國立彰化師範大學 97 學年度碩士班招生考試試題

系所：光電科技研究所碩士班　　科目：近代物理

☆☆請在答案紙上作答☆☆　　

Some constants you may need:

- ✓ Planck's constant $h=6.626\times10^{-34}$ J-s.
- ✓ $e = 1.602\times10^{-19}$ C , $\varepsilon_0 = 8.854\times10^{-12}$ $C^2/N.\ m^2$, $m_e=9.11\times10^{-31}$ kg

1. Please explain the following terminologies in details. (20%)
   (1) Electron affinity
   (2) Ionization energy
   (3) Fermi distribution
   (4) Hamiltonian
   (5) Spin-orbit coupling

2. What is the selection rule? What is the Exclusion principle? How do they apply to explain the spectra of molecules? (10%)

3. (20%) A particle having a mass of m and a total energy E, is incident into a potential barrier of the form

$$V(x)=\begin{cases}0 & x<0\ \&\ x>a\\ Vo & 0\le x\le a\end{cases}$$

   (a) If 0< E <Vo, please calculate the transmission and the reflection coefficient of this particle as functions of E, Vo, a and k, where $k\equiv\sqrt{2m(Vo-E)}/\eta$

   (b) Find the relative transmission probability if two electrons with energy of 1 and 2 eV, respectively, are incident on a barrier of 5 eV high and barrier width of 1 nm. What will this probability be changed if the barrier width is doubled?

4. (a) As shown in Fig. 1(a), a medium contains period structures. The refractive index of the medium is ***n***, and the periods are ***a*** and ***b***, respectively. Suppose the medium is placed into a specific liquid, and the index of the surrounding liquid is also ***n***. There is one collimated laser beam with vacuum wavelength of λ_1 incident on the medium, and the incident angle is θ. First, please calculate the value of angle θ when first order Bragg diffraction occurs. And then, please determine the Bragg diffraction angle and sketch the diffraction beam in the figure. (20%)

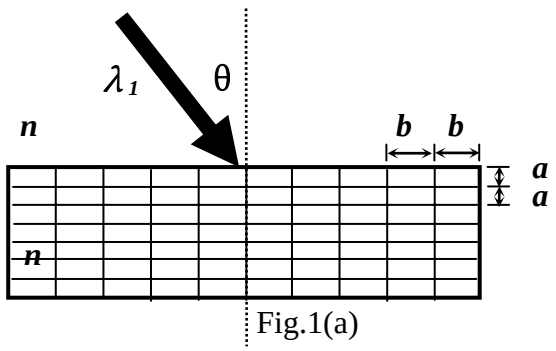

Fig.1(a)

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(b) Suppose the same medium described above is placed into the same liquid again. Now a collimated beam containing all various wavelengths is normal incident on the medium as shown in Fig. 1(b). Please describe and calculate the optical phenomena can be observed. (15%)

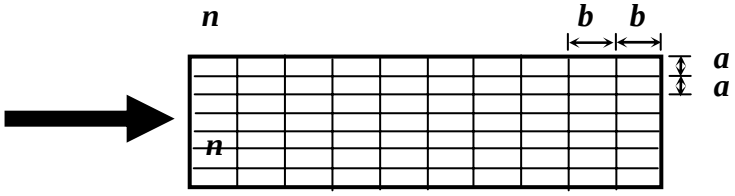

Fig.1(b)

5. A spacecraft receding from the earth emits radio waves at a constant frequency of 10^9 Hz. If the receiver on earth can measure frequencies to the nearest hertz, at what spacecraft speed can the difference between the relativistic and classical Doppler effects be detected? (15%)