**TOSS UP**

1. BIOLOGY *Short Answer* When testing for peptidoglycan, what color will Staphylococcus stain?  
     
   ANSWER: purple

**BONUS**

1. BIOLOGY *Short Answer* When viewed under a microscope, staphlococcus appear asW) grape-like clusters of spheres

X) long chains of connected spheres

Y) singular, isolated spheres

Z) singular, isolated rod shapes

ANSWER: W) grape-like clusters of spheres

**TOSS UP**

1. PHYSICS *Short Answer* A top is set spinning about its center axis in the counterclockwise direction, as viewed from above. In what direction, clockwise or counterclockwise, will it precess as viewed from above?ANSWER: counterclockwise

**BONUS**

1. PHYSICS *Short Answer* A 2 kilogram ball has a potential energy given by the function U(x) = 2x^2 + 3, where x is its displacement. What is the acceleration on the ball when it is at position x = 2 meters?ANSWER: - 4 m/s squared

**TOSS UP**

1. CHEMISTRY *Short Answer* What structural conformation would the molecule cyclohexane adopt in its most stable form?

ANSWER: CHAIR

**BONUS**

1. CHEMISTRY *Multiple Choice* A lindlar catalyst is used to facilitate the hydrogenation of W) alkenes into alkynes

X) alkenes into alkanes

Y) alkynes into alkanes

Z) alkynes into alkenesANSWER: Z) alkynes into alkenes

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What global coupled ocean-atmosphere phenomenon, credited with collapsing the Peruvian anchovy industry in the 1970s results from an anomalously warm countercurrent developing across the equatorial Pacific, thereby affecting climate across the Pacific ocean? ANSWER: EL NINO

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* By name or number, identify all of the following 5 phenomenon that are TRUE regarding the El-Nino southern oscillation1. El Nino results from the formation of a warm countercurrent that brings heat and moisture from the Western Pacific to the Eastern Pacific

2. the northern portions of North America typically experience warmer and drier winters

3. the west coast of South America typically sees a decrease in thunderstorms and an increase in fair weather

4. the counterpart of El Nino is called La Nina and often brings climate conditions opposite to El Nino

5. El Nino accompanies low air surface pressure in the west PacificANSWER: 1, 2, 4

**TOSS UP**

1. MATH *Short Answer* What is the equation of the line tangent to the function f(x) = e^x at the point x = 0?  
     
   ANSWER: x + 1

**BONUS**

1. MATH *Short Answer* Giving your answer as a simplified fraction in terms of e, find the expression for the volume of the solid formed by rotating the area bounded between y = e^x, x=0.5, x=2, and y = 0 360 degrees about the x-axis. ANSWER: e^4 + E / 2

**TOSS UP**

1. ENERGY *Multiple Choice* Which of the following explains why oil and gas companies rarely drill below 10 km in their search for fossil fuels?W) the commercial technology does not yet exist to drill to depths much farther than that

X) below 10 km, organic matter which could be converted into fuel is instead converted into CO2 due to the high temperatures

Y) a large layer of basalt lies below 10 km, making drilling impractical

Z) temperatures and pressure below that depth make drilling boreholes very impractical

ANSWER: X) below 10 km, organic matter which could be converted into fuel is instead converted into CO2 due to the high temperatures

**BONUS**

1. ENERGY *Multiple Choice* In which of the following would you most expect to find substantial deposits of methane clathrates?W) arctic siltstones

X) flood basalts

Y) breccia melange

Z) ophiolite suitesANSWER: W) arctic siltstones

**TOSS UP**

1. BIOLOGY *Short Answer* Deficiency in what vitamin causes the condition known as rickets?  
     
   ANSWER: Vitamin d

**BONUS**

1. BIOLOGY *Short Answer* What growth maneuver in triggered by the release of ethylene, and enables plant shoots to avoid obstacles as they grow upwards?ANSWER: triple response

**TOSS UP**

1. PHYSICS *Multiple Choice* Two forces, A and B act upon an object, with force A having a magnitude of 2 Newtons and the net force having a magnitude of 7 Newtons. Which of the following could NOT be a possible magnitude for force B?W) 5 Newtons

X) 6 Newtons

Y) 7 Newtons

Z) 8 NewtonsANSWER: W) 5 Newtons

**BONUS**

1. PHYSICS *Short Answer* A metal rod with length 2 meters and mass 5 kilograms has a 10 kilogram ball suspended from its left end. How far away from the center of the rod must the rod be suspended such that the entire system is in equilibrium? Give your answer to two decimal places and in meters.ANSWER: 0.33 meters

**TOSS UP**

1. CHEMISTRY *Short Answer* What is the sign of the enthalpy change of a reaction if it is spontaneous at all temperatures?  
     
   ANSWER: negative

**BONUS**

1. CHEMISTRY *Multiple Choice* Which of the following elements would be predicted to have the lowest Gibbs Free Energy of formation at 25 degrees celsius?W) carbon dioxide

X) ammonia

Y) benzene

Z) water (liquid)ANSWER: W) carbon dioxide

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What region in the middle of the North Atlantic Ocean, measuring 1,100 km wide and 3,200 km long is bounded by the currents that form the North Atlantic Gyre? These currents deposit much refuse and many marine plants into this area, giving this area its characteristic name related to seaweed. ANSWER: Sargasso Sea

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* Give the intrusive equivalents of the following four extrusive igneous rocks: 1. rhyolite 2. andesite 3. basalt 4. peridotiteANSWER: 1. grantie 2. diorite 3. gabbro 4. komatite

**TOSS UP**

1. MATH *Short Answer* What is the limit as h approaches 0 of the fraction with numerator cos of the quantity (pi over 2 plus h) minus cos of pi over two and denominator h?  
     
   ANSWER: -1

**BONUS**

1. MATH *Short Answer* What is the slope of the tangent to y to the third times x equals six at (2,1)?ANSWER: -1/6

**TOSS UP**

1. ENERGY *Multiple Choice* The fissile isotope most responsible for the energy generated in commercial nuclear power plants isW) plutonium 239

X) uranium 238

Y) uranium 235

Z) uranium 233

ANSWER: Y) uranium 235

**BONUS**

1. ENERGY *Short Answer* Which of the following decays directly through beta minus decay into plutonium 239, a process which is utilized in the production of weapons-grade plutonium?W) plutonium 240

X) neptunium 239

Y) uranium 239

Z) uranium 238ANSWER: X) neptunium 239

**TOSS UP**

1. BIOLOGY *Short Answer* What major DNA replication enzyme in the replisome serves to re-anneal the semi-conservative strands and join Okazaki Fragments of the lagging strand?  
     
   ANSWER: DNA LIGASE

**BONUS**

1. BIOLOGY *Short Answer* Match the following four DNA replication enzymes in the order from first to last that they would be encountered by a strand of DNA being replicated? DNA primase, topoisomerase, DNA helicase, DNA ligaseANSWER: topoisomerase, DNA helicase, dna primase, dna ligase, (2, 3, 4, 1)

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following statements best explains why water forms a regular meniscus when placed in a glass tube, but forms an inverted meniscus when placed in a tube coated with Teflon?W) the cohesive forces between the water and glass are greater than those between the water and Teflon

X) the cohesive forces between the water and glass are less than those between the water and Teflon

Y) the adhesive forces between the water and glass are greater than those between the water and Teflon

Z) the adhesive forces between the water and glass are less than those between the water and Teflon

ANSWER: Y) the adhesive forces between the water and glass are greater than those between the water and Teflon

**BONUS**

1. PHYSICS *Multiple Choice* An ideal fluid flows through section A of a pipe, then through section B. It is found that its velocity through A is greater than its velocity through B. In addition, section A is at a higher height than section B. Which of the following statements is true regarding the pressure of the fluid?W) the pressure is higher at section A

X) the pressure is higher at section B

Y) the pressure is the same in both sections

Z) there is not enough information to determine the pressure difference

ANSWER: X) the pressure is higher at section B

**TOSS UP**

1. CHEMISTRY *Short Answer* What rule formulated in 1931 and named after its proposer, has four criterion which can all be used to determine if a molecule will have aromatic properties?  
     
   ANSWER: huckel's rule

**BONUS**

1. CHEMISTRY *Multiple Choice* Which of the following is NOT one of the four criteria for aromaticity as stated by Huckel's rule?W) the molecule is cyclic

X) the molecule is planar

Y) the molecule is fully conjugated

Z) the molecule has 4n pi electrons, where n is any non negative integer

ANSWER: Z) the molecule has 4n pi electrons, where n is any non negative integer

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* If the critical density of the universe if estimated to be approximately 5 atoms per cubic meter and the observed average density of baryonic matter is 0.2 atoms per cubic meter, then from solely this information one would conclude that, based on the density parameter, the universe is  
   W) open

X) flat

Y) closed

Z) sphericalANSWER: Y) closed

**BONUS**

1. EARTH AND SPACE SCIENCE *Multiple Choice* If dark energy is described by phantom dark energy, an extreme form of quintessence, then the ultimate fate of the universe will most likely be that of aW) Big Freeze

X) Big Rip

Y) Big Crunch

Z) Big BounceANSWER: X) Big Rip

**TOSS UP**

1. MATH *Short Answer* Each day, a toad climbs 3 feet up the wall of a 50 foot well, then slides down a foot at night. If it starts at the bottom of the well, how many days does it take to reach the top?  
     
   ANSWER: 25

**BONUS**

1. MATH *Short Answer* John can do one job in 4 minutes. James can do the same job in 2 minutes. If John starts working by himself, and James joins in and helps after 1 minute of John working alone, how long does James have to help him until the job is completed? Assume both work at a steady rate, give your answer to the nearest minute. ANSWER: 1 minute

**TOSS UP**

1. ENERGY *Short Answer* What distillation process, commonly utilized in petroleum refineries and petrochemical plants to separate mixtures into their component parts, is used when the component parts of a mixture boil at less than 25 degrees Celsius from each other under standard pressure, and typically involves large columns into which feed is continuously added and products removed?ANSWER: continuous fractional distillation

**BONUS**

1. ENERGY *Short Answer* Order the following four fractions of crude oil by the fraction that boils at the lowest temperature to the fraction that boils at the highest temperature: gasoline, kerosene, asphalt, dieselANSWER: asphalt, diesel, kerosene, gasoline

**TOSS UP**

1. BIOLOGY *Multiple Choice* Which of the following statements of genetic drift is NOT TRUE?  
   W) it can cause allele frequencies to change at random

X) it can lead to a loss of genetic variation within populations

Y) it can cause harmful alleles to become fixed

Z) it is more significant in larger populations than smaller ones  
ANSWER: Z) it is more significant in larger populations than smaller ones

**BONUS**

1. BIOLOGY *Short Answer* A very large population of voles in Hardy-Wineberg equilibrium exists, where there are two fur colors: black and brown. Black fur color is completely dominant over brown. If the frequency of the black allele is if 0.8, and that of the brown is 0.2, what is the probability that two heterozygous voles will mate and produce a brown vole baby? Give your answer to three decimal places.ANSWER: 0.064

**TOSS UP**

1. PHYSICS *Short Answer* Two sprockets on a bike are connected by a chain that does not slip. The first sprocket rotates with an angular speed of 1 rad/s and has a radius of 0.2 m. What is the tangential velocity of the second sprocket, if it has a radius of 0.1 m?ANSWER: 0.2 m/s

**BONUS**

1. PHYSICS *Short Answer* A primitive yo-yo is made by wrapping a string around a solid cylinder with mass M and radius R. One end of the string is held stationary while the yo-yo is released, and the string unwinds but does not slip or stretch and the cylinder drops and rotates. Using conservation of energy, derive an expression for the velocity of the yo-yo in terms of h, the distance the yo-yo has dropped, and g, the acceleration due to gravity. ANSWER: sqrt (4/3gh)

**TOSS UP**

1. CHEMISTRY *Short Answer* By name or number, identify all of the following 4 changes which would increase the work done by a reversible, isothermal expansion of an ideal gas  
   1. increasing the change in volume

2. increasing the temperature of the gas

3. increasing the number of moles of the gas

4. increasing the pressure of the force opposing expansion  
ANSWER: all of them

**BONUS**

1. CHEMISTRY *Short Answer* Given that the molar constant-volume heat capacity of argon is 12.8 J/mol K, find the molar constant-pressure heat capacity, to one decimal place. ANSWER: 21.1 J/mol Kelvin

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* The volcanoes on the islands of Java and Indonesia occur due to which of the following plate tectonic settings?W) ocean-ocean convergence

X) ocean-continent convergence

Y) hot spot

Z) spreading centerANSWER: W) ocean-ocean convergence

**BONUS**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following astronomical tables predicts the position of the planets based on the Ptolemic model, with the earth at the center of the universe?W) Alfonsine

X) Prutenic

Y) Rudolphine

Z) Keplerian ANSWER: W) Alfonsine

**TOSS UP**

1. MATH *Short Answer* Triangle ABC, with coordinates A: (2,1) B: (4,1) and C: (3,3) is rotated 270 counterclockwise about the origin. What are the new coordinates of the triangle?  
     
   ANSWER: A: (-1, 2) B: (-1, 4) C: (-3, 3)

**BONUS**

1. MATH *Short Answer* Karthik is taking a multiple-choice exam of 10 questions. Each of the questions has five possible answer choices, with four wrong ones and one right one. If Karthik knows the correct answer, he will pick it, otherwise he picks randomly. If Karthik knows the answer to 70% of the questions, what is the probability he will answer any randomly selected questions correctly? Give you answer as a decimal to two places.ANSWER: 0.76

**TOSS UP**

1. ENERGY *Short Answer* What phenomenon is utilized in thermoelectric generators that convert temperature differences directly into electrical energy and is observed when the junctions of two dissimilar metals are at different temperatures, producing a current that flows through the metals?ANSWER: seebeck effect

**BONUS**

1. ENERGY *Multiple Choice* The decay of which of the following elements provides the primary power by which the Curiosity rover's thermoelectric generator runs?W) lead 208

X) polonium 210

Y) thorium 232

Z) plutonium 238

ANSWER: Z) plutonium 238

**TOSS UP**

1. PHYSICS *Short Answer* A horizontal line on a PV diagram represents what kind of process?

ANSWER: isobaric

**BONUS**

1. PHYSICS *Short Answer* On a PV diagram, which of the following is true regarding an adiabatic and isothermal process?W) both processes are decreasing, the adiabatic is decreasing faster than the isothermal

X) both processes are decreasing, the isothermal is decreasing faster than the adiabatic

Y) the adiabatic is increasing, the isothermal is decreasing

Z) the adiabatic is decreasing, the isothermal is decreasing

ANSWER: W) both processes are decreasing, the adiabatic is decreasing faster than the isothermal