**TOSS UP**

1. BIOLOGY *Short Answer* What transparent, gelatinous fluid is secreted from the ciliary epithelium and fills the space between the lens and the cornea in the eye?  
     
   ANSWER: aqueous humor

**BONUS**

1. BIOLOGY *Short Answer* This steroid hormone produced by the adrenal cortex causes the conservation of sodium, secretion of potassium, and increased water retention, for the purpose of increasing blood volume and therefore pressure. Name this hormone, which is part of the RAS and acts in the opposite function of atrial natriuretic hormone. ANSWER: aldosterone

**TOSS UP**

1. PHYSICS *Multiple Choice* Sunlight that has been reflected off the surface of a pond at the polarizing angle is polarizedW) parallel to the surface of the water

X) perpendicular to the surface of the water

Y) at an angle between 0 and 90 degrees normal to the surface of the water

Z) at an angle dependent on the angle of incidenceANSWER: W) parallel to the surface of the water

**BONUS**

1. PHYSICS *Multiple Choice* A ray of light oriented along the normal axis passes from a medium with greater index of refraction to one with a smaller index of refraction. After passing through the boundary into the medium with smaller index of refraction, the rayW) bends towards the normal

X) bends away from the normal

Y) does not bend relative to the normal

Z) is reflected at 90 degreesANSWER: Y) does not bend relative to the normal

**TOSS UP**

1. CHEMISTRY *Short Answer* How many points of inflection will the titration curve of phosphorous acid have?  
     
   ANSWER: TWO

**BONUS**

1. CHEMISTRY *Multiple Choice* Which of the following indicators would be appropriate for use in a strong-acid weak-base titration?W) phenol red

X) methyl orange

Y) bromothymol blue

Z) litmusANSWER: X) methyl orange

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What form of sandstone contains at least 25% feldspar, with quartz being the dominant mineral component? It is commonly formed from the weathering of feldspar-rich granitic rock. ANSWER: ARKOSE

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What principle of geology states that sediments are deposited under the influence of gravity as nearly horizontal beds? By this statement, folded or faulted strata have been deformed after the deposition of sediments.ANSWER: principle of original horizontality

**TOSS UP**

1. MATH *Short Answer* What function is defined as e to the x minus e to the negative x all over 2 and is the derivative of hyperbolic cosine?  
     
   ANSWER: hyperbolic sine

**BONUS**

1. MATH *Short Answer* Find the indefinite integral of hyperbolic cosine of the quantity 2x closed quantity times hyperbolic sine squared of the quantity 2x dxANSWER: hyperbolic sine to the third times two x over 6 plus C

**TOSS UP**

1. ENERGY *Multiple Choice* The Otto cycle uses which thermodynamic process during both its heat addition and rejection strokes?W) isobaric

X) isochoric

Y) isentropic

Z) isothermalANSWER: X) isochoric

**BONUS**

1. ENERGY *Short Answer* Which of the following processes in the Otto cycle is considered the power stroke of the engine?W) isochoric heat rejection from the air

X) isochoric heat transfer to the air from an external source

Y) isentropic compression of the air

Z) isentropic expansion of the airANSWER: Z) isentropic expansion of the air

**TOSS UP**

1. BIOLOGY *Short Answer* By name or number, identify all of the following 4 vitamins that are fat soluble  
   1. vitamin A

2. folic acid

3. Vitamin B2

4. Vitamin K  
ANSWER: 1 and 4

**BONUS**

1. BIOLOGY *Short Answer* What B vitamin is also known as pantothenoic acid and is required for the synthesis of coenzyme A as well as for the synthesis and metabolization of proteins, carbohydrates, and fats? Small quantities are found in nearly every food, with high amounts in whole grains, legumes, eggs, and meat. ANSWER: vitamin b5

**TOSS UP**

1. PHYSICS *Multiple Choice* A wave is circularly polarized in the x direction when its y and z components have the same magnitude are out of phase byW) 45 degrees

X) 90 degrees

Y) 180 degrees

Z) 360 degreesANSWER: X) 90 degrees

**BONUS**

1. PHYSICS *Short Answer* What form of polarization occurs when the two component waves are at right angles to each other, but are not a quarter-cycle out of phase, or have two different amplitudesANSWER: elliptical polarization

**TOSS UP**

1. CHEMISTRY *Short Answer* Which of the following gases behaves the least like an ideal gas?  
   W) helium

X) neon

Y) argon

Z) krypton  
ANSWER: Z) krypton

**BONUS**

1. CHEMISTRY *Multiple Choice* Which of the following atoms would release the largest amount of energy upon gaining an electron?W) sodium

X) magnesium

Y) chlorine

Z) iodineANSWER: Y) chlorine

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What term is given to planetary-mass objects that directly orbit the sun and are spherical due to gravitation, but have been unable to clear their orbital region of other objects?ANSWER: dwarf planet

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What term is given to minor planets or moons that share orbits with a planet or larger moon due to their positions at the stable Lagrangian points L4 and L5?ANSWER: trojans

**TOSS UP**

1. MATH *Short Answer* This solution was found by Huygens in 1959 who proved geometrically that this curve was a cycloid. What the curve for which the time taken for an object to slide frictionlessly in uniform gravity to its lowest point is independent of starting height?  
     
   ANSWER: tautochrone curve

**BONUS**

1. MATH *Short Answer* Taking the acceleration due to gravity as 10 m/s squared, find the time needed for an object to slide frictionlessly down a tautochrone curve whose radius is 4 meters with an initial starting height of 3 meters. Leave your answer as a simplified fraction in terms of pi.ANSWER: pi / 5

**TOSS UP**

1. ENERGY *Short Answer* What device, commonly used in automobiles catalyzes carbon monoxide, unburned hydrocarbons, and oxides of nitrogen to CI2, water vapor, and nitrogen in order to reduce toxic byproducts of fuel combustion?ANSWER: catalytIc converter

**BONUS**

1. ENERGY *Short Answer* In a Lindlar catalyst, salts of what metal are used to poison the palladium sites in order to reduce the hydrogen content in the bulk of palladium?ANSWER: lead

**TOSS UP**

1. BIOLOGY *Short Answer* Generally, sexual reproduction between hyphae in fungi begins when two mycelia release sexual signaling molecules known as what? These molecules will bind to receptors on the other if the fungi are of different mating types, and the hyphae will extend towards the source of these molecules.  
     
   ANSWER: pheromones

**BONUS**

1. BIOLOGY *Short Answer* What stage in the fungal life cycle lies between plasmogamy and meiosis, during which haploid nuclei contributed by the two parents fuse, producing diploid cells? In addition, zygotes and other transient structures form during this stage.ANSWER: karyogamy

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following statements regarding the formation of images by plane mirrors is true?W) plane mirrors produce magnified images

X) plane mirrors produce images that are a greater distance from the mirror than the object

Y) plane mirrors produce images that show front-black reversal

Z) plane mirrors produce images that are invertedANSWER: Y) plane mirrors produce images that show front-black reversal

**BONUS**

1. PHYSICS *Short Answer* Find the object distance from the vertex of a concave mirror that has a radius of curvature of 2 meters if a real image is formed at 1.5 metersANSWER: 3 meters

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Which of the following ions would be expected to act as the weakest Bronsted-Lowry base in water?  
   W) HSO4 -

X) H2PO4 -

Y) CH3COO-

Z) CH3CH(OH)COO-

ANSWER: W) HSO4 -

**BONUS**

1. CHEMISTRY *Short Answer* What group of molecules, have positive and negative electrical charges at different locations which cancel each other out to contribute to an overall neutral charge? One of the best-known examples of these molecules are amino acids. ANSWER: zwitterion

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What extinction event, occurring 252.28 million years ago, was the Earth's most severe known extinction event, with up to 96% aof marine species and 70% of terrestrial vertebrates becoming extinct?ANSWER: great dying or permian-triassic extinction event

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* The Great Dying marked the boundary between what two geological eras?ANSWER: paleozoic and mesosoic

**TOSS UP**

1. MATH *Short Answer* What is the indefinite integral of the square root of open quantity 2x minus 1 closed quantity?  
     
   ANSWER: 1/3(2x-1)^3/2 + c

**BONUS**

1. MATH *Short Answer* Integrate the function x times the square root of the quantity 2x - 1 closed quantity. ANSWER: 1/10(2x-1)^5/2 + 1/6(2x-1)^3/2 + c

**TOSS UP**

1. ENERGY *Short Answer* What international environmental treaty adopted 11 December 1997 set binding obligations on industrialized countries to reduce emissions of greenhouse gases, with the US signing but not ratifying the protocol which is named after the Japanese city it took place inANSWER: kyoto protocol

**BONUS**

1. ENERGY *Short Answer* What international treaty was intended to protect the ozone layer by phasing out numerous substances, most notably CFCs, and has been the most widely ratified treaty in UN history with ratification by 197 states. It is expected that if this protocol is adhered to, the ozone layer is expected to recover by 2050ANSWER: montreal protocol

**TOSS UP**

1. BIOLOGY *Short Answer* This organism lives in both mosquitoes and humans. Name this parasite, which was first seen by Laveran and causes malaria  
     
   ANSWER: plasmodium

**BONUS**

1. BIOLOGY *Short Answer* This process principally uses prokaryotes to remove pollutants from soil, air or water. One example involves the anaerobic bacteria and archaea to decompose the organic matter in sewage into landfill or fertilizer. Name this use of organisms, which include the processes of bioleaching, composting, and phytoremediationANSWER: bioremediation

**TOSS UP**

1. PHYSICS *Multiple Choice* The direction of polarization for an electromagnetic wave is always defined in terms of theW) direction of travel

X) magnetic field

Y) electric field

Z) z-axisANSWER: Y) electric field

**BONUS**

1. PHYSICS *Short Answer* Light from a lightbulb, with maximum intensity of 2 W/meters squared passes through two polarizers. The first polarizer in oriented at an angle of 23 degrees to the right of the vertical, and the second is oriented at an angle of 55 degrees to the right of the vertical. What is the intensity of the light after it passes through the two polarizers, to the nearest decimal and in Watts per meter squared?ANSWER: 1.5 w/m squared

**TOSS UP**

1. CHEMISTRY *Short Answer* What rule formulated by its namesake Russian chemist states that the addition of a binary acid to an alkene produces an alkane with the halide group attaching to the carbon with more alkyl substituents?  
     
   ANSWER: markovnikov's rule

**BONUS**

1. CHEMISTRY *Short Answer* What will the major product when 1-butene is reacted with hydrochloric acid?ANSWER: 2-chlorobutane

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What second-brightest object in the night sky is considered to be Earth's "sister planet" due to similar size, gravity, and bulk composition?ANSWER: venus

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What astronomical period is responsible for the cratering of the lunar maria, which are relatively young and could not have existed during the time of the Heavy bombardmentANSWER: late heavy bombardment

**TOSS UP**

1. MATH *Multiple Choice* Evaluate 4P2 times 5P3  
   W) 12

X) 60

Y) 480

Z) 720  
ANSWER: Z) 720

**BONUS**

1. MATH *Short Answer* A teacher is making a multiple choice quiz. She wishes to give each student the same questions, but have each student's questions appear in a different order. If there are 27 students in the class, what is the least number of questions the quiz must contain?ANSWER: 5

**TOSS UP**

1. ENERGY *Short Answer* What hydroelectric dam spans the Yangtze River in China and is the world's largest power station in terms of installed capacity, providing 22,500 megawatts with 32 main turbines?ANSWER: THREE GORGES DAM

**BONUS**

1. ENERGY *Multiple Choice* By name or number, identify all of the following four statements that are major disadvantages of the construction of the Three Gorges Dam.1. increased erosion downstream

2. loss of aquatic biodiversity

3. reduction of the river's barge capacity

4. increased landslide frequency behind the damANSWER: all but 3

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following statements regarding fluid mechanics is false?  
   W) is an object floats with half of its volume above the surface of a fluid, its density is half that of the fluid's

X) a column of water 10 meters tall exerts a pressure of roughly 1 atmosphere

Y) a column of water 1 meter high exerts more pressure at its base than a column of alcohol 1 meter high

Z) the pressure exerted on a submerged object acts parallel to the surface of that object  
ANSWER: Z) the pressure exerted on a submerged object acts parallel to the surface of that object

**BONUS**

1. PHYSICS *Short Answer* Calculate the total pressure exerted on a diver in a tank of oil if the oil's density 900 kg/meters cubed, the acceleration due to gravity can be approximated as 10 meters/second squared, and the diver is 2 meters below the surface. Give your answer to two significant digits, in scientific notation, and in pascals. ANSWER: 2.8 x 10^5 pascals