國立成功大學

112學年度碩士班招生考試試題

編　號：54

系　所：太空與電漿科學研究所

科　目：電磁學

日　期：0206

節　次：第 1 節

備　註：不可使用計算機

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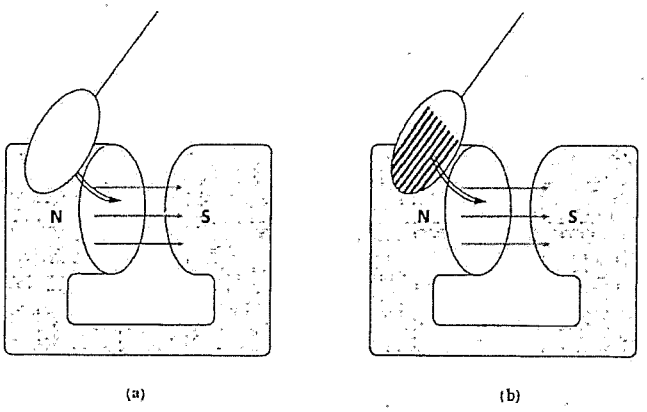
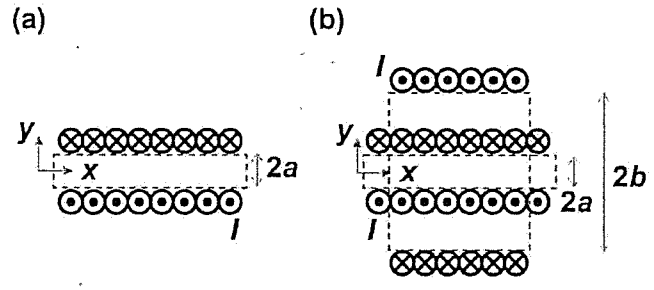
※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

- Derivation processes have to be given.

1. [10% in total] Shown in the following figures, there are two identical sets of magnets. Two aluminum plates are swung between the magnets. The plate in Fig. (b) has some cuts as shown in the figure. Which one will stop earlier and why? (10 %)



2. [15 % in total] Shown in the following figures, there are two sets of idea solenoids with infinite lengths. The current directions are shown in the figures. (2a) In Fig. (a), the radius of the solenoid is a, and there are N_a turns within a length of L. Assuming that the current flowing through the solenoid is I, what is the magnetic field at different y? (5 %) (2b) In Fig. (b), there are two coaxial solenoids. The radius of the inner solenoid is a while the radius of the outer solenoid is b. There are N_a turns within the length of L for the inner solenoid. There are N_b turns within the length of L for the outer solenoid. Assuming that the same current I flows through both solenoids but in the opposite direction, what is the magnetic field at different y? (10 %)



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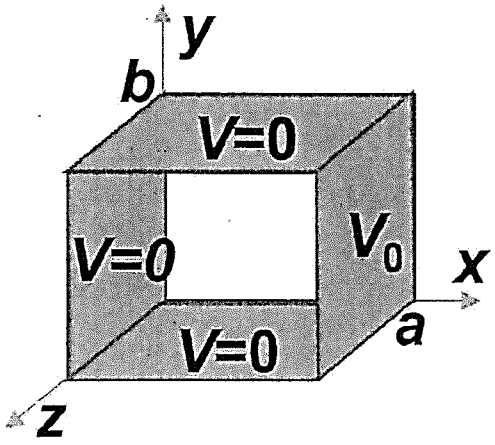
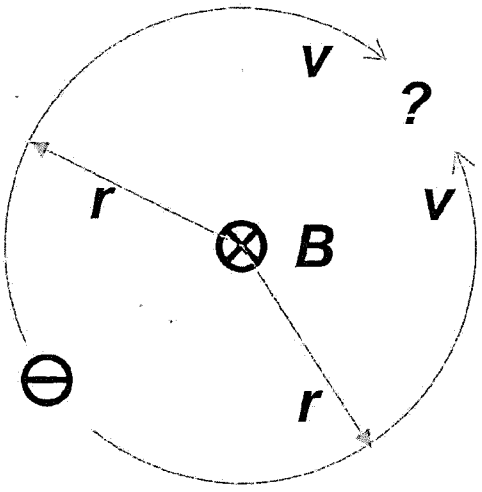
3. [30 % in total] The following figure shows four infinitely long metal plates. The one on xz plane and the one on yz plane are grounded, i.e., $V = 0$. The one parallel to xz plane located at $y = b$ is also grounded. The one parallel to yz plane located at $x = a$ is at a constant potential V_0. Please (3a) find the potential inside the resulting rectangular pipe. (20 %) (3b) Find the electric field inside the rectangular pipe. (10 %)



4. [25 % in total] As shown in the following figure, there is a uniform magnetic field pointing out of the paper (z axis). An electron is moving on the xy plane with a speed of v. The electron gyros around the magnetic field line (circular motion) due to the Lorentz force. (4a) Please write down the formula of the Lorentz force. (5 %) (4b) Does the electron gyro around the magnetic field line in the clockwise or counterclockwise direction? (5 %) (4c) What is the radius of the circular motion? (5 %) (4d) What's the rotational frequency (gyro frequency) of the circular motion? (10 %)



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5. [20 % in total] Shown in the following Fig. (a) is a simplified schematic of a Streak Camera that can convert temporal electron signal into a spatial image. In the camera, there is a pair of electrodes parallel to each other and with a separation of d. Lengths of both electrodes are S. The top electrode is at potential U_{up} while the bottom electrode is at potential U_{bottom} such that a uniform electric field $E\hat{y}$ is provided between the electrodes. Assume that no electric field is presented outside the electrode pair. The distance between the screen and the end of the region with the field is L. The screen is coated with phosphor so that it lights out when electrons reach the screen. Assume that the intensity of the screen is proportional to the number of electrons arriving on the screen. Assume that $L >> S$. When electrons with a velocity $\vec{v}_0 = v_0\hat{z}$ enter the camera, they are accelerated in the $\hat{y}$ direction because of the electric field within the electrode pair. (5a) Assuming that $U_{\text{up}} = U_o/2$ and $U_{\text{bottom}} = -U_o/2$, what's the acceleration of electrons when they are between electrode pair? (5 %) (5b) Assuming that $U_{\text{up}} = U_o/2$ and $U_{\text{bottom}} = -U_o/2$, electrons will arrive on the screen at $y = \delta$. What is δ? (10 %) (5c) Let U_{up} and U_{bottom} change with time. The functions are $U_{\text{up}}(t) = U_o/2 - U_o t/\tau$ and $U_{\text{bottom}}(t) = -U_o/2 + U_o t/\tau$. Let the time electrons pass through the electrode pair be neglected. Therefore, electrons that come into the camera at $t = 0$ arrive at the screen at $y = \delta$ while those come into the camera at $t = \tau$ arrive at the screen at $y = -\delta$. Figure (b) shows the number of electrons that enter the camera as a function of time. Please draw the intensity of the screen as a function of y. (5 %)