**TOSS UP**

1. PHYSICS *Short Answer* What experiment, important in quantum mechanics, involved sending a beam of particles through an inhomogeneous magnetic field and observing their deflection. The results showed that particles possess an intrinsic angular momentum that is most closely analogous to the angular momentum of a classically spinning object, but that takes only certain quantized values.   
     
   ANSWER: STERN-GERLACH EXPERIMENT

**BONUS**

1. PHYSICS *Short Answer* What class of fermion, one which can be its own antiparticle, is currently being researched for its using is quantum computing?ANSWER: MAJORANA FERMIONS

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following statements most accurately describes Einstein’s first postulate of special relativity?  
   W) The speed of light in a vacuum is the same in all inertial reference frames.  
   X) The laws of physics are the same in all inertial reference frames.  
   Y) It is impossible for an observer to travel at the speed of light in a vacuum.   
   Z) An observer cannot discern between inertial acceleration and acceleration due to gravity.ANSWER: X

**BONUS**

1. PHYSICS *Short Answer* What is the observed length of an object traveling at 0.6c if its proper length is 200 meters?ANSWER: 160 meters

**TOSS UP**

1. PHYSICS *Short Answer* As the velocity of an object approaches c, denote by name or number all of the following 3 events which would occur:  
   1. Its momentum approaches infinity.  
   2. It’s length approaches 0.  
   3. An observer would measure a clock on the object to run quicker relative to them.   
     
   ANSWER: 1 and 2

**BONUS**

1. PHYSICS *Multiple Choice* In which of the following wavelengths of electromagnetic radiation are the Paschen series hydrogen lines found?  
   W) Ultraviolet  
   X) Visible  
   Y) Infrared  
   Z) X-RayANSWER: Y

**TOSS UP**

1. PHYSICS *Short Answer* What value denotes the minimum amount of energy an electron must gain to escape from a particular surface?ANSWER: work function

**BONUS**

1. PHYSICS *Short Answer* What situation, created during laser emissions, is a nonequilibrium situation in which the number of atoms in a higher energy state is greater than the number in lower energy states?ANSWER: population inversion

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following is the sole variable which must be equal among different photons, which decides whether electromagnetic radiation can be considered coherent?  
   W) Frequency  
   X) Direction  
   Y) Phase  
   Z) Polarization  
     
   ANSWER: Y

**BONUS**

1. PHYSICS *Multiple Choice* Which of the following medical applications makes use of x-rays?  
   W) Computed Tomography  
   X) Magnetic Resonance Imaging  
   Y) Positron Emission Tomography  
   Z) UltrasoundANSWER: W

**TOSS UP**

1. PHYSICS *Short Answer* The equation lambda prime – lambda equals h/mc times the quantity 1-cos theta is a representation of what phenomenon, in which photons undergo inelastic scattering in matter resulting in a decrease in energy?ANSWER: compton scattering

**BONUS**

1. PHYSICS *Short Answer* What is the phenomenon in which a particle that encounters a potential barrier is able to emerge from the other side even if it doesn’t have enough kinetic energy to surmount the barrier according to Newtonian mechanics?ANSWER: TUNNELLING

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following types of Zeeman effect observatiosn is based entirely on the orbital angular momentum of the electron?  
   W) Anomalous  
   X) General  
    Y) Reverse  
   Z) Normal  
     
   ANSWER: Z

**BONUS**

1. PHYSICS *Short Answer* What quantity, denoted by mu sub b, is a natural unit for magnetic moment?ANSWER: Bohr magneton

**TOSS UP**

1. PHYSICS *Short Answer* The Fermi-Dirac distribution function emerges from which 2 of the following 3 phenomena in nuclear physics?  
   1. Pauli Exclusion Principle  
   2. Indistinguishability of electrons in metals  
   3. Aufbau Principle  
   ANSWER: 1 and2

**BONUS**

1. PHYSICS *Short Answer* Denote by name or number all of the following 3 magnetic quantum numbers which could be found in a hydrogen atom wave function in which the principle quantum number is equal to 2 and the orbital or angular momentum quantum number is equal to 1.  
   1. -1  
   2. 0  
   3. 1ANSWER: ALL OF THEM

**TOSS UP**

1. PHYSICS *Short Answer* In an insulator at absolute zero, what is the highest band that is completely filled?  
     
   ANSWER: valence band

**BONUS**

1. PHYSICS *Multiple Choice* Doping a semiconductor with which of the following atoms would create numerous holes in the crystal?  
   W) Bismuth  
   X) Phosphorus  
   Y) Arsenic  
   Z) AluminiumANSWER: Z

**TOSS UP**

1. PHYSICS *Short Answer* What sudden burst of impacts from 4.1 to 3.8 billion years ago lead to many of the craters we see on the moon today?ANSWER: late heavy bombaRdment

**BONUS**

1. PHYSICS *Short Answer* Place the following 4 periods of the geologic time scale in order from oldest to newest: Devonian, Cretaceous, Cambrian, PermianANSWER: cambrian, devonian, permian, cretaceous

**TOSS UP**

1. PHYSICS *Multiple Choice* If f’(x) and g’(x) exist, and f’(x) > g’(x) for all real x, the the graph of y = f(x) and the graph of y = g(x):  
   W) Intersect exactly once  
   X) Intersect no more than once  
   Y) Do not intersect  
   Z) Could intersect more than once  
     
   ANSWER: X

**BONUS**

1. PHYSICS *Short Answer* If sinx= e^y, 0<x<pi, then what is dy/dx in terms of x?ANSWER: cot (x)

**TOSS UP**

1. PHYSICS *Multiple Choice* Which of the following percentages most accurately represents the amount of U-235 in reactor grade, and weapons grade enriched uranium, respectively?  
   W) 1%, 50%  
   X) 50%, 1%  
   Y) 4%, 90%  
   Z) 90%, 4%ANSWER: Y

**BONUS**

1. PHYSICS *Short Answer* What gaseous element is the naturally occurring decay product of Uranium and Thorium?ANSWER: radon

**TOSS UP**

1. PHYSICS *Short Answer* What naturally occurring psychedelic compound produced by more than 200 species of mushrooms is currently being used in research for obsessive-compulsive disorder, cluster headaches, and anxiety related to terminal cancer, due to its mind-altering effects similar to those of LSD?  
     
   ANSWER: psilocybin