**TOSS UP**

1. BIOLOGY *Multiple Choice* The bacterial equivalent of sexual reproduction is known as  
   W) conjugation

X) transduction

Y) transformation

Z) transfection  
ANSWER: W) conjugation

**BONUS**

1. BIOLOGY *Short Answer* Bacteriophages are properly classified as W) bacteria

X) viruses

Y) prions

Z) fungiANSWER: X) viruses

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following branches of optics deals with the representation of light propagation as straight rays W) physical

X) geometrical

Y) analytical

Z) appliedANSWER: X) geometrical

**BONUS**

1. PHYSICS *Multiple Choice* You are at the edge of a clear pond and observe a fish swimming in the water in front of you. You pull out your laser pointer to provoke your cat, who is next to you, to pounce on the fish. To hit the fish with your laser, you should aimW) above the position of the fish as you see it

X) at the position of the fish as you see it

Y) below the position of the fish as you see it

Z) to the left of the position of the fish as you see itANSWER: X) at the position of the fish as you see it

**TOSS UP**

1. CHEMISTRY *Short Answer* You prepare 50-50 by molecules mixture of water and ethanol at room temperature. If the vapor pressure of water is 24 torr and that of ethanol is 45 torr at 25 degrees celsius, then what is the vapor pressure of the combined mixture in torr. Give your answer to three significant digits.  
     
   ANSWER: 36.5 torr

**BONUS**

1. CHEMISTRY *Multiple Choice* You prepare a mixture of isohexane, n hexane, and n heptane, all in equal mole fractions in a sealed container. After waiting a while so that the system can go to equilibrium, which of the following statements is true?W) isohexane is found in the greatest proportion in the vapor

X) n heptane is found in the greatest proportion in the vapor

Y) n hexane is found in the greatest proportion in the liquid

Z) isohexane is found in the greatest proportion in the liquidANSWER: W) isohexane is found in the greatest proportion in the vapor

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following is the time it takes for the Earth to complete one revolution of its orbit, as measured against a fixed reference frame such as the background stars?W) sidereal year

X) syndotic year

Y) tropical year

Z) draconic yearANSWER: W) sidereal year

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* Order the following four constellations in chronological order of the sun passing through them, starting on January 1st1. capricorn

2. cancer

3. gemini

4. scorpioANSWER: 1 3 2 4

**TOSS UP**

1. MATH *Short Answer* Evaluate the indefinite integral of x times e to the x squared dx  
     
   ANSWER: 1/2 e^x^2 + c

**BONUS**

1. MATH *Multiple Choice* If f-(x) = -f(x), and f(1) = 1, then f(x)could be W) 1/2e^(-2x + 2)

X) e^(1-x)

Y) e^-x

Z) -e^xANSWER: Y) e^-x

**TOSS UP**

1. ENERGY *Multiple Choice* Click here to enter text.ANSWER: Click here to enter text.

**BONUS**

1. ENERGY *Short Answer* Click here to enter text.ANSWER: Click here to enter text.

**TOSS UP**

1. BIOLOGY *Short Answer* Plant growth is sustained by the activity of what localized regions of cell division found at the tips of shoots and roots?  
     
   ANSWER: apical meristem

**BONUS**

1. BIOLOGY *Multiple Choice* Which of the following plant groups are the most closely relatedW) gymnosperms and angiosperms

X) hornworts and pterophytes

Y) angiosperms and lycophytes

Z) pterophytes and hornwortsANSWER: W) gymnosperms and angiosperms

**TOSS UP**

1. PHYSICS *Short Answer* A pitcher throws a baseball with spin such that when viewed from above, the ball rotates counterclockwise. As the ball travels along its trajectory, from the pitcher's point of view the ballW) travels in a straight line

X) curves down

Y) curves left

Z) curves rightANSWER: Y) curves left

**BONUS**

1. PHYSICS *Short Answer* A ideal fluid is flowing through two sections of a pipe. Its velocity through the second section of the pipe is greater than that at the first section of the pipe. By name or number, identify all of the following three statements which MUST be true1. the fluid's pressure in the second section is lower

2. the fluid's flow rate is constant through the two sections

3. if the height of the second section of pipe is lower than that of the first, then the fluid's pressure in the second section is higher

ANSWER: 2 and 3

**TOSS UP**

1. CHEMISTRY *Short Answer* What equation is derived from the relation Delta G is equal to delta G standard plus RT ln K and the definition of Gibbs free energy and relates the change in temperature to the equilibrium constant?  
     
   ANSWER: Van't hoff equation

**BONUS**

1. CHEMISTRY *Short Answer* Give the equilibrium constant expression for the following reaction: H2S gas plus O2 gas yields SO2 gas plus H2O gasANSWER: [h2o]2 [so2]2 / [o2]3 [h2s]2

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following is the average salinity of seawater in the world's oceans?W) 35 parts per hundred

X) 35 parts per thousand

Y) 35 parts per million

Z) 35 parts per billionANSWER: X) 35 parts per thousand

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What ice shelf is the largest ice shelf of Antarctica, covering an area about the size of France and forms the main drainage outlet for the West Antarctic Ice Sheet?ANSWER: ross ice shelf

**TOSS UP**

1. MATH *Multiple Choice* Let h be a differentiable function, and let f be another differentiable function defined by f(x) equals h of the quantity x^2 - 3 close quantity. Which of the following is equal to f prime of 2   
   W) h prime of 1

X) 4h prime of 1

Y) h prime of 4

Z) 4 h prime of 4  
ANSWER: X) 4h prime of 1

**BONUS**

1. MATH *Multiple Choice* Which of the following series converges for all real numbers x?W) the summation from n = 1 to infinity of the fraction with numerator x to the n and denominator n

X) the summation from n = 1 to infinity of the fraction with numerator x to the n over n squared

Y) the summation from n = 1 to infinity of the fraction with numerator x to the n and denominator square root of n

Z) the summation from n = 1 to infinity of the fraction with numerator e to the n time x to the n and denominator n factorialANSWER: Z) the summation from n = 1 to infinity of the fraction with numerator e to the n time x to the n and denominator n factorial

**TOSS UP**

1. ENERGY *Short Answer* The Ostwald process is used industrially to make what acid?ANSWER: nitric acid

**BONUS**

1. ENERGY *Short Answer* What is the primary raw material by which the Ostwald process produces nitric acid?ANSWER: ammonia

**TOSS UP**

1. BIOLOGY *Short Answer* In evolutionary biology, what branching diagram shows the inferred evolutionary relationships between various species based upon similarities and differences in their characteristics, and are useful in fields such as bioinformatics and systematics?  
     
   ANSWER: phylogenetic tree

**BONUS**

1. BIOLOGY *Short Answer* By name or number, identify the following three processes of the nitrogen cycle as being either reducing or oxidizing1. nitrogen fixation

2. nitrification

3. denitrificationANSWER: 1. red 2. ox 3. red

**TOSS UP**

1. PHYSICS *Short Answer* By name or number, identify all of the following three changes to a monatomic gas which would increase the mean free path of its molecules1. increasing the temperature of the gas

2. increasing the volume of the container

3. decreasing the atomic radii of the gasANSWER: 2 and 4

**BONUS**

1. PHYSICS *Multiple Choice* Which of the following electrical devices seemingly violates Ampere's law if the displacement current correction is not made, and only the conduction current is considered?W) non-ohmic resistor

X) ohmic resistor

Y) parallel plate capacitor

Z) infinitely long and thin conducting wireANSWER: Y) parallel plate capacitor

**TOSS UP**

1. CHEMISTRY *Short Answer* Cisplatin, with molecular formula PtCl2(NH3)2, has what molecular geometry?  
     
   ANSWER: square planar

**BONUS**

1. CHEMISTRY *Short Answer* By name or number, order the following four ligands in order of field, from lowest to highest1. CN-

2. NH3

3. I-

4. H2OANSWER: 3 4 2 1

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What underwater currents of rapidly moving, sediment laden water are primarily responsible for the erosion of submarine canyons?ANSWER: turbity currents

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* By name or number, identify all of the following 4 dunes which are formed from prevailing winds which blow predominatly from a single direction1. barchan

2. longitudinal

3. parabolic

4. starANSWER: 1 and 3

**TOSS UP**

1. MATH *Multiple Choice* How many distinct ways can 7 people be seated around a circular table?   
     
   ANSWER: 720

**BONUS**

1. MATH *Short Answer* The derivative of the function f is given by f'(x) equals x^2 times cos(x^2). How many points of inflection does the parent function f have on the open interval negative 2 to 2?ANSWER: 5

**TOSS UP**

1. ENERGY *Short Answer* Identify the three main components which constitute dry woodANSWER: cellulose hemicellulose lignin

**BONUS**

1. ENERGY *Short Answer* Classify the following three woods as being either considered "hard" or "soft"1. oak

2. cypress

3. pineANSWER: 1. hard 2. soft 3. soft

**TOSS UP**

1. BIOLOGY *Multiple Choice* Which of the following trees relies primarily on wind to disperse its seeds?  
   W) coconut

X) oak

Y) maple

Z) willow  
ANSWER: Y) maple

**BONUS**

1. BIOLOGY *Short Answer* What horticultural technique involves the insertion of tissues from one plant into that of another such that the two sets of tissues can join together. In most cases of this process, one plant is selected for its roots, and the other for the desired genes to be duplicated in the form of leaves, flowers, etc. ANSWER: grafting

**TOSS UP**

1. PHYSICS *Short Answer* The speed of sound in air is approximately 340 m/s. If air was made four times denser, but its bulk modulus remained the same, what would the speed of sound in this new air be?

ANSWER: 170 m/s

**BONUS**

1. PHYSICS *Short Answer* At 1 meter, the intensity of a wave is 10 W/m squared. How much softer, in decibels, is the wave perceived to be at 10 meters?ANSWER: 20 decibels

**TOSS UP**

1. CHEMISTRY *Short Answer* You are adding bromine water into a colorless liquid at room temperature. You notice the brown color of the bromine disappears after the two liquids are mixed. Which of the following could be the identity of the liquid?  
   W) n-octane

X) benzene

Y) 2, 4 dimethyl pentane

Z) heptyne  
ANSWER: Z) heptyne

**BONUS**

1. CHEMISTRY *Multiple Choice* In the allyl radical, formed by the homolytic cleavage of allyl bromide into Br- and the allyl cation, which of the following best describes the orbital occupied by the unpaired electron?W) nonbonding s orbital

X) bonding p orbital

Y) nonbonding p orbital

Z) antibonding p orbitalANSWER: Y) nonbonding p orbital

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* Identify the following cloud type: dense, towering vertical clouds associated with thunderstorms and atmospheric instability, formed by powerful upward air currents ANSWER: cumulo nimbus

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What boundary layer of the atmosphere is responsible for and marks the flat, anvil-like top of well-developed cumulonimbus clouds?ANSWER: tropopause

**TOSS UP**

1. MATH *Short Answer* What is the limit as x approaches zero of sin x cos x over x?  
     
   ANSWER: 1

**BONUS**

1. MATH *Short Answer* Let f be a function where f(x) = 2, f '(3) = -1, f ''(3) = 6, and f '''(3) = 12. Give an expression in terms of x for the third-degree Taylor polynomial for f about x = 3. ANSWER: 2 - (x-3) + 3(x-3)^2 + 2(x-3)^3

**TOSS UP**

1. ENERGY *Short Answer* What compound is defined on the octane rating scale as having an octane number of zero?ANSWER: n heptane

**BONUS**

1. ENERGY *Short Answer* Give the IUPAC name for isooctane?ANSWER: 2 2 4 trimethyl pentane

**TOSS UP**

1. BIOLOGY *Short Answer* The production of effector cells from a clone of lymphocytes during the first exposure to a foerign antigen, along with the secretion of plama cells by B cells represents what form of immune response?  
     
   ANSWER: primary immune response

**BONUS**

1. BIOLOGY *Short Answer* By name or number, identify all of the following four structures found in the mammalian kidney1. Loop of Henle

2. malpighian tubule

3. metanephridia

4. cortical nephronANSWER: 1 and 4