

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

- Derivation processes have to be given.

1. Maxwell's equations in the differential form are given in the following:

$$\nabla \cdot \vec{D} = \sigma_f, \quad (1)$$

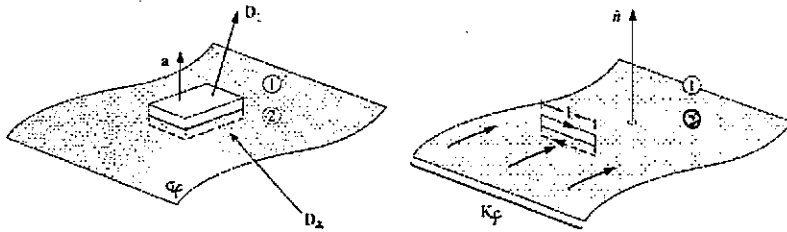
$$\nabla \cdot \vec{B} = 0, \quad (2)$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}, \quad (3)$$

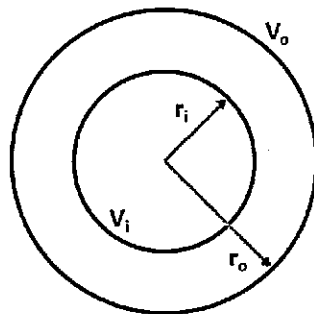
$$\nabla \times \vec{H} = \vec{J}_f + \frac{\partial \vec{D}}{\partial t}. \quad (4)$$

Please derive the Maxwell's equations in the integral form using the Gauss's divergence theorem and the Stokes' theorem. (8%)

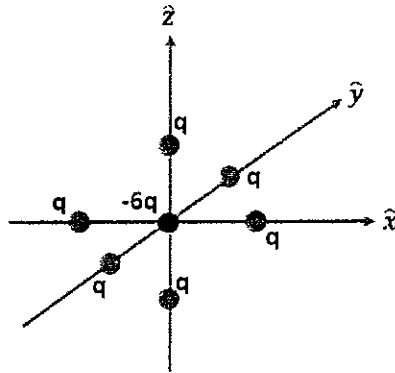
2. Please derive the boundary conditions of \vec{E} , \vec{B} , \vec{D} , and \vec{H} across a boundary between two different media with surface charge density σ_f and surface current density \vec{K}_f using Maxwell's equations. Make sure the boundary conditions for fields normal and tangential to the surface are given. (8%)



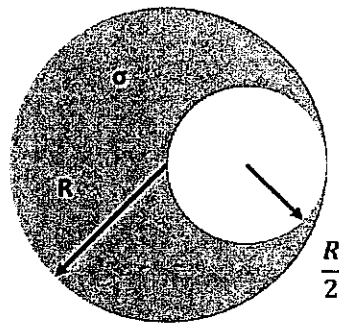
3. In problem 1, Maxwell's equations in the differential form are given. (a) Please use them to derive the electromagnetic wave equation in vacuum. (6%) (b) Please show that the speed of light $c = 1/\sqrt{\epsilon_0\mu_0}$ where ϵ_0 and μ_0 are permittivity and permeability of free space, respectively. (2%)
4. As shown in the following figure, two concentric spheres with radii r_i and r_o have corresponding voltages V_i and V_o . Assuming that the voltage at infinity is zero. What are the voltages and electric fields at the following three regions? (a) $r < r_i$. (6%); (b) $r_i \leq r \leq r_o$. (6%); (c) $r_o < r$. (6%)



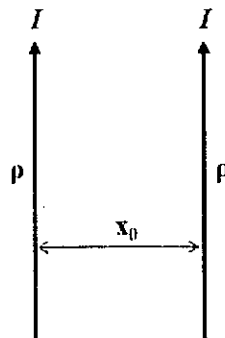
5. As shown in the following figure, there are 7 charged particles in the space. The charge of the one at the origin is $-6q$ while charges of all the others are q and locate at $(\pm\delta, 0, 0)$, $(0, \pm\delta, 0)$, and $(0, 0, \pm\delta)$. What are the electric field and the voltage? (10%)



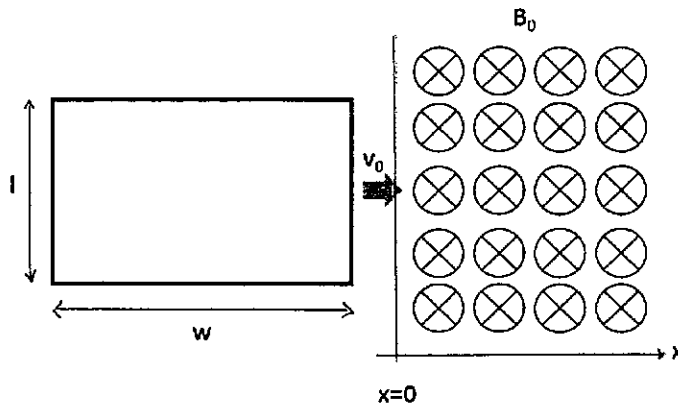
6. As shown in the following figure, a nonconducting solid sphere with a cavity has uniform charge density σ . The radii of the sphere and the cavity are R and $R/2$, respectively. The centers of the sphere and the cavity locate at origin and $(R/2, 0, 0)$, respectively. What are the electric field and the voltage outside the sphere? (10%)



7. As shown in the following figure, two parallel wires with mass density ρ carry the same current I flowing in the same direction. The initial distance between two wires is x_0 . Please derive (a) the acceleration of each wire. (6%); (b) the equation of motion of each wire using $\vec{F} = m\vec{a}$. (6%); (c) the time when two wires crash into each other. (6%)



8. As shown in the following figure, a uniform magnetic field B_0 pointing into the page at $x > 0$ is present. A rectangular ring with total resistance R enters the region of $x > 0$ from the region of $x < 0$ with an initial velocity $\vec{V} = V_0 \hat{x}$. The mass, the length and the width of the rectangular ring are m , l and w , respectively. Assume that the shape of the ring does not change. Please derive (a) the force acts on the ring. (6%); (b) the equation of motion of the ring using $\vec{F} = m\vec{a}$. (6%) (c) What's the requirement of w and l to stop the rectangular ring? (6%)



- (d) What happen if there is a cut on one side of the rectangular ring as shown in the following? (2%)

