編號： 45　　**國立成功大學102學年度碩士班招生考試試題**　　

系所組別：光電科學與工程學系甲、乙組

考試科目：電磁學　　考試日期：0224，節次：2

※ 考生請注意：本試題不可使用計算機　　請勿在本試題紙上作答，否則不予計分

1. A practical application of electrostatic is in electrostatic separation of solids. As shown in Fig. 1, it can be separated into its component by applying a uniform electric field. Assume the initial velocity and displacement are zero and take E = 500 kW/m and Q/m = 9 μC/kg for both positively and negatively charged particles. After falling 80 cm, the separation between the positively and negatively charged particles is ____. (10%) (The gravitational constant $g = 9.8\ \text{m/s}^2$)

2. Assume the electric charge density inside an atomic nucleus of radius a can be described by $\rho(r)=\rho_0\left(1-\frac{r^2}{a^2}\right)$, which exists in the region $0 \le r \le a$. Beyond the radius a, the charge density is zero.

   (a) The total charge Q is ____. (5%) (b) The electric potential V inside the nucleus is ____. (5%) (c) The magnitude of the electric field maximal is at r = ____. (5%)

3. Sketched in Fig. 2 is a pn junction between two semiconducting half-spaces, doped p-type and n-type, respectively. The volume charge distribution in the semiconductor can be approximated the following function:

$$\rho(x)=\begin{cases}-\rho_0 e^{x/a}, & for\ \ x<0\\ \quad 0 \quad, & for\ \ x=0\ ,\\ \rho_0 e^{-x/a}, & for\ \ x>0\end{cases}$$

   Where ρ_0 and a are positive constants. The permittivity of the semiconductor is ε.

   (a) The electric field intensity vector in the p-type region is ____(5%), and the electric field intensity vector in the n-type region is ____. (5%) (b) From the end on the n-type side to the end on p-type side of the junction, the voltage between the ends of the semiconductor is ____. (5%)

4. A long coaxial cable has conductors of radii a and b ($a < b$) and the dielectric permittivity ε. The voltage between the cable conductors is V. Find (a) the energy density is ____. (5%) (b) the energy per unit length is ____. (5%)

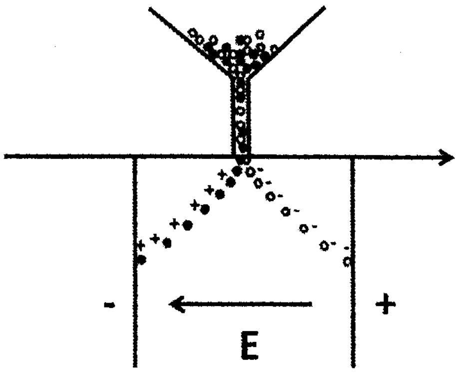


Figure 1

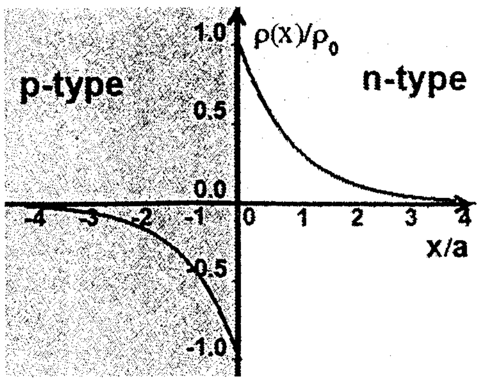


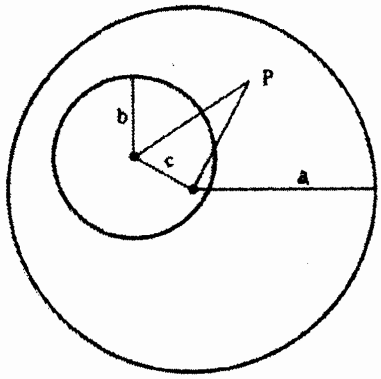
Figure 2

(背面仍有題目,請繼續作答)

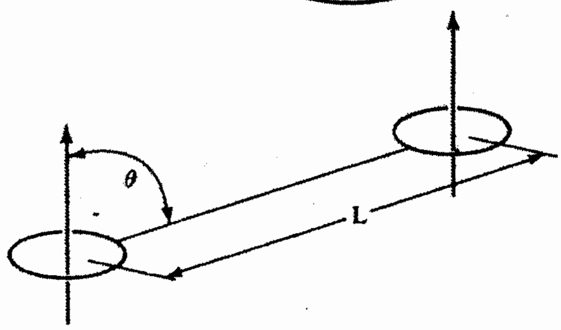
※ 考生請注意：本試題不可使用計算機

5. An electron is launched with a velocity $v = 10^4$ cm/sec at 45° to a uniform field $H = 10^4$ oersteds. Describe quantitatively and completely the ensuing motion in one sentence. (Be sure to specify completely and quantitatively the exact motion.) (10%)

6. A long straight wire of radius a has a circular hole of radius b parallel to the axis of the wire but displaced from the center by a distance c. A current I flows in the wire and is uniformly distributed across the conductor. Find the magnetic field everywhere in space. (15%)



7. Find the torque and the force between two circular loops of wire, carrying the same currents I, and of the same radius R, when they are located a distance L apart, with $L >> R$, and with their axes parallel and the currents in the same direction. Express the torque and force in terms of the angle θ between their axes and their line of centers. (10%)



8. Consider a plane electromagnetic wave of frequency ω normally incident on a nonmagnetic metallic surface with given conductivity σ.
   (a) Write down the partial differential equation for the magnetic field, appropriate to interior of the metal. Assume that ω is small enough that displacement current effects can be neglected. (5%)
   (b) State the boundary conditions for the tangential components $\vec{E}^t$ and $\vec{H}^t$ of the electric and magnetic fields at the surface. (5%)
   (c) Evaluate the (complex) surface impedance $Z(\sigma,\omega)$ defined by $\vec{E}^t = Z\vec{H}^t \times \hat{n}$ where $\hat{n}$ is a unit vector normal to the surface. (5%)