

所別：大氣物理研究所碩士班 一般生 科目：電磁學

1. A spherical capacitor is formed by two concentric metallic spheres of inner radius b and outer radius a . The charge on the inner sphere is $+Q$ and that on the outer sphere is $-Q$.
 - (a) Determine the potential difference between the spheres. (5 points)
 - (b) Determine the capacitance of the system. (3 points)
 - (c) Estimate the energy stored in the system. (4 points)
 - (d) Find the capacitance of an "isolated" sphere. (4 points)
 - (e) Deduce an approximate expression for the capacitance when the separation between the sphere is very small as compared to their radii. (4 points)
2. (a) Apply Gauss's law for electric fields ($\oint_s \vec{D} \cdot d\vec{s} = Q$) to show the boundary condition, $D_{n1} - D_{n2} = \rho_s$, pertaining to the normal component of the electric flux density at an interface. (6 points)
 - (b) Apply the conservative \vec{E} field ($\oint_c \vec{E} \cdot d\vec{l} = 0$) to show the boundary condition, $E_{t1} - E_{t2} = 0$, pertaining to the tangential component of the electric flux density at an interface. (6 points)
 - (c) What is the electric field intensity inside a conductor? (3 points)
 - (d) Explain that the electrostatic field just above a conductor is always normal to the surface of a conductor using $D_{n1} - D_{n2} = \rho_s$ and $E_{t1} - E_{t2} = 0$. (5 points)
3. The potential difference between the anode and cathode of a cathode-ray oscilloscope is V_1 . For an electron with mass m released from the anode with a zero initial velocity, find
 - (a) the velocity in the x direction as it enters the vertical deflection plates with a separation L and potential difference V_0 in the z direction, (4 points)
 - (b) the acceleration and the velocity in the z direction within the plates with the same length d , (8 points)
 - (c) the vertical displacement as the electron exits the vertical deflection plates at $x = d$. (4 points)
 - (d) the exit velocity in the z direction. (4 points)
4. (a) Write down the most general form of Faraday's law and explain its physical meaning. (7 points)
 - (b) A tightly wound rectangular coil having N turns is rotating in an angular frequency ω in a uniform magnetic field. The area enclosed by the coil is A . Determine the induced emf (electromotive force) in the coil using the concept of motional emf (8 points) and Faraday's law of induction. (5 points)

注意：背面有試題

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5. A thin annular disc of inner radius b and outer radius a carries a uniform surface charge density ρ_s in free space.
- (a) Calculate the electric flux density and electric field intensity at any point when $b \rightarrow 0$ and $a \rightarrow \infty$ using Coulomb's law. Note that explain Coulomb's law before you do the calculation. (12 points)
- (b) Calculate the electric flux density and electric field intensity at any point when $b \rightarrow 0$ and $a \rightarrow \infty$ using Gauss's law for electric fields. Note that explain Gauss's law before you do the calculation. (8 points)