

八十六學年度 工程與系統科學系(所) _____ 組碩士班研究生入學考試

科目 近代物理 科號 4008 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. (20%) A 100 keV photon collides with an electron at rest. It is scattered through 90° . What is its energy after the collision? What is the kinetic energy in eV of the electron after the collision, and what is the direction of its recoil?

2. (20%) A particle of mass m moves in a circular orbit of radius r under the influence of a "spring" force kr directed toward the center (k is a constant). Assuming that Bohr's quantization rules of the atom apply to this system, derive the equation for
 - (a) the radii of the permissible orbits and
 - (b) the total energies of the particle moving in these orbits in terms of the quantum number n .
 - (c) Show that the frequency of the electromagnetic radiation emitted when the particle makes a transition from one orbit to the adjacent orbit is the same as the frequency of the circular motion.

3. (25%) A particle moves in the potential shown in Fig. 1 with a total energy $E < V_0$.
 - (a) Find the equation defining the possible energy values of the particle.
 - (b) Show by solving this equation graphically that the energy spectrum of the particle is discrete.

4. (20%) An electron in the Coulomb field of a proton is in a state described by the wave function

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科目 近代物理 科號 009 共 2 頁第 2 頁 *請在試卷【答案卷】內作答

$$\frac{1}{5}[4\psi_{100}(\vec{r}) + 3\psi_{211}(\vec{r})]$$

- (a) What is the expectation value of the energy?
 (b) What is the expectation value of L^2 ?
 (c) What is the expectation value of L_z ?

5. (15%) What are the possible values of the total angular momentum of an electron in a d state (the $l = 2$ state)? What are the angles between the spin and the orbital angular momentum?

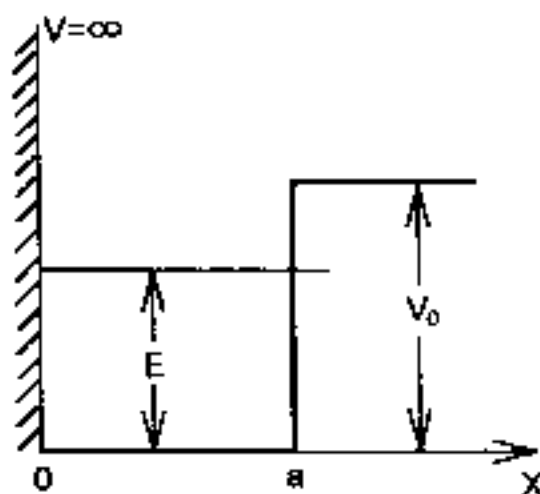


Fig. 1

Useful Constants

Planck's constant $h = 6.626 \cdot 10^{-34}$ joule-sec

1 eV = $1.602 \cdot 10^{-19}$ joule

electron mass $m_e = 9.1 \cdot 10^{-31}$ kg