※ 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. Please write down Maxwell's equations in a matter in the differential form. (10%)

2. As shown in Fig. 1(a), the radii of two concentric spheres are $r_i$ and $r_o$, respectively. The electric potential of the inner sphere is $V_0$ while the outer sphere is grounded. (a) What's the electric potential as a function of $r$ between two spheres? (5%) (b) What's the electric field as a function of $r$ between two spheres? (5%) (c) What's the capacitance between two spheres? (5%) (d) Shown in Fig. 1(b), there are three concentric spheres. Their radii of the inner, the middle, and the outer spheres are $r_1$, $r_2$, and $r_3$, respectively. The electric potential of the inner sphere is $V_0$ while the outer sphere is grounded. What is the electric potential of the middle sphere? (5%)
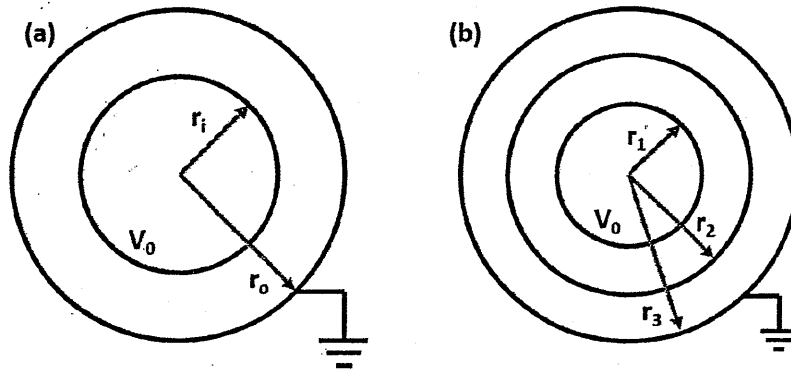


Figure 1:

3. Shown in Fig. 2 are four infinite wires parallel to each other. The diameter of each wire is $d$. The mass density of each wire is $\rho$. They are arranged in a circle with a radius of $r_0$. Assume that a constant current $I$ flows through each wire. (a) What's the acceleration of each wire? (5%) (b) What's the equation of motion of each wire? (5%) (c) What's the total kinetic energy per unit length when four wires collide with each other at the center? (10%)
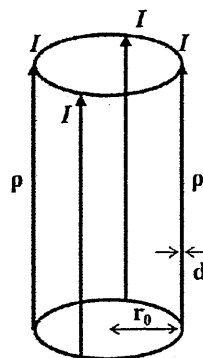


Figure 2:

4. Shown in Fig. 3 is a solenoid with a single loop coil inside the solenoid. The length of the solenoid is $L$. There are $N$ turns of coils. The radius of each coil is $r_2$. The radius of the single loop coil is $r_1$. Assuming that the current flows through the solenoid increases with time and is written as $I = \alpha t$ where $\alpha$ is a constant. (a) What is the induced voltage between point $A$ and $B$? (5%) (b) If a resistor with a resistance $R$ is connected between point $A$ and $B$, what is the pinch force on the single loop coil right after the resistor is connected to the single loop? (5%) (c) What is the equation of motion of the single loop coil assuming that the solenoid does not move? (10%)
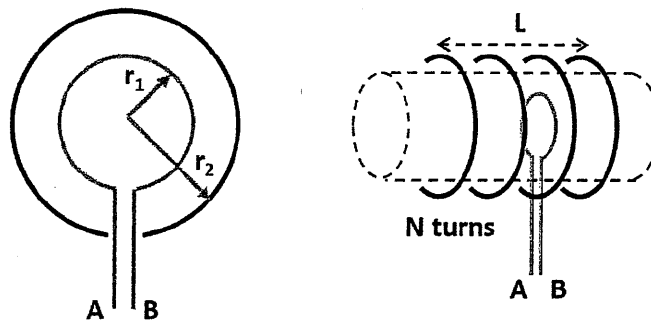


Figure 3:

5. Shown in Fig. 4 a parallel-plate capacitor filled with two slabs of linear dielectric material. The thickness of each slab is $d$. The dielectric of Slab 1 and Slab 2 are $\epsilon_1$ and $\epsilon_2$, respectively. The free charge density on the top and the bottom plate are $+\sigma$ and $-\sigma$, respectively. (a) What are the electric displacements $\vec{D}$ in each slab? (5%) (b) What are the electric fields $\vec{E}$ in each slab? (5%) (c) What is the polarization $\vec{P}$ in each slab? (5%) (d) What is the potential difference between the two plates? (5%) (e) What are the bounded charges in each slab? (5%) (f) What are the bounded surface charges on each slab? (5%)
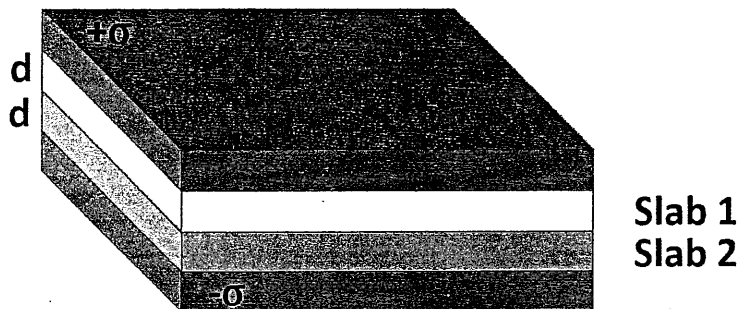


Figure 4: