AP PHYSICS 2: MODERN PHYSICS

Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and place the letter of your choice in the corresponding box on the student answer sheet.

Note: To simplify calculations, you may use $g = 10\,\text{m/s}^2$ in all problems.

1. Two blocks of different sizes and masses float in a tray of water. Each block is half submerged, as shown in the figure. Water has a density of $1000\,\text{kg/m}^3$. What can be concluded about the densities of the two blocks?

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SECTION II
5 Questions

Directions: Answer all questions. The parts within a question may not have equal weight. All final numerical answers should include appropriate units. Credit depends on the quality of your solutions and explanations, so you should show your work. Credit also depends on demonstrating that you know which physical principles would be appropriate to apply in a particular situation. Therefore, you should clearly indicate which part of a question your work is for. 15

$n = 4$ ————————
$n = 3$ ———————— -6.04 eV
$n = 2$ ———————— -13.6 eV

$n = 2$ ———————— -54.4 eV

Note: Energy levels not drawn to scale.

1. The diagram above shows the lowest four discrete energy levels of an atom. An electron in the $n = 4$ state makes a transition to the $n = 2$ state, emitting a photon of wavelength 121.9 nm.

   (a) Calculate the energy level of the $n = 4$ state.

   (b) Calculate the momentum of the photon.

   The photon is then incident on a silver surface in a photoelectric experiment, and the surface emits an electron with maximum possible kinetic energy. The work function of silver is 4.7 eV.

   (c) Calculate the kinetic energy, in eV, of the emitted electron.

   (d) Determine the stopping potential for the emitted electron.

2. The momentum of a particular proton is 5.5×10^{-20} kg·m/s. Relativistic effects can be ignored throughout this question.

   (a) Calculate the de Broglie wavelength of the proton.

   (b) Calculate the kinetic energy of the proton.

   The proton is directed toward a very distant stationary uranium nucleus, ${}^{235}_{92}\text{U}$. The proton reaches a distance D from the center of the nucleus and then reverses direction. Assume that the nucleus is heavy enough to remain stationary during the interaction.

   (c) Calculate the value of D.

   (d) After the proton has moved away, the ${}^{235}_{92}\text{U}$ nucleus spontaneously fissions into ${}^{148}_{57}\text{La}$ and ${}^{84}_{35}\text{Br}$, along with three neutrons. As a result, 2.5×10^{-11} J of energy is released. Indicate whether the mass of the nucleus is greater or less than the mass of the fission products.

   ____ Greater ____ Less

   Calculate the mass difference.