淡江大學 99 學年度轉學生招生考試試題

系別：物理學系三年級　　　　　科目：電　磁　學

1. A sphere of radius R is uniformly charged to a density ρ. The sphere contains an uncharged spherical cavity of radius R_1. The centers of the two spheres are separated by a distance a, where $a + R_1 < R$. Find the electric field $\vec{E}$ inside the cavity.

2. Suppose the electric potential is given by

$$V(\vec{r}) = A\frac{e^{-\lambda r}}{r}$$

for all r (A and λ are constants). Find the electric field $\vec{E}$, the charge density ρ, and the total charge Q.

3. Consider the magnetic field on the axis of two current loops a distance s apart as shown in Fig. 1.

   (a) Find the $\vec{B}$ field on the axis as a function of z, and show that $\partial\vec{B}/\partial z$ is zero at the point midway between them ($z = 0$).

   (b) Determine s such that $\partial^2\vec{B}/\partial z^2 = 0$ at the midpoint, and find the resulting magnetic field $\vec{B}$ at the midpoint.

4. A metal bar of mass m, length l, and resistance R slides down a pair of frictionless rails of negligible resistance inclined at an angle θ to the horizontal as shown in Fig. 2. A uniform magnetic field is directed vertically upward.

   (a) Find the current induced in the bar.
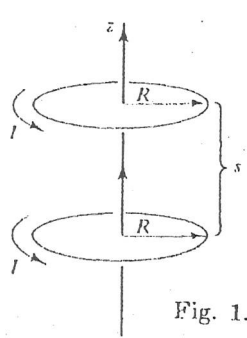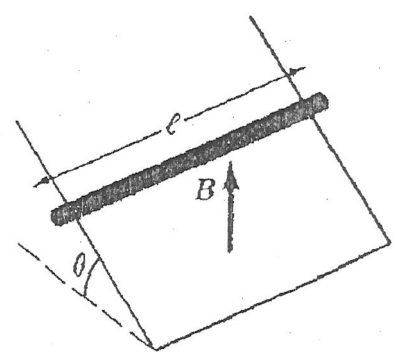
   (b) Find the terminal velocity of the bar.

Fig. 1.

Fig. 2.