

國立中央大學八十五學年度碩士班研究生入學試題卷

所別: 電機工程研究所 乙組

科目: 近代物理

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(一) 解釋名詞: (30%)

1. Hund's rule, 2. Zeeman effect, 3. Coherence of light,
4. Boson and Fermion, 5. Brillouin zone, 6. Josephson effect

(二) 計算題: (70%)

1. (a) If 13.6 eV is required to separate a stationary hydrogen atom into a proton and an electron, estimate the orbital radius and velocity of electron in a hydrogen atom. (7%)

(b) Repeat above calculation for a moving hydrogen atom. (8%)

$$[m_p = 1.673 \times 10^{-27} \text{ kg}, m_e = 9.11 \times 10^{-31} \text{ kg}, \hbar = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}, k = 1.38 \times 10^{-23} \text{ J/K}]$$

2. A photon having an initial energy of 207 eV suffers three collisions with three electrons in sequence. In collisions, the photon is deflected by 45° firstly, 60° secondarily, and 90° thirdly. Find the final wavelength of the photon. (15%)

3. (a) According to a simple model, the energy of a free electron in a crystal is the following function of the wave number:

$$E = A - B \cos ka$$

where A and B are constants, and a is the distance between adjacent atoms. What value of the effective mass can you deduce from this formula? (10%)

(b) if $a = 2 \text{ \AA}$, what is the range of electron wavelength in the first Brillouin zone? (5%)

4. (a) The spacing between the relevant Bragg planes in the nickel crystal is 0.91 \AA . From the Bragg condition, with $n=1$, calculate the wavelength of the mono-energetic electrons that gives the strong reflected beam at $\phi = 50.0^\circ$ as shown in the figure below. (10%)

(b) The measured energy of these electrons is 54.0 eV.

Calculate the wavelength from de Broglie's relation.

Can you explain the discrepancy between the results

(a) and (b)? (15%)

