**TOSS UP**

1. BIOLOGY *Short Answer* Name the group of organisms, of phylum Petromyzontida, which represent the oldest living lineage of vertebrates.   
     
   ANSWER: LAMPREYS

**BONUS**

1. BIOLOGY *Short Answer* Denote by name or number all of the 3 statements which is or are true of chondrichthyans.   
   1. The restricted distribution of bone in the chondrichthyan body is a derived condition, emerging after chondrichthyans diverged from other gnathostomes.  
   2. Sharks have a pair of regions in the skin of their head that can detect electric fields generated by the muscle contractions of nearby animals.  
   3. The majority of shark species are viviparous. ANSWER: 1 and 2

**TOSS UP**

1. PHYSICS *Short Answer* A train with a 500 Hz siren on is moving at a constant speed of 8 m/s in a straight line. An observer is in front of the train and off its line of motion. What is a possible frequency of the siren that the observer hears? Take the speed of found to be 340 m/s, and give your answer as a whole number. ANSWER: 490 Hz – 510 Hz

**BONUS**

1. PHYSICS *Short Answer* Denote by name or number all of the following 4 statements which are true of polarization.  
   1. The transmitted intensity, I, of the electromagnetic wave, is inversely proportional to the square of the electric field.   
   2. The Brewster angle is the angle of incidence at which the reflected ray is 100% polarized along a plane parallel to the reflecting surface.   
   3. If a substance can rotate the plane of polarization, it is said to be optically active.   
   4. An electromagnetic wave is said to be plane polarized if the electric field always lies in the same plane, as the wave propagates. ANSWER: 2, 3 and 4

**TOSS UP**

1. CHEMISTRY *Multiple Choice* When 1000 mL of 100% methanol is mixed with 1000 mL of water, less than 1950 mL of liquid results. This is most likely due to:  
   W) Evaporation of some of both of the liquids prior to mixing  
   X) Evaporation of the solution after mixing, a process which increases the temperature of the solution  
   Y) Cooling of the solution due to mixing, resulting in a denser solution with less volume  
   Z) Adjustment of the hydrogen bonding of the liquids, resulting in a denser solution and hence, a smaller volume  
     
   ANSWER: Z) ADJUSTMENT, ETC.

**BONUS**

1. CHEMISTRY *Multiple Choice* Why is the oxygen-hydrogen absorption of CH3OH such a broad band in the IR reading?  
   W) Rotational energy levels broaden the absorption.  
   X) Hydrogen bonding broadens the absorption.  
   Y) Resonance broadens the absorption.  
   Z) Hyperconjugation resonance broadens the absorption.ANSWER: X) HYDROGEN BONDING LEVELS BROADEN THE SPECTRUM

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* When an electrical conductor rotates and is stirred by convection, it can convert some of the energy flowing outward as convection into a magnetic field. What is the name of this process?ANSWER: dynamo effect

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What is the name of the locations in the H–R diagram in which protostars have become detectable at visible wavelengths because their cocoons have disappeared?ANSWER: birth line

**TOSS UP**

1. MATH *Multiple Choice* A figure skater competing at a local competition needs a mean of 5.8 (out of a total 6.0) to win the first-place medal. If there are three judges and one of them gives her a 5.5, what is the lowest score she can get from the remaining two judges if she still wants to finish first?  
   W) 4.9  
   X) 5.8  
   Y) 5.9  
   Z) 6.0  
   ANSWER: Y) 5.9

**BONUS**

1. MATH *Short Answer* Denote by name or number all of the following 3 sets of integers which are Pythagorean triples: (5, 12, 13), (6, 8, 10), (7, 20, 23)ANSWER: 1 and 2

**TOSS UP**

1. ENERGY *Short Answer* What is the name of the odorant added to propane to serve as a warning agent for escaping gas?ANSWER: Mercaptan

**BONUS**

1. ENERGY *Multiple Choice* Which of the following statements is false of photovoltaic cells?
2. N-type silicon is doped with phosphorus.
3. Phosphorus gives the silicon a positive character, and the tendency to attract electrons.
4. P-type silicon is doped with boron.
5. Boron gives the silicon a positive character, and the tendency to attract electrons.

ANSWER: X) phosphorus gives the silicon a positive character, and the tendency to attract electrons.

**TOSS UP**

1. BIOLOGY *Short Answer* What is the name of the zipper-like protein structure which physically connects replicated homologs during synapsis?  
     
   ANSWER: SYNAPTONEMAL COMPLEX

**BONUS**

1. BIOLOGY *Short Answer* Denote by name or number all of the following 3 statements which is or are true of gene regulation.  
   1. Tryptophan functions in the *trp* operon as a repressor.  
   2. The *lac* operon is an inducible operon.   
   3. The catabolite activator protein in the *lac* operon stimulates negative gene regulation.ANSWER: 2 only

**TOSS UP**

1. PHYSICS *Short Answer* What are the root mean square quantities of the current and voltage of a generator with alternating current if its peak voltage is 40 V and its peak current is 2.5 A? Give your answers to the nearest whole number. ANSWER: 28 V, 2 A

**BONUS**

1. PHYSICS *Short Answer* The square of the absolute value of an electron’s wave function can be used to find what quantity related to that electron?ANSWER: the probablility that the electron will be found near position x at time t.

**TOSS UP**

1. CHEMISTRY *Short Answer* The Haber process is a common mechanism for creating ammonia from nitrogen and hydrogen gas. The reaction is as follows: N2(g) + 3H2(g) --> 2NH3(g) + heat. There is large closed vat in which the Haber process occurs. In which direction would the reaction shift if the vat were to mechanically and instantly decrease in size, all else remaining constant?  
     
   ANSWER: RIGHT

**BONUS**

1. CHEMISTRY *Multiple Choice* Which of the following alkyl halides would be expected to most like to go through an SN2 reaction?  
   W) CH3CH2Cl  
   X) CH3CH2F  
   Y) CH3CH2I  
   Z) CH3CH2BrANSWER: y) ch3ch2i

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* Many permeable aquifers, typically sandstones, are bounded above and below by low-permeability beds, such as shales. What are the names of these relatively impermeable beds?ANSWER: aquicludes

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What are the old and stable parts of the continental lithosphere, which often survived cycles of merging and rifting of continents, and are generally found in the interiors of tectonic plates?ANSWER: cratons

**TOSS UP**

1. MATH *Short Answer* In the geometric series, *gn*, where g1 is 3 and g3 is ¾, what is g10?  
     
   ANSWER: 3/512

**BONUS**

1. MATH *Short Answer* A region is bounded between the graphs of y = -1 and y = f(x) for x between -1 and 0, and between the graphs of y = 1 and y = f(x) for x between 0 and 1. Give the integral that corresponds to the area of this region.ANSWER:

**TOSS UP**

1. ENERGY *Short Answer* In the Uranium Fuel Cycle, yellowcake Uranium is converted into what gas, which is then shipped to a gaseous diffusion plant for enrichment?ANSWER: uranium hexafluoride

**BONUS**

1. ENERGY *Short Answer* Put the following steps of the Uranium Fuel Cycle in order from earliest to latest: Conversion, Milling, Reprocessing, Mining, Fuel Fabrication, Nuclear Reactor, Used Fuel Storage, EnrichmentANSWER: Mining, milling, conversion, enrichment, fuel fabrication, nuclear reactor, used fuel storage, reprocessing

**TOSS UP**

1. BIOLOGY *Short Answer* What is the name of the phenomenon by which evolutionary changes in the timing or rate of developmental events leads to striking evolutionary transformations in an organism?  
     
   ANSWER: heterochrony

**BONUS**

1. BIOLOGY *Short Answer* Ascomycetes reproduce asexually by producing enormous numbers of asexual spores, produced externally at the tips of specialized hyphae. What are the names of these hyphae?ANSWER: CONIDIOPHORES

**TOSS UP**

1. PHYSICS *Short Answer* The equations x’=x-vt and t’=t represent what mathematical conversion, used between two reference frames traveling at speeds much less than the speed of light?ANSWER: GALILEAN TRANSFORMATION

**BONUS**

1. PHYSICS *Short Answer* Denote by name or number all of the following 4 tests which were used to affirm the theory of general relativity.1. The Shapiro Time Delay Experiment  
   2. The Michelson-Morley Experiment  
   3. Muon Decay Experiments  
   4. The observation that light bends near massive objects. ANSWER: 1 and 4

**TOSS UP**

1. CHEMISTRY *Short Answer* What is the absolute maximum number of nitro groups that can be added to toluene?  
     
   ANSWER: 5

**BONUS**

1. CHEMISTRY *Short Answer* A 2° amine reacts with an aldehyde. What type of molecule is produced?ANSWER: Enamine

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What is the name of the volcanic rock found in underground pipes which is currently the most important source of mined diamonds?ANSWER: kimberlite

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What is the white to cream-colored clay produced by the weathering of feldspar, named for Gaoling, a hill in southwestern China where it was first obtained?ANSWER: kaolinite

**TOSS UP**

1. MATH *Short Answer* Give f(g(1)) given that f(x)=2x+2, and g(x)= -x/(2+x^2).  
     
   ANSWER: 4/3

**BONUS**

1. MATH *Short Answer* Give the value of x where the function f(x)= x^3 – 9x^2 +24x+4 has a local maximum. ANSWER: x=2

**TOSS UP**

1. ENERGY *Short Answer* What is the name of the Generation 3 nuclear reactor which recently received approval from the US Nuclear Regulatory Committee to build 3 new reactors in the US?ANSWER: AP1000

**BONUS**

1. ENERGY *Short Answer* What is the name of the process by which most hydrogen is produced today, in which high-temperature steam separates hydrogen from the carbon atoms in methane?ANSWER: STEAM REFORMING

**TOSS UP**

1. BIOLOGY *Short Answer* What are the two main variables which affect water potential?  
     
   ANSWER: solute potential and pressure potential

**BONUS**

1. BIOLOGY *Short Answer* Classify each of the following fruits as either simple, aggregate, multiple, or accessory: Cranberry, Strawberry, Pineapple, AppleANSWER: Simple, aggregate, multiple, Accessory

**TOSS UP**

1. PHYSICS *Multiple Choice* A positive charge moves in the positive x direction in a magnetic field pointing in the negative y direction. What is the direction of the force on the object?W) Positive z direction  
   X) Negative z direction  
   Y) Clockwise around the direction of motion  
   Z) Counterclockwise around the direction of motionANSWER: x) negative z direction

**BONUS**

1. PHYSICS *Short Answer* A charge of 3 C moves at 10 m/s through a magnetic field of 10 T. What is the maximum force it can experience assuming varied angles of passage through the magnetic field?ANSWER: 300 N (f=qvbsintheta)

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Which of the following elements would you expect to have the highest third ionization energy?  
   W) Magnesium  
   X) Aluminum  
   Y) Phosphorus  
   Z) Argon  
     
   ANSWER: w) magnesium

**BONUS**

1. CHEMISTRY *Short Answer* Fill in the blank in the following reaction: Na2S2O5 + \_\_\_\_\_\_\_ → 2NaOH + 2SO2ANSWER: H20

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What type of wind, best developed where large temperature differences exist between land and water, occurs due to the warm air rising over land, and cold air sinking over the water?ANSWER: sea breeze

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What phenomenon associated with upper atmosphere lightning is an enormous, blue electrical discharge found near the tops of thunderstorms?ANSWER: blue jets

**TOSS UP**

1. MATH *Short Answer* The position of a particle moving along the x-axis at time t is given by x(t)=(sin(4~t))^2. At which of the following values of t will the particle change direction? 1) t=1/6, 2) t=1, 3) t=2  
     
   ANSWER: 2 and 3

**BONUS**

1. MATH *Short Answer* Determine the y-intercept of the tangent line to the curve of the function, f(x) = sqrt(x^2 + 33) at x=4? Give your answer as a fraction. ANSWER: 33/7

**TOSS UP**

1. ENERGY *Short Answer* What is the term used to describe the electricity that utilities have to generate all the time to meet the basic needs of a city?ANSWER: base load power

**BONUS**

1. ENERGY *Short Answer* What type of renewable energy source is described in the following passage: The energy from the sun heats the surface water of the ocean. In tropical regions, the surface water can be 40 or more degrees warmer than the deep water. This difference can be used to produce electricity.ANSWER: Ocean thermal energy conversion

**TOSS UP**

1. BIOLOGY *Short Answer* What class of glial cells protects the nervous system from invading microorganisms?  
     
   ANSWER: microglia

**BONUS**

1. BIOLOGY *Short Answer* What is the structure, found on the basilar membrane, which contains the mechanoreceptors of the ear, the hair cells?ANSWER: organ of cORTI