

國立臺灣海洋大學 103 學年度研究所碩士班招生考試試題

考試科目：電磁學

系所名稱：光電科學研究所碩士班不分組

*可使用計算器

1. 答案以橫式由左至右書寫。2. 請依題號順序作答。

1 Consider two widely separated conducting spheres A and B with radius $R_A = R$, $R_B = 2R$. Initially spheres A and sphere B has charge $2Q$ and $-3Q$ respectively. A thin conducting wire was then connected between two spheres until electrostatic equilibrium was established. Assume $V(\infty) = 0$.

- (1) What would be V_A and V_B before and after the connection of wire? (5%)
 (2) What would be charges on sphere A and B respectively after the connection of wire? (5%)
 (3) What will be the ratio of surface charge density on sphere A and B after the connection of wire? (5%)

2 A long metal cylinder with radius a is supported on an insulating stand on the axis of a long, hollow, metal tube with radius b . The positive charge per unit length on the inner cylinder is λ , and there is an equal negative charge per unit length on the outer cylinder.

- (1) Use Gauss's law to calculate the electric field for $r < a$; $a < r < b$; $r > b$. Plot $E(r)$ as a function of r . (5%)
 (2) Assume $V(\infty) = 0$, calculate the potential $V(r)$ for $r < a$; $a < r < b$; $r > b$. Plot $V(r)$ as a function of r . (5%)
 (3) For a section of length L of this cylinder, what is its capacitance? (5%)

3 Use Biot-Savart law to calculate the magnetic field B at the crossed position of circuits shown in Fig. 1(a), 1(b) : all circuits carrying a counterclockwise current i and consisting of concentric circular arcs (either half- or three quarter-circles of radii r , and $2r$) and radial lengths.

4 In Fig. 2, a long rectangular conducting loop, of width L , resistance R , and mass m , is hung in a horizontal, uniform magnetic field B that is directed into the page and that exists only above line aa . The loop is then dropped; during its fall, it accelerates until it reaches a certain terminal speed v_t . Ignoring air drag, find that terminal speed.

5 Write down the boundary conditions for electric field and magnetic field at the boundary between two non-magnetic dielectric with dielectric constant ϵ_1 and ϵ_2 .

6 (1) Write down Maxwell's equations for electromagnetism. Explain the meaning of each equation.
 (2) Write down the wave equation for electric field of a traveling electromagnetic wave propagating along positive x-axis and polarized in y plane. What is the propagating velocity of such wave?

7 A plane electromagnetic wave given by the expressions $E_x = 0$, $E_y = 2\cos[2\pi \times 10^{14}(t - x/c)]$, $E_z = 0$.

- (1) What is the frequency, wavelength, propagation direction, amplitude, and polarization of the wave?
 (2) Write down the expression for the magnetic field and Poynting vector.

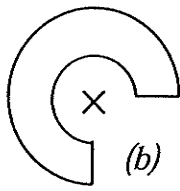
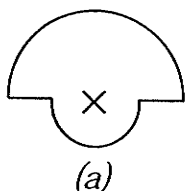


Fig. 1

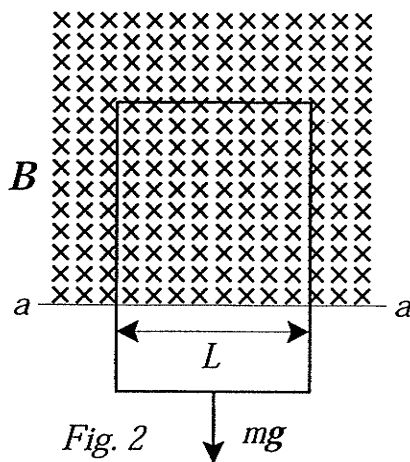


Fig. 2