

國立清華大學命題紙

98學年度 奈米工程與微系統研究所 (0518) 碩士班 入學考試

科目 物理 科目代碼 1804 共 3 頁 第 1 頁 請在試卷答案紙內作答

注意:

1. 請按照題目順序作答
2. 填充題不須寫計算過程

填充題(30%)

1. (5%) When three capacitors,  $C_1$ ,  $C_2$ , and  $C_3$  are connected in series, the equivalent capacitance  $C_{eq}$  is \_\_\_\_\_.
2. (5%) Consider a nonconductive, infinite plane with a uniform surface charge density  $+\sigma$ , what is the electric field? \_\_\_\_\_
3. (5%) A container of argon gas (molar mass 40 g) is five times hotter than a container of hydrogen gas (molar mass 2g). When both containers are at thermal equilibrium, the ratio of respective root mean square speeds (argon versus hydrogen molecules) is \_\_\_\_\_.
4. (5%) Under the conditions of angular momentum conservation, if the moment of inertia is reduced to half, what will the kinetic energy become with respect to the initial kinetic energy ( $E_0$ )? \_\_\_\_\_.
5. (5%) A light of frequency  $f$  travels in a transparent medium with refractive index  $n$ . What is the relation between the light speed in this medium ( $v$ ) and that in vacuum ( $c$ )? \_\_\_\_\_.
6. (5%) A solid conducting sphere with radius  $R$  is filled with positive charge  $Q$ . Please find the electric field inside the sphere. \_\_\_\_\_

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計算題(70%)

1. (a) For a uniform rigid rod of length  $L$  and mass  $M_1$ , please calculate its moment of inertia, when the rotation axis is through one of the ends and is perpendicular to the rod. (5%) (b) If there is another disk with radius  $R$  and mass  $M_2$  which is connected to another end of the rod through the center of disk, please calculate the combined moment of inertia. (10%)
2. The fastest possible rate of rotation of a planet is that for which the gravitational force on material at equator just barely provides the centripetal force needed for the rotation. Show that the corresponding shortest period of rotation is  $T = \sqrt{\frac{3\pi}{G\rho}}$ , where  $G$  is the gravitational constant and  $\rho$  is the mass density of the planet. (10%)
3. Consider a capacitor-resistor circuit shown in Figure 1. The capacitor  $C$  is discharged through a resistor  $R$  after the switch is closed. (a) Please derive the charge on the capacitor ( $Q$ ) as a function of time (the initial charge on the capacitor is  $Q_0$ ). (10%) (b) How much time will it take for the charge on the capacitor drops to one fifth of its initial value? (5%) (c) How much time will it take for the stored energy on the capacitor drops to half of its initial value? (5%)

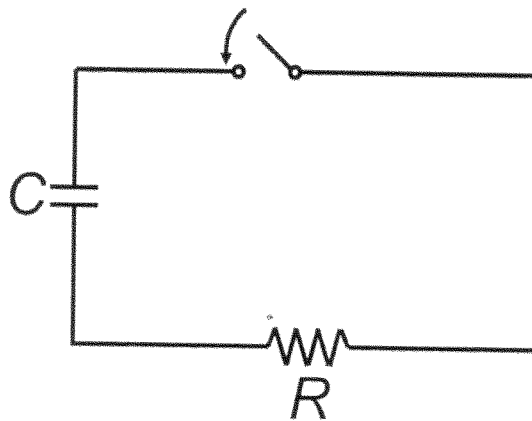


Figure 1

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4. The conducting bar as shown in Figure 2 has a mass  $m$  and length  $l$ , moving on two frictionless parallel rails. There is a uniform magnetic field  $B$  directed into the page. The bar is given an initial velocity  $v_i$  to the right and is released at  $t = 0$ . Please find the velocity of bar as a function of time. (10%) (b) What is the direction of the induced current in loop (clockwise or counterclockwise)? (5%)

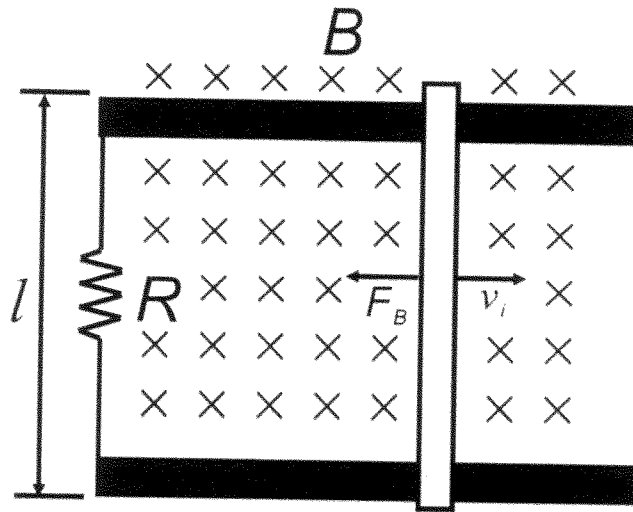


Figure 2

5. In the Young's double-slit experiment, a viewing screen is placed from a double-slit source by 1 m. The distance between the two slits is 0.2 mm. The third bright fringe (not counting the central bright fringe straight ahead from the slits) is found to be displaced by 7.5 mm from the central fringe. Please find the wavelength of the light. (10%)