**TOSS UP**

1. BIOLOGY *Short Answer* What genus of bacteria infects arthropod species, as well as some nematodes and is also probably the most frequent source of bacterial infection on the planet? It is a unique microbe in that it is most commonly a parasite but can sometimes form other symbiotic relationships and is also notable for significantly altering the reproductive capabilities of its hosts.   
     
   ANSWER: wolbachia

**BONUS**

1. BIOLOGY *Short Answer* What enzyme catalyzes the first major step of carbon fixation in the Calvin cycle of photosynthesis?ANSWER: Rubisco (ribulose-1, 5-biphosphate carboxylase oxygenase)

**TOSS UP**

1. PHYSICS *Short Answer* Which of the following statements regarding pressure is not true? W) gauge pressure is the excess measured pressure above atmospheric pressure

X) pressure exerted by a fluid is only dependent on the depth of an object beneath the surface and not the surface area of a fluid

Y) a fluid at rest exerts a force parallel to any surface in contact with it

Z) increasing the pressure at the surface of a fluid will also increase the pressure at any depth by the same amountANSWER Y) a fluid at rest exerts a force parallel to any surface in contact with it:

**BONUS**

1. PHYSICS *Short Answer* Expressing your answer using scientific notation and with two significant figures, how many Pascals are equivalent to two atmospheres?ANSWER: 2.0 x 105

**TOSS UP**

1. CHEMISTRY *Short Answer* Which of the three most common states of matter has the least molar Gibbs free energy, and thereby the most stable, at the coldest temperatures?  
     
   ANSWER: solid

**BONUS**

1. CHEMISTRY *Short Answer* By name or number, identify all of the following five factors which would favor spontaneity for an ENDOTHERMIC reaction 1. delta H is negative

2. delta H is positive

3. delta G is negative

4. delta S is negative, given that T times delta s is greater than delta H and delta G is negative

5. delta S is positive, given that T times delta s is greater than delta H and delta G is negativeANSWER: 2, 3, 5

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following is closest to the mass limit above which a white dwarf is unable to support itself through the pressure of electron degeneracy?W) 0.7 solar masses

X) 1.0 solar masses

Y) 1.4 solar masses

Z)2.0 solar massesANSWER: Y) 1.4 solar masses

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* Stars which surpass the Chandrasekhar limit evolve into one of two possible stellar objects. Identify these two objects. ANSWER: neutron star, black hole

**TOSS UP**

1. MATH *Short Answer* Solve for 0 is less or equal to theta which is less than two pi.   
     
   ANSWER: 3π/4, 7π/4

**BONUS**

1. MATH *Short Answer* An observer on the flat ground looks up at a plane flying towards him at an altitude of 17 km. The observer's line of sight forms a 45 degree angle with the ground. How much closer, in kilometers, must the plane fly in order for the observer's line of sight to form a 60 degree angle with the ground? Round your answer to the nearest whole kilometer. ANSWER: 7

**TOSS UP**

1. ENERGY *Short Answer* What process produces liquid hydrocarbons through hydrogenation of coal at high temperatures and pressure?ANSWER: bergius process

**BONUS**

1. ENERGY *Multiple Choice* The Energy Policy Act of 2005 requires what percentage of electricity consumed by the Federal Government to come from renewable energy in the fiscal years of 2010 - 2012?W) no less than 3%

X) no less than 5%

Y) no less than 7.5%

Z) no less than 10%ANSWER: X) no less than 5%

**TOSS UP**

1. BIOLOGY *Short Answer* What term refers to live microorganisms which, when administered in adequate amounts, can confer a health benefit to the host. These organisms are commonly consumed as part of fermented foods with added live cultures such as yogurt; examples include lactic acid bacteria and bifidobacteria.  
     
   ANSWER: probiotics

**BONUS**

1. BIOLOGY *Short Answer* Most cells of the human body, such as mature nerve cells and muscle cells, are in what non-dividing phase? This phase occurs when cells exit the cell cycle at the G1 checkpoint.ANSWER: g0 phase

**TOSS UP**

1. PHYSICS *Short Answer* What is the baryon number of an up quark?ANSWER: 1/3

**BONUS**

1. PHYSICS *Short Answer* Calculate the Helmholtz energy of a system at 200K if its internal energy is 10,000 Joules and it has an entropy of 10 Joules/Kelvin.

ANSWER: 8,000 Joules (A = U - TS)

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Which of the following compounds would be least likely to form a precipitant?  
   W) iron (II) iodide

X) iron (III) iodide

Y) silver chloride

Z) aluminum bromide  
ANSWER: X) iron (III) iodide (does not form)

**BONUS**

1. CHEMISTRY *Short Answer* What is the coordination complex which results when aqueous Ag+ reacts with aqueous ammonia?ANSWER: Ag(NH3)2+

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What type of solid-state flow produces a change in the size and shape of an object without fracturing it? Deformation of a rock through this process is heavily aided by high temperatures and confining pressures.ANSWER: ductile deofrmation

**BONUS**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following rocks would be MOST susceptible to ductile deformation based on their composition and texture?W) shale

X) schist

Y) granite

Z) basaltANSWER: W) shale

**TOSS UP**

1. MATH *Multiple Choice* Which of the following is not a solution of if x is greater than or equal to 0 degrees and less than 360 degrees?

W) 75°  
X) 105°

Y) 235°

Z) 315°  
ANSWER: Y) 235°

**BONUS**

1. MATH *Short Answer* Evaluate cos 105 degrees, giving an exact answer using the trigonometric sum and difference identities. ANSWER: (cos 45°cos60°-sin45°sin60°)

**TOSS UP**

1. ENERGY *Multiple Choice* Which of the following countries is NOT a member of the Organization of Petroleum Exporting Countries, or OPEC as of 2011?W) the United Arab Emirates

X) Algeria

Y) Venezuela

Z) IndonesiaANSWER: Z) indonesia (it withdrew in 2008)

**BONUS**

1. ENERGY *Short Answer* As of 2011, how many member states is OPEC constituted of?ANSWER: twelve

**TOSS UP**

1. BIOLOGY *Short Answer* Hydrolysis of what molecule provides energy for the assembly of amino acid chains during elongation?   
     
   ANSWER: Gtp

**BONUS**

1. BIOLOGY *Short Answer* Using the terms P site, A site, and E site as a word bank, at which site is tRNA released from the ribosome?ANSWER: e site

**TOSS UP**

1. PHYSICS *Short Answer* Which of the following flavors of quarks is the most stable?W) up

X) charm

Y) top

Z) strangeANSWER: W) up

**BONUS**

1. PHYSICS *Short Answer* What is the most stable, charged baryon?ANSWER: proton

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Which of the following is NOT true regarding benzene?  
   W) benzene is the first annulene, having the least number of carbon atoms out of all the completely conjugated monocyclic hydrocarbons

X) all monoderivatives of benzene have only one isomer, while all diderivatives of benzene have exactly three

Y) the carbon atoms in benzene are bonded in a continuous pi bond

Z) although it is highly unsaturated, benzene does not readily undergo addition reactions like a typical alkene

ANSWER: W) benzene is the first annulene, having the least number of carbons out of all the completely conjugated monocyclic hydrocarbons

**BONUS**

1. CHEMISTRY *Short Answer* How many sigma and pi bonds are present in a molecule of nitrogen?ANSWER: 1 sigma, 2 pi

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* In contrast to hard stabilization, which involves the construction of permanent structures, this type of non-permanent shoreline stabilization involves the addition of large quantities of sand to build up the beach, improving beach quality and storm protection, albeit temporarily and at a huge monetary cost.ANSWER: beach nourishment

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* One type of hard stabilization involves the construction of this type of structure built parallel to the shoreline. While the structure's intended purpose is to shelter boats from the force of breaking waves, it also doubles to allow sand to accumulate on the beach behind the structure, causing seaward growth of that portion of the beach. Identify this structure, which sometimes has the unintended consequence of filling the boat anchorage it protects with sand. ANSWER: breakwater

**TOSS UP**

1. MATH *Short Answer* Solve the following equation, given that x is greater than or equal to zero degrees and less than 360 degrees:  
     
   cos x tan x = 1/2  
     
   ANSWER: 30 degrees, 150 degrees

**BONUS**

1. MATH *Short Answer* Solve for all real values of x, giving your answer in radians and in the format x + 2πk or x + πk, where k is an element of the integers

ANSWER: x = π/3 + πk

**TOSS UP**

1. ENERGY *Multiple Choice* Bob the builder is installing a light switch. He needs to hold two of the three wires in his hand, but does not want to be shocked. Assuming that the electrical wiring is compliant with the color coding of the National Electrical Code, with the three colors being white, black, and green, touching which two of the three wires would be the safest?W) white and black

X) white and green

Y) black and green

Z) it is impossible for Bob to be safe, as all of the wires are liveANSWER: X) white and green

**BONUS**

1. ENERGY *Multiple Choice* Which of the following could NOT be a possible color for a phase or "hot" wire in a circuit based on the National Electrical Code?W) black

X) red

Y) gray

Z) orangeANSWER: Y) gray

**TOSS UP**

1. BIOLOGY *Short Answer* Plants adapted to deserts and other regions with little moisture are known as what? Examples include stone plants and cacti.  
     
   ANSWER: xerophytes

**BONUS**

1. BIOLOGY *Short Answer* Order the following five sections of a tree trunk from outermost to innermost: sapwood, vascular cambium, heartwood, secondary phloem, peridermANSWER: periderm, secondary phloem, vascular cambium, sapwood, heartwood

**TOSS UP**

1. PHYSICS *Short Answer* What term is given to an ideal surface which both absorbs all wavelengths of electromagnetic radiations incident upon it and also is the best possible emitter of radiation at any wavelength?ANSWER: blackbody

**BONUS**

1. PHYSICS *Short Answer* What is the velocity of an object in terms of Planck's Constant and m/s if its de Broglie wavelength is 10 cm and its mass is 1 gram? ANSWER: 0.0001/h m/s

**TOSS UP**

1. CHEMISTRY *Short Answer* What process involves continuous redistillation to separate mixtures of liquids with similar boiling points into their component parts; it is commonly used in petroleum refineries to separate crude oil into different petroleum products.   
     
   ANSWER: fractional distillation

**BONUS**

1. CHEMISTRY *Multiple Choice* Which of the following petroleum products would be found highest in a fractionating column when separating crude oil?W) gasoline

X) kerosene

Y) fuel oil

Z) asphaltANSWER: W) gasoline

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* Using the terms cirrus, cumulus, and stratus, identify which form of cloud would form continuous sheets or layer which cover much if not all of the sky.ANSWER: stratus

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What type of high, thin, generally uniform cloud is capable of forming halos and moon halos? ANSWER: cirrostratus

**TOSS UP**

1. MATH *Short Answer* Solve if theta is greater than or equal to zero and less than 2 pi  
     
   ANSWER: 0, 2π/3, 4π/3

**BONUS**

1. MATH *Short Answer* What is sec(x-y) if csc x = 5/3 and tan y = 12/5? Give your answer as a fraction in simplest terms.ANSWER: 65/56

**TOSS UP**

1. ENERGY *Multiple Choice* Crude oil that is said to be "sweet" has a low content of which of the following elements?W) sulfur

X) nitrogen

Y) hydrogen

Z) carbonANSWER: W) sulfur

**BONUS**

1. ENERGY *Multiple Choice* Which of the following is the closest to the average national price of a gallon of gasoline in the United States in the first week of April 2012?W) $3.00

X) $3.45

Y) $3.90

Z) $4.15ANSWER: Y) $3.90

**TOSS UP**

1. PHYSICS *Short Answer* What experiment performed in the 19th century by Michael Faraday was an experimental test of Gauss's Law and involved lowering a charged ball into a metal ice pail, allowing it to touch the pail, and removing it to find that the ball had lost all its charge?  
     
   ANSWER: faraday's ice-pail experiment

**BONUS**

1. PHYSICS *Short Answer* A point charge Q is placed at the center of a sphere with radius r. The total electric flux passing through the surface of the sphere is given by phi (pronounced fee). If the same charge is taken out of the sphere and placed in a larger sphere with radius 2r, by what factor will the electric flux, phi, passing through the surface of the larger sphere change? ANSWER: 1 (total electric flux is independent of a sphere's radius)