國立彰化師範大學 100 學年度碩士班招生考試試題

系所：光電科技研究所　　科目：近代物理

☆☆請在答案紙上作答☆☆　　

Some constants you may need:

- ✓ Planck's constant h=6.626×10^{-34} J-s. Boltzmann's constant = 1.38×10^{-23} J/K.
- ✓ e = 1.602 x 10^{-19} C , ε_0 = 8.854 x 10^{-12} C^2/N·m^2, m_e=9.11 x 10^{-31} kg
- ✓ 該標示單位的答案，一定要寫上「單位」

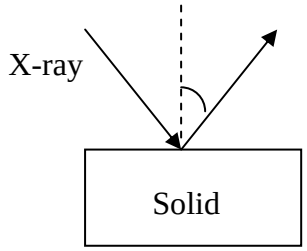
1. (20%) Please explain the following terminologies in details.
   (a) Bragg diffraction
   (b) Photoelectric effect
   (c) Compton effect
   (d) de Broglie wave

2. (10%) Green light has a wavelength of about 550nm. Through what potential difference must an electron be accelerated to have this wavelength?

3. (10%) Find the energy levels of an electron in a box 0.1nm wide.

4. (10%) A beam of x-rays is scattered by a target. At 45^o from the beam direction the scattered x-rays have a wavelength of $2.2\,pm$. What is the wavelength of the x-rays in the direct beam?

5. (25%) At room temperature, there is a solid with a bandgap of 2 eV.
   (1) Please calculate the probability of electron distribution on the conduction band by assuming Boltzman distribution?
   (2) Please calculate the emission photon wavelength of a light emitting diode (LED) made by this solid.
   (3) If this solid is doped and its Fermi level is 0.1 eV below the conduction band, please calculate the probability of electron distribution on the conduction band?
   (4) Please describe the property differences of emitting light between laser and light emitting diode (LED) made by this solid? You may draw some pictures to explain the details.
   (5) If an X-ray with a wavelength of 3 Å is incident into this solid, a strong Bragg diffraction peak is obtained at an angle of 35° (as indicated in figure below). Please calculate the distance between two adjacent atomic planes in this solid.



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6. (25%) A particle having a mass of M and a total energy E, is incident into a potential barrier of the form

$$V(x)=\begin{cases}0 & x<0\ \&\ x>d \quad \text{(region I)}\\ V_o & 0\le x\le d \quad \text{(region II)}\end{cases}$$

(1) Write down the wave functions of this particle in region I and region II.

(2) Write down the boundary conditions between region I and region II.

(3) If 0< E <V_o, please calculate the transmission of this particle as functions of E, V_o, d and k, where $k\equiv\sqrt{2M(V_o-E)}/\hbar$

(4) Find the relative transmission probability if one electron with energy of 2 eV is incident on a barrier of 3 eV high and barrier width of 1 nm. What will this probability be changed if the barrier width is doubled?