

國立中央大學九十一年度碩士班研究生入學試題卷

所別: 大氣物理研究所 不分組 科目: 近代物理學 共 1 頁 第 1 頁

1. A photon of energy E is scattered by a particle of rest energy E_0 (assumed to be initially at rest in the laboratory frame).
 - (a) Find the scattering angle of the photon in term of the kinetic energy of the recoiling particle, E , and E_0 . (10%)
 - (b) Find the maximum kinetic energy of the recoiling particle in term of E , and E_0 . (5%)
 - (c) Find the maximum momentum of the recoiling particle. (5%)
 - (d) What is the energy of the photon after this maximal collision? (5%)
2. A 500 kg satellite is in a circular orbit about the earth with a period of 90 minutes.
 - (a) Applying the Bohr quantum condition on angular momentum, calculate the quantum number n for this orbit. (5%)
 - (b) Find the radius of this orbit. (5%)
 - (c) Find the radius distance between this orbit and the next allowed higher orbit. Could we detect this distance experimentally? (5%)
(Planck constant is $6.626 \times 10^{-34} J.s$, and the radius of the earth is 6378 km with the gravitational acceleration $9.8 m/s^2$ on the earth surface.)
3. A classical oscillator with mass m on a spring with spring-constant κ . The energy of the oscillator is given by
$$E = \frac{p^2}{2m} + \frac{\kappa x^2}{2}$$
where p is the momentum and x is the displacement distance.
 - (a) Determine the energy for a quantum oscillator, in term of the momentum and the displacement distance. (5%)
 - (b) Determine the uncertainty of position Δx at which the energy is minimum. (10%)
 - (c) Determine the minimum energy, in terms of the angular frequency of a classical oscillator $\omega = \sqrt{\kappa/m}$. (5%)
4. What are the angles between the orbital angular momentum vector \vec{L} and the z-axis for the orbital quantum number $l = 2$ of a hydrogen atom? (10%)
5. Describe building up the periodic table of the elements. (10%)
6. What is the principle of a three-level laser? (10%)
7. Consider a gas of atoms, each atom has only three possible energies: $-e$, 0 , $+e$.
 - (a) Obtain an expression for the probability that, when the system is in thermal equilibrium at temperature T , the lowest level is occupied. (5%)
 - (b) Find the average energy of the system. (5%)

參考用