

# 國立中央大學八十八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 共 / 頁 第 / 頁

- (10) An electron is constrained in the infinite square well with width of 0.1 nm. (a) Calculate the energy level values for the electron for levels up to  $n=4$ . (b) Find the wavelengths of all photons that can be emitted by the electrons in making transitions that would eventually get it from the  $n=4$  state to the  $n=1$  state.
- (10) Sketch the wavefunctions  $\psi(x)$  and the probability density  $|\psi(x)|^2$  for the lowest four states of a particle in a finite potential well.
- (15) Tunneling of a particle through barriers that are high or wide (or both) is very unlikely. Show that for a square barrier (barrier height of  $U$  and barrier width of  $L$ ) with  $\frac{2mUL^2}{\hbar^2} \gg 1$  and particle energies well below the top of the barrier ( $E \ll U$ ), the probability for transmission is approximately 
$$p \approx 16 \frac{E}{U} e^{-2[\sqrt{2m(U-E)}/\hbar]L}$$
- (10) A neutron beam with a selected speed of 0.5 m/s is directed through a double slit with a 1.0 mm separation. An array of electrons is placed 15 m from the slit. (a) What is the de Broglie wavelength of the neutrons? (b) How far off axis is the first zero-intensity point on the detector array? (c) Can we say which slit any particle neutron passed through? Explain.
- (15) Show that the average kinetic energy of a conduction electron in a metal at 0 K is given by  $E = 3E_F/5$ , where  $E_F$  is Fermi energy.
- (15) Explain the principle of a gas laser? Why must a lasing medium possess at least three energy levels?
- (10) The bandgap of GaN crystal is about 3.4 eV. What is its color to human eyes? Why?
- (15) Explain the following items: (a) photon, (b) phonon, (c) boson, (d) fermion, (e) Bohr radius.