

國立成功大學  
110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： 0202

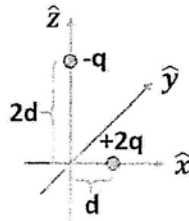
節 次： 第 1 節

備 註： 不可使用計算機

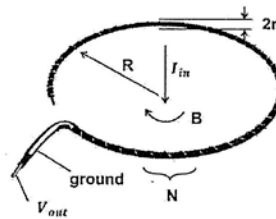
※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

- Derivation processes have to be given.

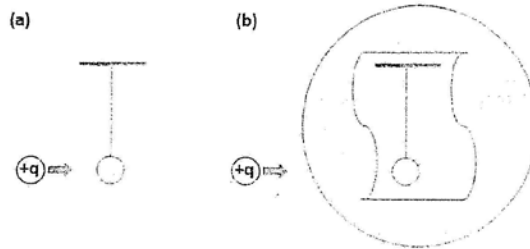
1. As shown in the following figure, there are 2 charged particles in the space. The charge of the one locating at  $(d, 0, 0)$  is  $+2q$ . The charge of the one locating at  $(0, 0, 2d)$  is  $-q$ . What are the electric field and the electric potential? (11 %)



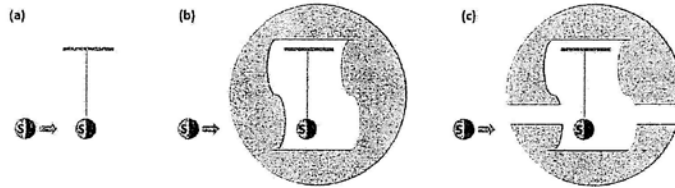
2. Shown in the following figure is called the Rogowski coil. It is used to measure the current going through the center of the coil. Assume that the radius of the coil is  $R$ . There are  $N$  small coils with a radius of  $r$  around the Rogowski coil connected in series. One end of the coil is at ground and the other end of the coil is indicated as  $V_{out}$  in the figure. When there is a current  $I_{in}$  going through the center of the coil, it generates a magnetic field  $B$  as shown in the figure. If the current changes with time, it induces a voltage  $V_{out}$  across all coils. Please show  $V_{out}$  as a function of  $I_{in}$ . (11 %)



3. As shown in the following figures, two pendulums are hanging freely. The weights of the pendulum are metal balls while the strings are made of insulators. Assuming that a charged particle with charge  $+q$  moves toward the pendulum. (A) What will happen to the pendulum in Fig. (a)? (4 %) (B) Please explain the reason for your answer to question (A). (4 %) (C) As shown in Fig. (b), assuming that the pendulum is placed in a perfect conductor. What will happen to the pendulum in Fig. (b)? (4 %) (D) Please explain the reason for your answer to question (C). (10 %)



4. As shown in the following figures, three pendulums are hanging freely. The weights of the pendulum are permanent magnets with the north and the south poles indicated in the figures. The strings are made of insulators. Assuming that a permanent magnet moves toward the pendulum. (A) What will happen to the pendulum in Fig. (a)? (4 %) (B) Please explain the reason for your answer to question (A) (4 %) (C) As shown in Fig. (b), assuming that the pendulum is placed in a perfect conductor. What will happen to the pendulum in Fig. (b)? (4 %) (D) Please explain the reason for your answer to question (C). (10 %) (E) As shown in Fig. (c), assuming that the pendulum is placed in a perfect conductor with a cut. What will happen to the pendulum in Fig. (c)? (4 %) (F) Please explain the reason for your answer to question (E). (10 %)



5. Shown in the following figure (a) is the schematic of a Thomson Parabola Spectrometer. In the spectrometer, there is a pair of magnet that provides a uniform magnetic field  $\vec{B}_0 = -B_0\hat{y}$ . The length of the pair of the magnets is  $S$ . In the same range, there is a pair of electrodes with a separation of  $d$ . One of the electrodes is at ground and the other one is at  $U_0$  such that a uniform electric field  $\vec{E}_0 = -E_0\hat{y}$  is provided in the same range. Assume that no electric field and no magnetic field are presented outside the electrodes' and magnets' pairs. The distance between the screen and the end of the region with fields is  $L$ . Assume that  $L \gg S$ . When an ion with charge  $q$  and velocity  $\vec{v}_0 = v_0\hat{z}$  enters the spectrometer, it moves toward  $-\hat{y}$  because of the electric field and moves toward  $\hat{x}$  because of the magnetic field. When ions with different energy pass through the field regions and arrive at the screen, they form a curved line as shown in the following figure (b). (A) Please write down the equation of motion of the ion. (4 %) (B) Please write down the equation of the curve on the screen. (12 %) (C) There are two curves from two different kinds of ions as shown in figure (b). We have known that one is from hydrogen ions and the other one is from deuterium ions. Deuterium is the isotope of hydrogen. The mass of the deuterium ion is twice that of the hydrogen atom. So, which curve is from deuterium ions and which one is from hydrogen ions? (4 %)

