**TOSS UP**

1. BIOLOGY *Multiple Choice* The "round" dance of honeybees returning to the nest indicates that  
   W) there is a source of food less than 50m from the hive

X)there is a source of food more than 50m from the hive, and in the same direction as the sun

Y) there is a source of food more than 50m from the hive, and in the opposite direction as the sun

Z) the queen is ready to mate with drones  
ANSWER: W) there is a source of food less than 50m from the hive

**BONUS**

1. BIOLOGY *Multiple Choice* A bird which eats frogs catches a bright-red one, and quickly finds that it tastes bitter and poisonous. It is observed that this bird thereon avoids all frogs of bright color. This is an example ofW) imprinting

X) spatial learning

Y) cognitive mapping

Z) associative learningANSWER: Z) associative learning

**TOSS UP**

1. PHYSICS *Short Answer* By name or number, identify all of the following three statements that are true regarding electric flux1. electric flux through a surface enclosing a point charge is independent of size of the surface

2. a square plane is not a valid Gaussian surface and so the flux through it cannot be calculated using Gauss' law

3. the SI unit of electric flux is Volts / meterANSWER: 1 only

**BONUS**

1. PHYSICS *Short Answer* Approximate the electric field 1 cm away from a 10 m by 10 m metal sheet with a charge density of 8.854 Coulomb/meter squared given that epsilon naught is 8.854 x 10^-12 Farads/meter. Give your answer to two significant figures and in scientific notationANSWER: 5.0 x 10^11 n/C

**TOSS UP**

1. CHEMISTRY *Short Answer* Order the following three hybridizations for a carbon atom in order of increasing shielding from NMR magnetic radiation 1. sp 2. sp2 3. sp3  
     
   ANSWER: sp2 sp sp3 (2 1 3)

**BONUS**

1. CHEMISTRY *Short Answer* In a proton NMR, identify how many peaks would be found in the spectra of each of the following compounds1. 1-bromopropane

2. 2-bromopropane

3. 1-butyneANSWER: 1. three 2. two 3. three

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* At about 30 degrees north and south latitude, the Hadley cell circulation creates a zone of subsiding air. What pressure system encircles the earth near this region, whose stable dry conditions are responsible for many of the great deserts of Australia, Arabia, and North Africa?ANSWER: SUBTROPICAL HIGH

**BONUS**

1. EARTH AND SPACE SCIENCE *Multiple Choice* In which of the following latitudes do the Westerlies blow?W) 0 degrees

X) 0 - 30 degrees

Y) 30 - 60 degrees

Z) 60 - 90 degreesANSWER: Y) 30 - 60 degrees

**TOSS UP**

1. MATH *Short Answer* A function f is defined such that f(x) is equal to the integral from 0 to x of the quantity t squared plus one closed quantity dt. What is the slope of f at x = 2  
     
   ANSWER: 5

**BONUS**

1. MATH *Short Answer* The differential equation dy/dx = -x/y gives the slope for what type of conic section?ANSWER: circle

**TOSS UP**

1. ENERGY *Short Answer* By name or number, identify all of the following 3 compounds which act as neutron poisons in a nuclear reactor1. Xenon 135

2. boric acid

3. Beryllium 9ANSWER: 1 , 2

**BONUS**

1. ENERGY *Short Answer* What is the balanced cell reaction of a cell which has a platinum-coated hydrogen electrode and a copper electrode?ANSWER: Cu 2+ aq plus H2 g yields Cu solid plus 2H+ aq

**TOSS UP**

1. BIOLOGY *Short Answer* By name or number, identify all of the following three eukaryotes which have plastids which originated from endosymbiosis of red algea  
   1. dioflagellates

2. euglenids

3. apicomplexans  
ANSWER: 1 and 3

**BONUS**

1. BIOLOGY *Multiple Choice* Which of the following groups of protists include brown algae, diatoms, and pathogens such as plasmodium?W) excavata

X) archaeplastida

Y) chromalveolata

Z) unikontaANSWER: Y) chromalveolata

**TOSS UP**

1. PHYSICS *Short Answer* The average translational kinetic energy of a molecule of ideal gas in a sample is solely dependent on what quantity?ANSWER: temperature

**BONUS**

1. PHYSICS *Short Answer* What is the change in entropy for 1 cycle of a Carnot Cycle that operates between 1 and 2.71828 Kelvin?ANSWER: zero

**TOSS UP**

1. CHEMISTRY *Multiple Choice* When Q sub sp is less than K sub sp for a solution   
   W) the solution is at saturation

X) solute is precipitating out of the solution

Y) additional solute can be dissolved

Z) the change in Gibbs free energy for the disassociation reaction is zero  
ANSWER: Y) additional solute can be dissolved

**BONUS**

1. CHEMISTRY *Short Answer* What phenomenon explains why, when dissolved in water, nitric, hydrochloric, and perchloric acid all have similar pHs for a given molarity, although their pKas differ widely?

ANSWER: leveling effect

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* An astronomer is out in the desert observing the night sky when he notices an object streak across the sky and land close to him. He locates the impact point and finds that the object was a meteorite. Such an event is an example of a W) fall

X) find

Y) drop

Z) plungeANSWER: W) fall

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* By name or number, order the following four meteorites from least to greatest in terms of number that fall to earth1. iron

2. stony-iron

3. chondrites

4. achondritesANSWER: 3 4 1 2

**TOSS UP**

1. MATH *Multiple Choice* The mean, median, unique mode, and range of 8 integers are all equal to 8. The largest integer of these integers is  
   W) 11

X) 12

Y) 13

Z) 14  
ANSWER: Z) 14

**BONUS**

1. MATH *Short Answer* A square and an equilateral triangle have the same perimeter. Let A be the area of a circle circumscribed about the aforementioned square and B the area of a circle which is circumscribed about the aforementioned triangle. Find the ratio A/B in simplest form. ANSWER: 27/32

**TOSS UP**

1. ENERGY *Short Answer* Who first theorized the existence and approximate mass of the meson, and thought that it was the carrier of the nuclear force which holds atomic nuclei together?ANSWER: yukawa

**BONUS**

1. ENERGY *Short Answer* Carl David Anderson unknowingly discovered this particle in 1936 while searching in the decay products of cosmic ray interactions. Due it having similar mass as Yukawa's hypothetical meson, it was at first thought to be a meson, but it did not participate in the strong force. Identify this lepton. ANSWER: muon

**TOSS UP**

1. BIOLOGY *Short Answer* During protein construction, from what tRNA binding site on the ribosome do discharged tRNAs leave?  
     
   ANSWER: E site

**BONUS**

1. BIOLOGY *Short Answer* Give the mRNA complementary strand from 5 prime to three prime for the following DNA sequence: 5 prime GAT CCC CGC TAA GGC 3 primeANSWER: 5 prime gcc uua gcg ggg auc 3 prime

**TOSS UP**

1. PHYSICS *Short Answer* What specific angle is the angle of incidence at which unpolarized light reflected by a surface is perfectly potarized parallel to the plane of the reflecting surface?ANSWER: brewster's angle

**BONUS**

1. PHYSICS *Short Answer* Calculate the coefficient of performance for a carnot refrigerator if it operates between 200 and 600 kelvinANSWER: 1/2

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Which of the following statements regarding functional groups is NOT TRUE?  
   W) compounds which are esters must contain at least two oxygen atoms

X) nitriles containing the cyano group share similar properties with inorganic cyanide

Y) the nitro group has a partial positive charge on the nitrogen and a partial negative charge on one oxygen

Z) compounds with a carboxyl group commonly have sharp flavors  
ANSWER: X) nitriles containing the cyano group share similar properties with inorganic cyanide

**BONUS**

1. CHEMISTRY *Short Answer* What approach route is taken during nuchleophilic attack on aldehydes and ketones, with the nucleophiles attacking at about 107 degrees to the carbon-oxygen bond, and is named after the two crystallographers who first investigated it.ANSWER: burgi dunitz trajectory/angle

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* The majority of North Africa is covered in a climate which has a Copen Classification of W) Aw

X) BWh

Y) Cfa

Z) HANSWER: X) BWh

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* By name or number, identify all of the following 4 data choices which are used to classify climates in the Koppen classification system1. mean monthly temperature

2. average annual precipitation

3. mean monthly humidity

4. distribution of natural vegetationANSWER: 1 and 2

**TOSS UP**

1. MATH *Short Answer* What number is 1/3 of the way from 1/4 to 3/4?  
     
   ANSWER: 5/12

**BONUS**

1. MATH *Short Answer* At a camp, 60% of the children play soccer, 30% swim, and 40% of the soccer players swim. To the nearest whole percent, what percent of the non-swimmers play soccer?W) 32%

X) 51%

Y) 74%

Z) 81%ANSWER: X) 51%

**TOSS UP**

1. ENERGY *Multiple Choice* In which of the following parts of a refrigerator does the working fluid undergo the greatest temperature drop?W) expansion valve

X) evaporator

Y) condenser

Z) compressorANSWER: W) expansion valve

**BONUS**

1. ENERGY *Multiple Choice* Which of the following measurements is NOT equivalent to the unit of mechanical horsepower?W) 33,000 ftlb/min

X) 550 ft lb/s

Y) 75 kg force m/s

Z) 812 WattsANSWER: Z) 812 Watts

**TOSS UP**

1. BIOLOGY *Multiple Choice* Roughly how many cells must be present in a frog embryo until the blastocoel forms?  
   W) 2

X) 8

Y) 128

Y) 4,000  
ANSWER: Y) 128

**BONUS**

1. BIOLOGY *Short Answer* Order the following four stages in blastula development in chronological order1. gastrulation begins with the migration of mesenchyme cells from the vegetal pole into the blastocoel

2. fusion of the archenteron with the blastocoel wall

3. invagination of the vegetal plate

4. formation of the archenteron ANSWER: 1 3 4 2

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following quantities must be zero for an isochoric process?W) heat added to the system

X) expansion work done by the system

Y) nonexpansion work done on the system

Z) temperature change of the systemANSWER: X) expansion work done by the system

**BONUS**

1. PHYSICS *Short Answer* What is the change in temperature when 50 Joules of work are done on 1 mol of an ideal gas, given that its heat capacity at constant pressure is 20.8 J/molK?ANSWER: 4 K

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Which of the following orbitals in ethene contributes the most to its reactivity with electrophiles?

W) C-H sigma orbital

X) C-C sigma orbital

Y) C-C pi orbital

Z) C-C pi star orbital  
ANSWER: Y) C-C pi orbital

**BONUS**

1. CHEMISTRY *Multiple Choice* In a real gas with a compression factor, Z, that is greater than 1,W) intermolecular repulsions between molecules are dominant

X) intermolecular attractions between molecules are dominant

Y) intermolecular attractions and repulsions between molecules are negligible

Z) the gas takes up less volume than an ideal one under the same conditionsANSWER: W) intermolecular repulsions are dominant

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following geologic features is associated with uplift caused by plate convergence?W) Ural Mountains, Russia

X) Black Hills, North Dakota

Y) Basin and Range Region, Western US

Z) Great Rift Valley, KenyaANSWER: W) Ural Mountains, Russia

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* According to the Goldschmidt classification, elements of what group are most likely to be found in mineral ores?W) lithophiles

X) siderophiles

Y) chalcophiles

Z) atmophilesANSWER: Y) chalcophiles

**TOSS UP**

1. MATH *Short Answer* How many trailing zeroes are in 50 factorial?  
     
   ANSWER: 12

**BONUS**

1. MATH *Short Answer* An ant starts at the lower left corner of a 3 x 6 grid. It can only move up or right one grid length each time along the grid lines. How many possible paths are there for the ant to reach the upper right corner?ANSWER: 84

**TOSS UP**

1. ENERGY *Short Answer* Parity, the concept that left and right are interchangeable, is violated by what fundamental force of nature?ANSWER: weak interaction

**BONUS**

1. ENERGY *Short Answer* By name or number, identify all of the following 3 pairs of particles that could NOT be produced in pair production1. electron and positron

2. up quark and down quark

3. muon and antimuonANSWER: 1 and 3

**TOSS UP**

1. PHYSICS *Multiple Choice* A clear glass rod is submerged into a tank of oil, and when viewed from the side the submerged portion is nearly invisible. This indicates that  
   W) the index of refraction of the oil is close to that of the glass

X) the index of refraction of the glass is greater than that of the oil

Y) the index of refraction of the oil is greater than that of the glass

Z) the glass rod is a poor emitter  
ANSWER: W) the index of refraction of the oil is close to that of the glass

**BONUS**

1. PHYSICS *Short Answer* What is the critical angle for an oil-air boundary if the index of refraction of the oil is 2.00 and that of air can be approximated as 1.00?ANSWER: 30 degrees