note middle C has an approximate wavelength of 1.3 meters. Two speakers, both playing middle C in phase are placed such that when the sound is recorded, the volume is much less than either of the two speakers. What is the minimum distance to two significant figures and in meters that the speakers are offset from each other by?  
     
   ANSWER: 0.65 meters

**BONUS**

1. PHYSICS *Short Answer* A guitarist is tuning a string to middle C and finds that it is very out of tune. With his superhuman hearing, he notes that the beat frequency is 131 Hz. Given the frequency of middle C as 262 Hz and taking his guitar string to be fixed at both ends, by what factor must he increase the tension in the string in order to bring it in tune?ANSWER: 4 times