國立清華大學 104 學年度碩士班考試入學試題

系所班組別：0598 聯合招生

考試科目（代碼）：9802 近代物理

 *請在【答案卷】作答

Useful constants: $c = 3.00\times10^{8}$ m/s, $k_B = 1.38\times10^{-23}$ J/K, $h = 6.63\times10^{-34}$ J·s, $e = 1.60\times10^{-19}$ C, $m_e = 9.11\times10^{-31}$ Kg, $\mu_B = 9.274\times10^{-24}$ J/T, Coulomb constant $k = 8.988\times10^{9}$ N·m^2/C^2.

1. (10%) What is the minimum kinetic energy of each proton (equal kinetic energy for each proton) must have in the head-on collision of equation, $p + p \rightarrow \pi^+ + d$, in order to produce the positively charged pion π^+ and deuterium d? The mass of π^+ is 139.6 MeV/c^2, mass of proton 938.3 MeV/c^2, mass of deuterium 1875.6 MeV/c^2.

2. (15%) For Compton scattering using a graphite target. (a) Write down the momentum conservation equation and energy conservation equation of Compton scattering (Fig. 2a). Here E_e is the total energy of the scattered electron. (b) What is the origin of the measured peak at λ_0 shown in Fig.2b (How is it produced)? (c) What is the importance of the results of Compton scattering experiment?

Fig. 2a

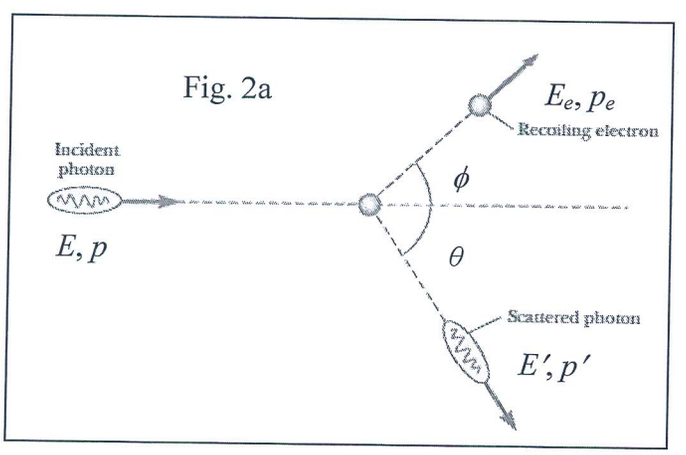
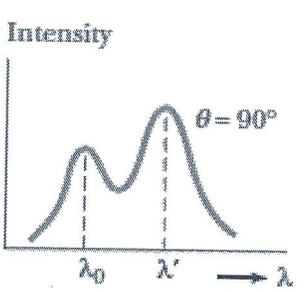


Fig. 2b



3. (8%) The surface temperature of the Sun is 5800 K and the total power per unit area from the Sun is measured at the Earth to be 1400 W/m^2. If the surface temperature of the Sun is decreased to 2900 K, what will be the total power per unit area from the Sun measured at the Earth?

4. (5%) The wavelength marking the maximum power emission of the Sun is 500 nm (peak intensity wavelength), corresponding to the Sun surface temperature 5800K. What will be the peak intensity wavelength corresponding to a surface temperature of 2900 K?

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5. (6%) Calculate the de Broglie wavelength of an electron with a kinetic energy of 50 keV.

6. (6%) The electron in a hydrogen atom has ground state energy of -13.6 eV. What is the electron ground state energy of a Li^{2+} ?

7. (5%) What kind of potentials that the energy levels (a) $E_n \sim -(1/n^2)$; (b) $E_n \sim n^2$; (c) $E_n \sim (n+1/2)h\omega/2\pi$.

8. (5%) What is Hund's rule?

9. (5%) Please write down the full English names of ESR and STM?

10. (5%) What are English names of the four quantum numbers, n, l, m_l and m_s ?

11. (5%) (a) Give the spectroscopic notation of $n=5$, $l=4$, $j=9/2$. (b) What are the values of l and j for the spectroscopy notation of $2P_{3/2}$.

12. (5%) For a non-relativistic free particle, what is the relation between ω (frequency) and k (momentum or wave vector), assume the mass of the particle is m.

13. (5%) Please write down the one-dimensional time-dependent Schrodinger wave equation and time-independent Schrodinger wave equation.

14. (5%) What is the relation between μ (magnetic moment) and L (angular momentum) for an orbiting charge with charge q with mass m? If the applied magnetic field is B, what is the relation between the Larmor frequency (ω_L) and B.

15. (5%) Calculate the Larmor frequency of an electron in the $n=2$ state of hydrogen atom, if the applied field is 0.5 T, please calculate magnetic energy of the electron in this hydrogen atom. Assume $h=6.63\times10^{-34}$ Js; the electron mass is 9.11×10^{-31} kg

16. (5%) (a) Which element in the periodical table (Z<82) has highest ionization energy of the electron? (b) Which element in the periodical table (Z< 82) has highest atomic volume?