

淡江大學 108 學年度日間部寒假轉學生招生考試試題

系別：物理系三年級

科目：電磁學

25-1

考試日期：1月13日(星期一) 第1節

本試題共 3 大題， 1 頁

1. Consider a uniformly charged “solid sphere” of radius  $a$  and total charge  $q$ . The sphere is surrounded by a “concentric shell” of radius  $b$  carrying a uniform negative surface charge density of total charge  $-q$ .

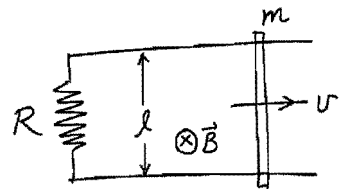
- (a) Use Gauss’s law to find the electric field  $\vec{E}$  for the regions  $a \geq r \geq 0$ ,  $b > r \geq a$ , and  $r \geq b$ , where  $r$  is the distance from the center of the sphere. (20%)
- (b) Take the reference point where the potential  $V = 0$  to be at  $r = \infty$ . Then find the electric potential  $V(r)$  also for  $a \geq r \geq 0$ ,  $b > r \geq a$ , and  $r \geq b$ . (15%)

2. A steady current flows along a long “cylindrical” wire of radius  $a$  with the symmetry axis on the  $z$ -axis. Suppose that the current density in the wire is given by

$$\vec{J} = J_0(a - s)\hat{z}$$

where  $s$  is the radial coordinate and  $J_0$  is a constant. Use the Ampere’s law to find the magnetic field both inside and outside the wire. (30%)

3. A metal bar of mass  $m$  slides frictionlessly on two parallel conducting rails a distance  $l$  apart as shown. A resistor  $R$  is connected across the rails, and a uniform field  $\vec{B}$ , pointing into the page, fills the entire region.



- (a) If the bar moves to the right at a speed  $v$ , what is the current in the resistor? In what direction does it flow, clockwise or anti-clockwise? (12%)
- (b) What is the magnetic force on the bar? In what direction, right or left? (6%)
- (c) If the bar starts out with speed  $v_0$ , at time  $t = 0$ , what is  $v(t)$  as a function of time  $t$ ? (12%)
- (d) Show that the total energy delivered to the resistor is the same as the initial kinetic energy of the bar  $\frac{1}{2}mv_0^2$ . (5%)