國　立　清　華　大　學　命　題　紙

八十五學年度 材料科學工程研究所(錄)(所) 甲三 組碩士班研究生入學考試

科目 近代物理(I) 科號 1901 (2001) 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. Assume that there is a transparent object with refractive index n, and length L. Light can emit from one end, propagate inside of the object, and reflect back from the other end. When the object is at rest, the time for light to make a round trip is measured by an observer to be t.

(i) Let the object move with speed V in the direction perpendicular to the light propagation. What is the time the observer measured for light to make a round trip? (10%)

(ii) If the object move with the same speed, but in the direction of light propagation, what is the time the observer measured for light to make the same round trip? (10%)

2. State four experiments and explain how the results support the particle-like properties of light. (20%)

3. (i) State the de Broglie's hypothesis for wave-particle relationship. (5%)

(ii) Use the hypothesis to show that the group velocity of a de Broglie wave V_g equals to the velocity V of the same particle. (5%)

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2001

4. Compare the uncertainty in the momentum of an electron confined to a region of linear dimension a_0 with the momenum of an electron in a ground-state Bohr orbit. (10%)

5. For single-photon excitation of the first excitation state of hydrogen, only 10.2eV photons will work. However, any single electron with K.E.>10.2eV will work. Explain. (5%)

6. Please explain (a) induced absorption, (b) spontaneous emission, and (c) induced emission. (3%)

7. Please state principle of the three-level laser. (7%)

8. The only way for the wave function to be constant in a certain region of space is for the kinetic energy to be zero there. Prove this condition by using the one-dimensional, time independent, nonrelativistic Schrödinger wave equation. (13%)

9. The semiclassical amplitude, A, of a harmonic oscillator can be obtained from $\frac{1}{2}m\omega_c^2 A^2 = E$. Show that A is quantized and find its allowed values. Why can $|x|$ be greater than A? (12%)