**TOSS UP**

1. BIOLOGY *Short Answer* Denote by name or number all of the following 4 possible treatments which have been shown to successfully inhibit HIV infection.  
   1. Protease Inhibitors  
   2. AZT   
   3. Nucleases  
   4. Chemokines  
   ANSWER: 1 and 2

**BONUS**

1. BIOLOGY *Short Answer* What is the name of the viral cell surface molecule which acts to help the daughter virus break free of the host cell once viral replication has been completed?ANSWER: NEURAMINIDASE

**TOSS UP**

1. PHYSICS *Multiple Choice* If the index of refraction is equal for two bordering media of differing densities, the angle of refraction of light passing from one medium to the other will be:  
   W) Greater than the incident angle if the first medium is denser than the second  
   X) Equal to the incident angle  
   Y) Less than the incident angle if the first medium is denser than the second  
   Z) The answer cannot be determined. ANSWER: X

**BONUS**

1. PHYSICS *Short Answer* On a large violin with strings that have a length of 5 m between fixed points, a string has a linear mass density a 40 g/m and a fundamental frequency of 20 Hz. Calculate the frequency and wavelength of the second overtone. ANSWER: 60 Hz, 3.33 m

**TOSS UP**

1. CHEMISTRY *Short Answer* Denote by name or number all of the following 4 molecules in which pi bonding occurs.   
   1. SCN-  
   2. PF3  
   3. CH3COOH  
   4. NO3-  
     
   ANSWER: 1, 3 and 4

**BONUS**

1. CHEMISTRY *Multiple Choice* Which of the following substances would be least soluble in water?  
   W) Zn(OH)2  
   X) Na2[Zn(OH)4]  
   Y) ZnCl2  
   Z) Zn(NO3)2ANSWER: W

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* As a star cluster ages, its main sequence grows shorter. You can judge the age of a star cluster by looking at what location on the main sequence, where stars evolve to the right to become giants.ANSWER: turnoff point

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* Denote by name or number all of the following 4 statements which is or are true of supernovae.  
   1. Type 2 supernovae have spectra which contain no hydrogen lines.  
   2. Type 2 supernovae occur in or near regions of active star formation.  
   3. Carbon deflagration occurs in Type 1a supernovae.  
   4. Type 1b supernovae are less common than Type 1a supernovae. ANSWER: 2, 3, and 4

**TOSS UP**

1. MATH *Multiple Choice* Which of the following is an equation to the line tangent to the graph of f(x)= x^4 + 2x^2 at the point where f ’(x)= 1 ?W) y=8x-5  
   X) y=x+0.763  
   Y) y= x+7  
   Z) y= x-0.122  
     
   ANSWER: Z

**BONUS**

1. MATH *Short Answer* Let f(x) be an antiderivative of ((lnx)^3)/x. If f(1)=0, then what does f(9) equal? Give your answer to the nearest tenth.ANSWER: 5.8

**TOSS UP**

1. ENERGY *Short Answer* What low temperature charcoal produced from a biomass of wood and leafy plant materials can be used to produce the fertile soil known as terra preta?ANSWER: biochar

**BONUS**

1. ENERGY *Short Answer* Recent reports from the US Department of Energy has shown that carbon dioxide can be sequestered in this rock, which contains cations in it that can bind with CO2, forming carbonate minerals. ANSWER: basalt

**TOSS UP**

1. BIOLOGY *Short Answer* Oranges, lemons, and limes make up what group of fruits, which contain more than one seed, and have a leathery skin?  
     
   ANSWER: HESPERIDIUMS

**BONUS**

1. BIOLOGY *Multiple Choice* Which of the following plant hormones is correctly matched with one of its functions?W) Abscisic acid; Activation of bud growth  
   X) Gibberelins; Inhibition of enzyme production in germinating seeds  
   Y) Oligosaccharins; Pathogen defense  
   Z) Ethylene; Inhibition of fruit ripeningANSWER: Y) Oligosaccharins; pathogen defense

**TOSS UP**

1. PHYSICS *Short Answer* If Sally can bounce 5 meters in the air on a trampoline, how fast is she going when she reaches the trampoline? Assume g = 10 m/s2ANSWER: 10 m/s

**BONUS**

1. PHYSICS *Short Answer* A sled with mass 25 kg rests on frictionless ice. It is attached to a pole by a 5 meter rope. Once given a push, the sled revolves uniformly in a circle around the post. If the sled makes 5 complete revolutions a minute, find the force exerted on it by the rope, to the nearest integer.ANSWER: 34.3 N

**TOSS UP**

1. CHEMISTRY *Multiple Choice* Which of the following statements is true about the difference between sodium and magnesium?  
   W) The atomic radius of Sodium is smaller than that of Magnesium  
   X) The second ionization energy of Sodium is greater than that of Magnesium  
   Y) Sodium as a higher nuclear charge than Magnesium  
   Z) Magnesium has more core electrons than Sodium  
     
   ANSWER: X

**BONUS**

1. CHEMISTRY *Multiple Choice* Pure HCl and HBr can both be found in gaseous states. The two gasses are placed in identical molar amounts into chambers of equal volumes. Assuming the two molecules are only equal in size, what is the relationship between the pressures of the different compounds?  
   W) HCl has a lower pressure because it is more polar than HBr and its attractive forces cause less pressure against the chamber walls.  
   X) HCl has a higher pressure because it is more polar than HBr and its attractive forces cause more pressure against the chamber walls.  
   Y) HBr has a lower pressure because it is more polar than HCl and its attractive forces cause less pressure against the chamber walls.  
   Z) HBr has a higher pressure because it is more polar than HCl and its attractive forces cause more pressure against the chamber walls.ANSWER: W

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* What is the term used to describe different magnetic time periods on Earth, similar to how eons are representative of a geologic time scale?ANSWER: CHRONS

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* Give the 3 primary components which lead to variation in Earth’s orbit, as per the Milankovitch hypothesis.ANSWER: Eccentricity, Tilt of earth’s axis, precession of earth’s axis

**TOSS UP**

1. MATH *Multiple Choice* If f is a linear function, and 0<a<b, then what is the integral from a to b of f ‘’(x) dx equal to?  
     
   ANSWER: 0

**BONUS**

1. MATH *Short Answer* If f and g are twice differentiable, and if h(x)=f(g(x)), then h’’(x)=  
   W) f’’(g(x))[g’(x)]^2 + f’(g(x))g’’(x)  
   X) f’’(g(x))(g’’(x))  
   Y) f’’(g(x))[g’(x)]^2  
   Z) f’’(g(x))ANSWER: W

**TOSS UP**

1. ENERGY *Short Answer* Which type of light water reactor has a negative temperature coefficient of reactivity, which allows the reaction to slow down if the temperature increases inside the reactor vessel?ANSWER: pressurized water reactor

**BONUS**

1. ENERGY *Short Answer* What chart plots neutron number vs proton number, and shows that as more protons are added, the number of neutrons needed to stabilize the atom increases at a greater rate?ANSWER: segre plots

**TOSS UP**

1. BIOLOGY *Short Answer* Match the following millimolar concentrations of cytoplasmic ions with either Na+, K+, or CL-: 150, 7, 15   
     
   ANSWER: Na+ = 15, K+ = 150, Cl- = 7

**BONUS**

1. BIOLOGY *Multiple Choice* Which of the following best describes why cocaine is addictive?W) Cocaine inhibits pathways in the so called limbic system, thus increasing pleasure perception.  
   X) Cocaine increases the number of dopamine receptors, thus increasing the amount of dopamine needed to maintain the levels of limbic activity desired.  
   Y) When cocaine binds to the dopamine transporters, the neurotransmitter survives longer in the synapse and continues to stimulate the postsynaptic cell.  
   Z) Cocaine destroys transporter proteins found in the synaptic clefts, which are needed to remove dopamine. ANSWER: Y

**TOSS UP**

1. PHYSICS *Multiple Choice* A mirror with a focal length of -2.5 m. An object is placed 7.5 m in front of the mirror. Where will the image of the object show up?  
   W) 1.9 meters behind the mirror  
   X) 1.9 meters in front of the mirror  
   Y) 0.33 meters behind the mirror  
   Z) 0.33 meters in front of the mirrorANSWER: W

**BONUS**

1. PHYSICS *Short Answer* Denote by name or number all of the following 4 statements which is or are true of Huygen’s Principle.1.It can be applied ONLY to the propagation of waves in the near field  
   2. Huygens proposed that every point to which a luminous disturbance reaches becomes a source of a spherical wave.  
   3. Huygen’s principle is the consequence of the isotropy of space.  
   4. The direction of propagation of the wave is always parallel to the surface of the wavefront at each point.ANSWER: 2 and 3

**TOSS UP**

1. CHEMISTRY *Short Answer* Denote by name or number all of the following 4 molecules which is or are Lewis bases, but not Arrhenius bases.1. BaO  
   2. NH3  
   3. NH4Cl  
   4. NaHSO4  
     
   ANSWER: 2 only

**BONUS**

1. CHEMISTRY *Multiple Choice* When dilute acid was added to a solution of one of the following chemicals, a gas was evolved. This gas is denser than air and can be poured over a flaming candle to extinguish the flame. The chemical was:  
   W) NaCl  
   X) HC2H3O2  
   Y) C2H5OH  
   Z) NaHCO3ANSWER: Z

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* Which galaxy type has the least gas and dust?ANSWER: eliptical

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What form of dark matter is currently considered the most probable type, which allowed for the formation of the current large scale structure of the universe?ANSWER: cold dark matter

**TOSS UP**

1. MATH *Short Answer* Name the mathematician who stated that the path taken between two points by a ray of light is the path that can be traversed in the least time.  
     
   ANSWER: fermat

**BONUS**

1. MATH *Short Answer* Let R be the region enclosed by the graph of y=1 + ln(cos^4(x)), the x axis, and the lines x= -2/3 and x=2/3. What is the closest integer approximation of the area of R?ANSWER: 1

**TOSS UP**

1. ENERGY *Short Answer* What renewable energy source uses the difference between cooler deep and warmer shallow or surface ocean waters to run a heat engine and produce useful work, usually in the form of electricity?ANSWER: OTEC

**BONUS**

1. ENERGY *Short Answer* What system of creating tidal power makes use of the potential energy in the difference in height between high and low tide, and are essentially dams across the full width of a tidal estuary? ANSWER: tidal barrage

**TOSS UP**

1. BIOLOGY *Short Answer* In the male reproductive system, denote which cell types LH and FSH act on respectively, which maintain secondary sex characteristics and promote spermatogenesis?   
     
   ANSWER: LH – Leydig, fsh- sertoli

**BONUS**

1. BIOLOGY *Short Answer* Denote which immunoglobulin class is being described in each of the following 4 statements:1. Found in external secretions  
   2. First type of secreted during primary immune response  
   3. Most abundant  
   4. Primary cause of allergic symptomsANSWER: IgA, igm, igg, ige

**TOSS UP**

1. PHYSICS *Multiple Choice* A family sits on a 8m long see-saw. The daughter, massing 20kg, sits at the left end of the see-saw, and the father, massing 80kg, sits in the middle-right portion of the see-saw. Where must the mother, massing 60kg, sit in order to make the see-saw in static equilibrium and level with the ground?  
   W) 1 meter left of the pivot  
   X) 1 meter right of the pivot  
   Y) 4/3 meter left of the pivot  
   Z) 4/3 meter right of the pivotANSWER: Y

**BONUS**

1. PHYSICS *Short Answer* What is the equation which is used to show how characteristic x ray spectra could be understood on the basis of energy levels of the atoms, and is defined as f=(2.48x10^15)(Z-1)^2ANSWER: mosley’s law

**TOSS UP**

1. CHEMISTRY *Short Answer* Denote by name or number all of the following 3 statements which can correctly complete the following sentence: A chlorine atom can form:  
   1. A single sigma bond  
   2. Four sigma bonds and three pi bonds  
   3. Four sigma bonds and four pi bonds  
     
   ANSWER: 1 and 2

**BONUS**

1. CHEMISTRY *Short Answer* At 25°C the solubility product constant, Ksp, for CoS is 5x10^–22 and the acid dissociation constants K1 and K2 for H2S are 1x10^–7 and 1x10^–13, respectively. What is the equilibrium constant for the reaction represented by the following equation at 25°C: CoS (s) + 2H^+ ---> Co^2+ + H2S (g)ANSWER: 0.05

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* As hydrothermal solutions percolate up to the shallower parts of the crust, they react with the rocks they penetrate, changing their chemical and mineral compositions and sometimes completely replacing one mineral with another without changing the rock's texture. This kind of change in a rock's bulk composition by fluid transport of chemical substances into or out of the rock is called what?ANSWER: metasomatism

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* Order the following 4 minerals in order of crystallization in magma, starting with the earliest to crystallize: Pyroxene, Biotite Mica, Quartz, AmphiboleANSWER: pyroxene, amphibole, biotite mica, quartz

**TOSS UP**

1. MATH *Multiple Choice* Which of the following is equal to the integral from 0 to pi of sin(x) dx?   
   W) The integral from 0 to pi of cos(x) dx  
   X) The integral from negative pi over two to pi over two of cos(x) dx  
   Y) The integral from negative pi over two to pi over two of sin(x) dx  
   Z) The integral from pi to 2pi of sin(x) dx  
     
   ANSWER: x

**BONUS**

1. MATH *Short Answer* What is the coefficient of x^6 in the Taylor series expansion about x=0 for f(x)= sin(x^2) ?ANSWER: -1/6

**TOSS UP**

1. ENERGY *Short Answer* What external combustion power cycle used in steam engines has adiabatic compression and isobaric heat addition, along with adiabatic expansion, and isobaric heat rejection? ANSWER: rankine

**BONUS**

1. ENERGY *Short Answer* Which type of heat engine has the highest thermal efficiency of any regular internal or external combustion engine due to its very high compression ratio?ANSWER: diesel

**TOSS UP**

1. BIOLOGY *Short Answer* What is the name of the procedure used to study tumors in which the nuclear DNA from tumor cells is isolated and cleaved into random fragments, in which each fragment is then tested individually for its ability to induce cancer in the cells that assimilate it?  
     
   ANSWER: transfection

**BONUS**

1. BIOLOGY *Multiple Choice* Which one of the following orders of insects best represents the following description: The most diverse animal order; two pairs of wings; front pair of wings is a hard cover that partially protects the transparent rear pair of flying wings; heavily armored exoskeleton; biting and chewing mouthparts; complete metamorphosis.  
   W) Coleoptera  
   X) Hemiptera  
   Y) Orthoptera  
   Z) LepidopteraANSWER: W) COleoptera