

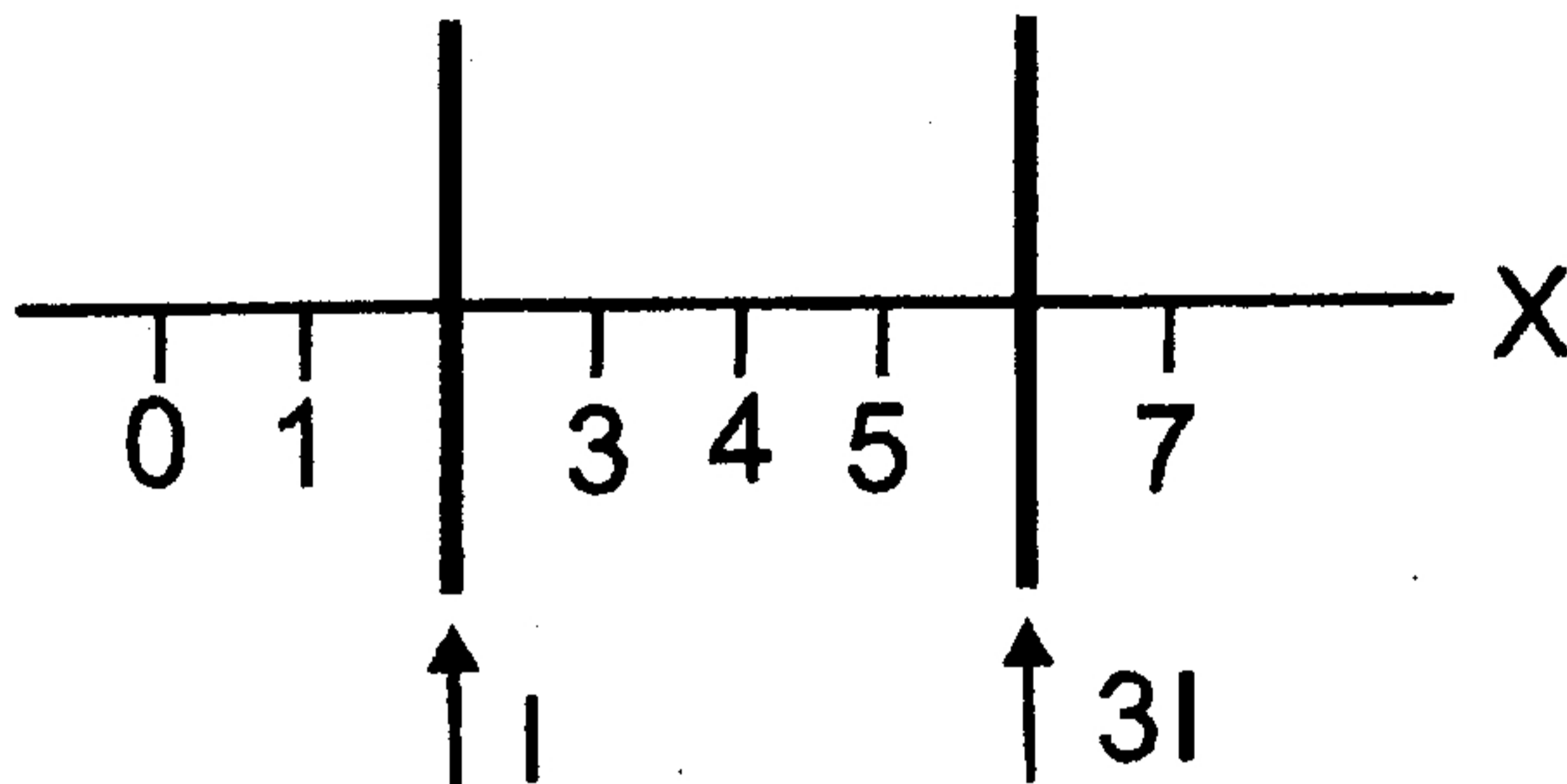
本試題是否可以使用計算機： 可使用， 不可使用 (請命題老師勾選)

考試日期：0301，節次：2

☒ 單選題共 8 題佔 40 分、計算題共 6 題共 60 分，請於答案卷上依序列出答案 ☒

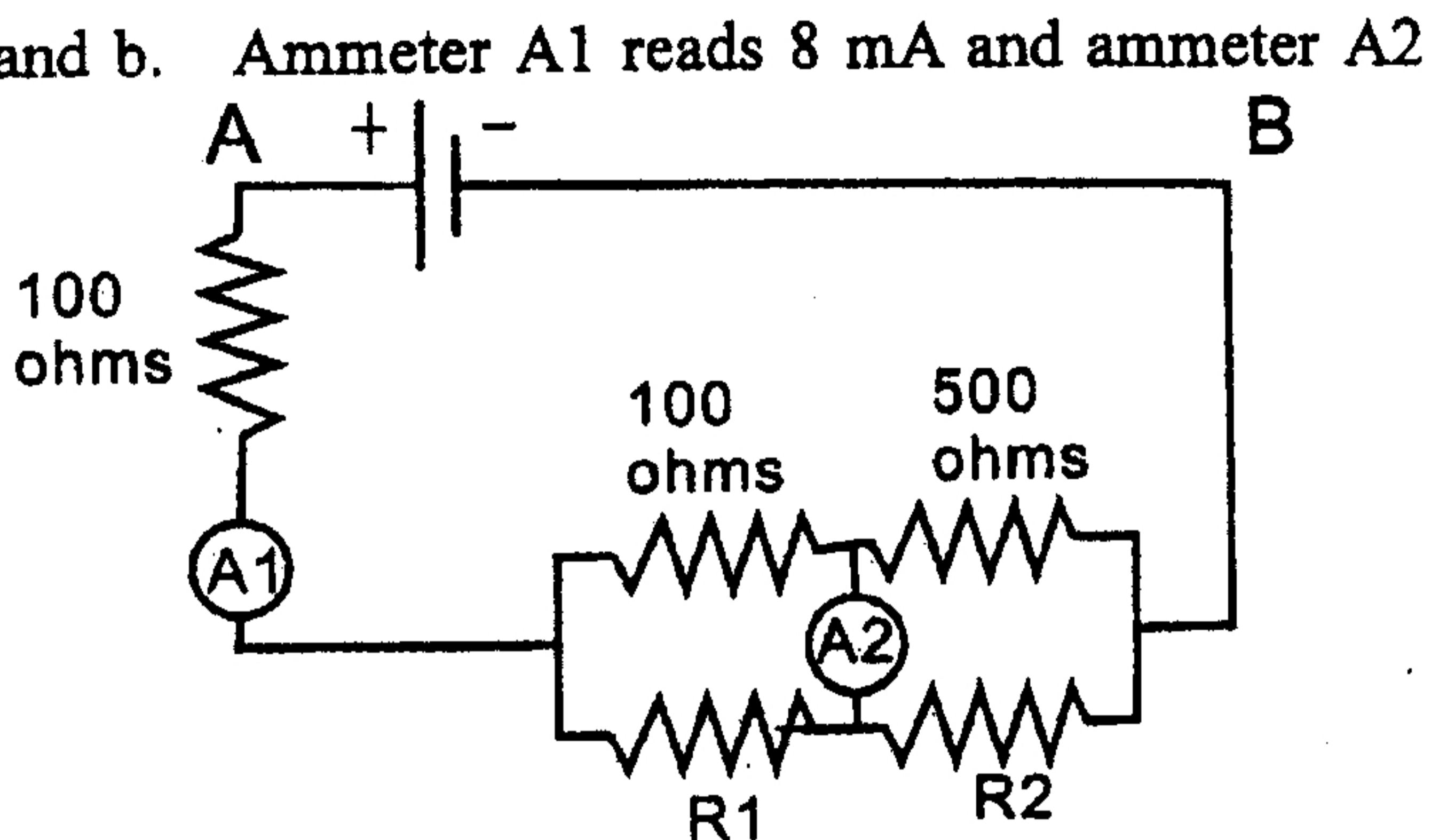
1. 單選題： (總分: 40%，每題: 5%)

(1) Two long straight current-carrying parallel wires cross the x axis and carry currents I and $3I$ in the same direction, as shown. At what value of x is the net magnetic field zero?



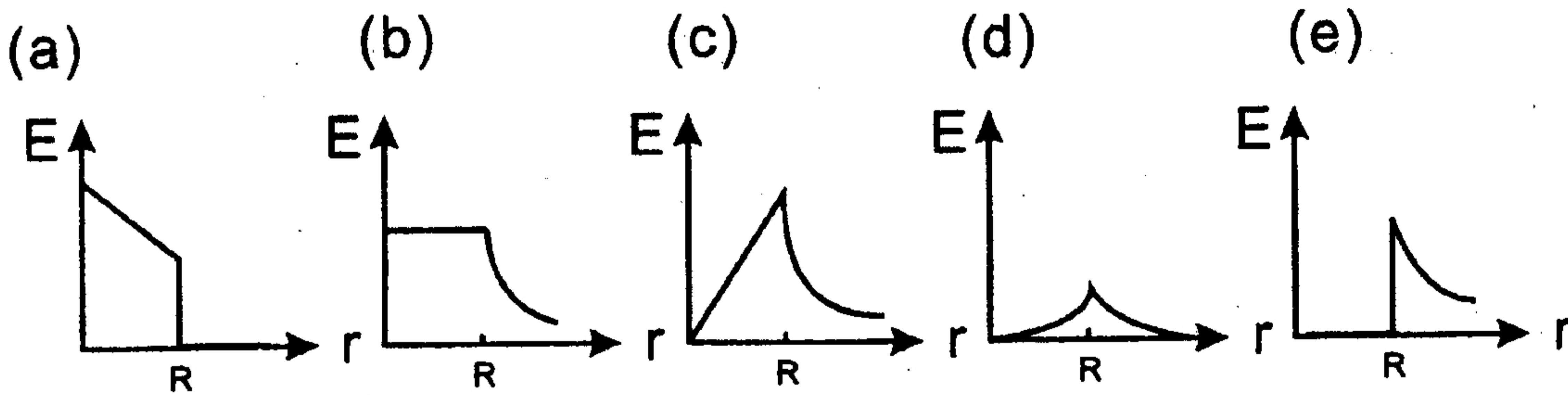
- (a) 0 (b) 1 (c) 3 (d) 5 (e) 7

(2) A battery maintains two volts between points a and b. Ammeter A1 reads 8 mA and ammeter A2 reads zero. What is the value of R_1 ?



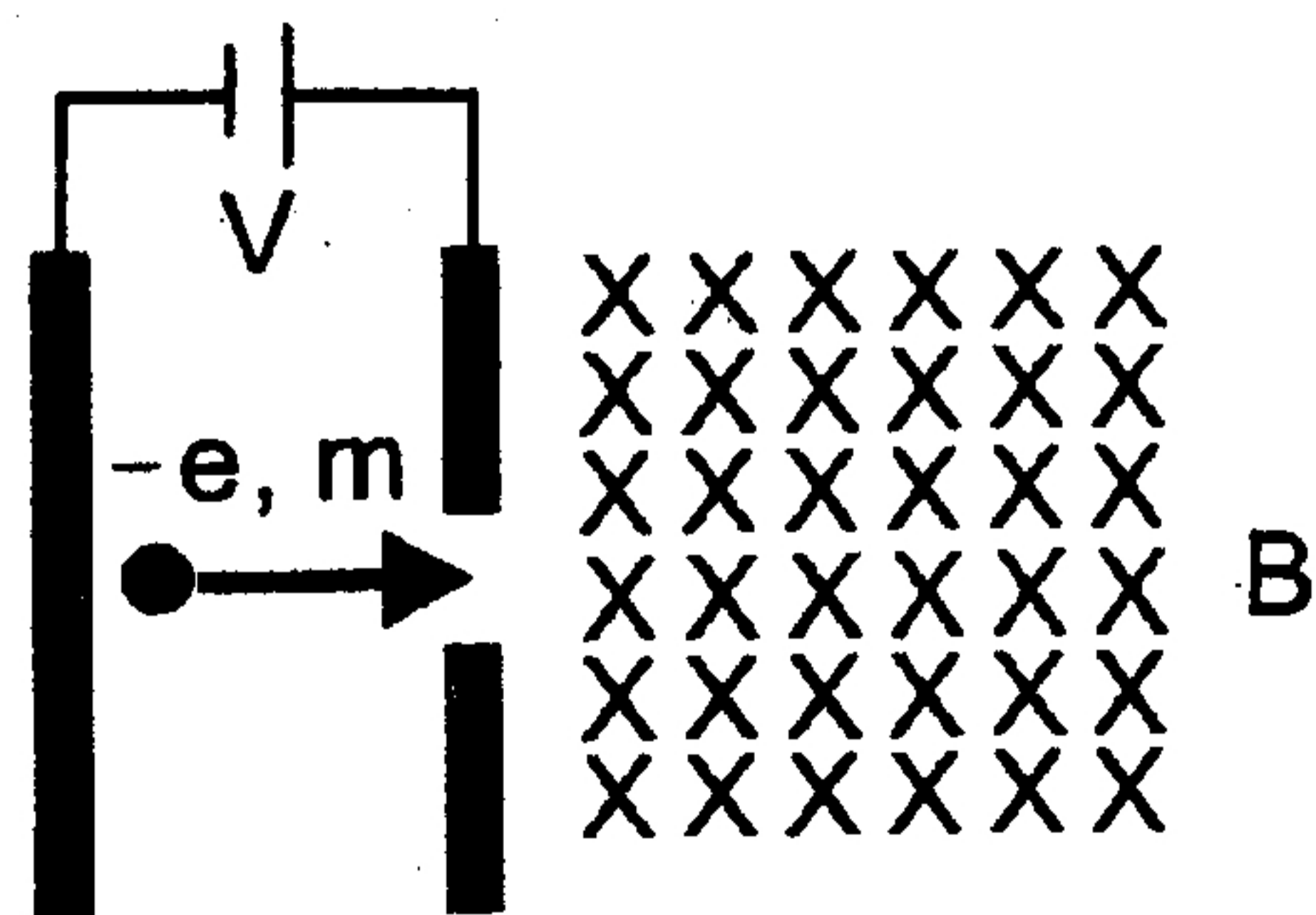
- (a) 33.3 Ω
 (b) 50.0 Ω
 (c) 66.7 Ω
 (d) 166.7 Ω
 (e) 300 Ω

(3) A solid insulating sphere of radius R contains a uniform volume distribution of positive charge. Which of the graphs below correctly gives E as a function of r ?



(4) Electrons (mass m , charge $-e$) are accelerated from rest through a potential difference V and are then deflected by a perpendicular magnetic field B . The radius of the resulting electron trajectory is:

- (a) $\frac{\sqrt{2eV/m}}{B}$ (b) $B\sqrt{2eV/m}$ (c) $\frac{\sqrt{2mV/e}}{B}$
 (d) $B\sqrt{2mV/e}$ (e) non of these



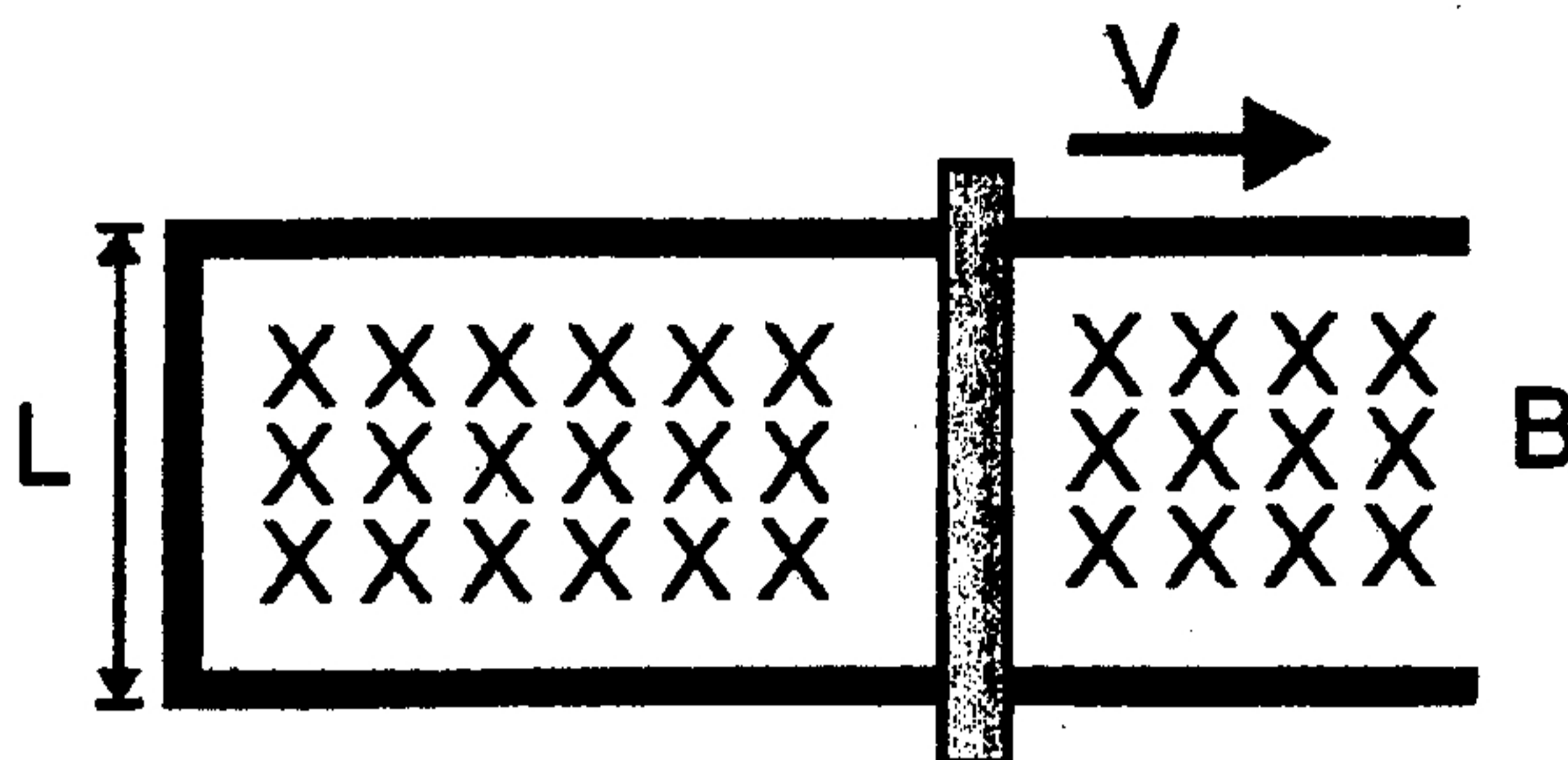
(背面仍有題目,請繼續作答)

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(5) A rod lies across frictionless rail in a uniform magnetic field B , as shown. The rod moves to the right with speed V . In order for the emf around the circuit to be zero, the magnitude of the magnetic fields should:

- (a) not change
- (b) increase linearly with time
- (c) decrease linearly with time
- (d) increase quadratically with time
- (e) decrease quadratically with time



(6) The dimensions of the product $\mu_0 \epsilon_0$ are related to those of velocity as:

- (a) Velocity
- (b) Velocity
- (c) $\frac{1}{\text{Velocity}}$
- (d) $\frac{1}{(\text{Velocity})^2}$
- (e) $\frac{1}{\sqrt{\text{Velocity}}}$

(7) Which of the following expression for Maxwell's equation is correct?

- (a) $\nabla \cdot E = -\frac{\partial B}{\partial t}$
- (b) $\nabla \times E = \frac{\rho}{\mu_0}$
- (c) $\nabla \cdot B = \frac{\rho}{\mu_0}$
- (d) $\nabla \times B = \mu_0 J + \mu_0 \epsilon_0 \frac{\partial E}{\partial t}$

(8) Which is the correct boundary condition in electrostatics and magnetostatics, respectively, at a boundary between two different media?

- (a) The component of E tangent to the surface has the same value and the component of B tangent to the surface has the same value
- (b) The component of E tangent to the surface has the same value and the component of B normal to the surface has the same value
- (c) The component of E normal to the surface has the same value and the component of H tangent to the surface has the same value
- (d) The component of D tangent to the surface has the same value and the component of H normal to the surface has the same value

2~7 題為計算題：（總分：60%，每題：10%）

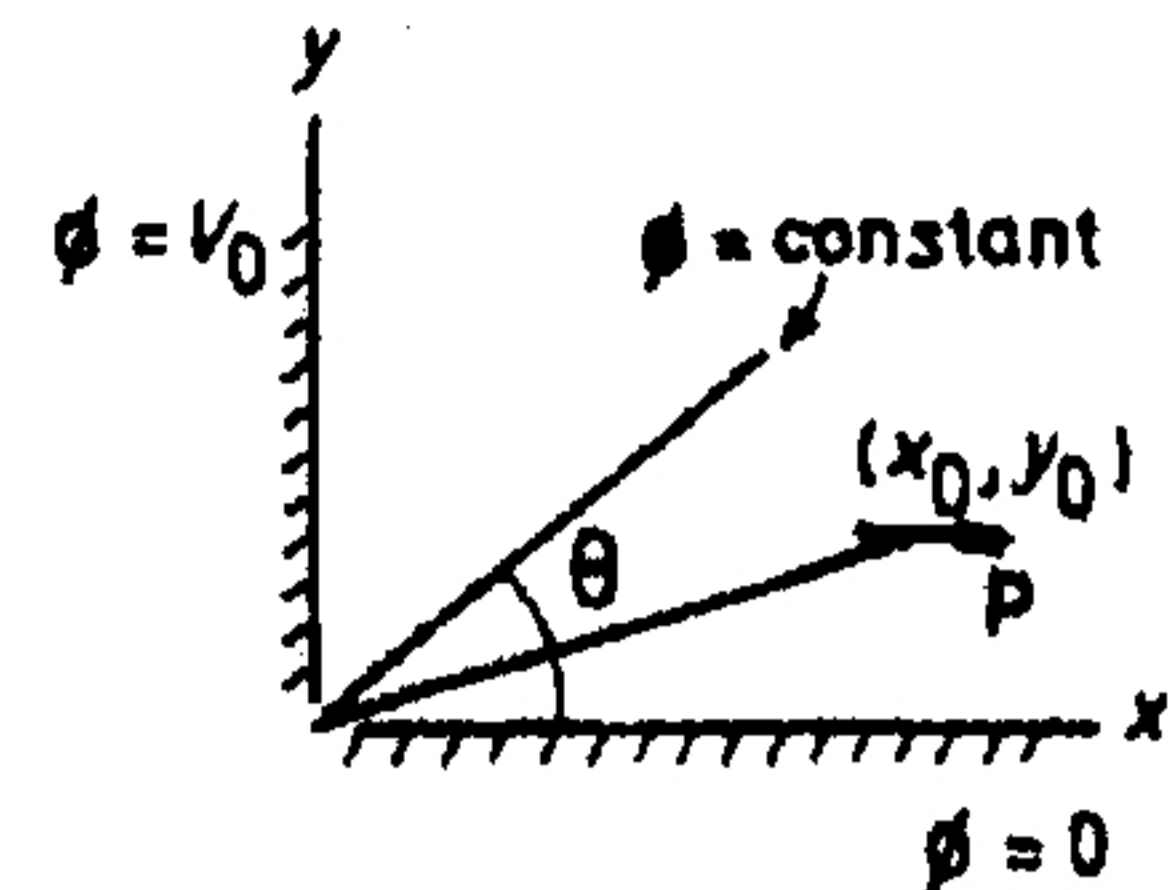
2. Calculate the amount of electrostatic energy of a uniform sphere of charge with radius b and a volume charge ρ stored in the following regions: (a) Inside the sphere, (b) outside the sphere.
3. Find the inductance per unit length of a very long solenoid with air core having n turns per unit length.
4. A plane wave with instantaneous expression for the electric field $E(z,t) = a_x E_{10} \sin(\omega t - kz) + a_y E_{20} \sin(\omega t - kz + \phi)$. (a) show it is elliptically polarized, and (b) draw the polarization ellipse

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5. An electric dipole of moment $\vec{P} = (P_x, 0, 0)$ is located at the point $(x_0, y_0, 0)$, where $x_0 > 0$ and $y_0 > 0$.

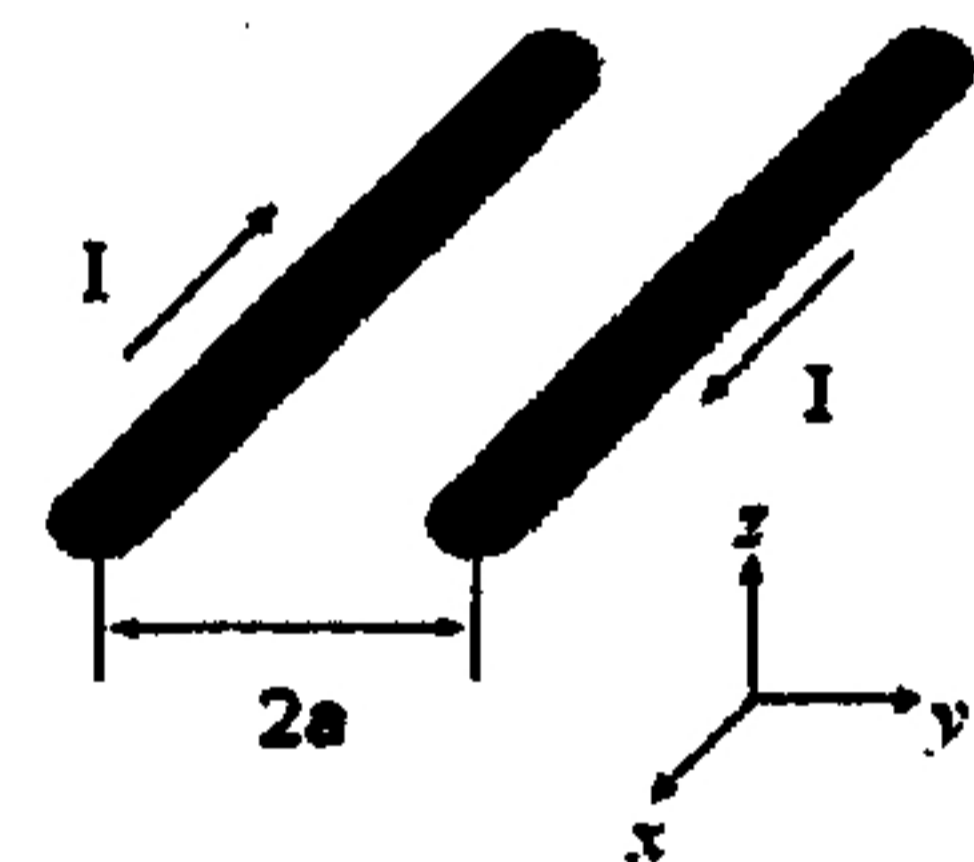
The planes $x = 0$ and $y = 0$ are conducting plates with a tiny gap at the origin. The potential of the plate at $x = 0$ is maintained at V_0 with respect to the plate $y = 0$. The dipole is sufficiently weak so that you can ignore the charges induced on the plates. The right figure is a sketch of the conductors of constant electrostatic potentials.



- (a) Please deduce a simple expression for the electrostatic potential $\phi(x, y)$.
- (b) Calculate the force on the dipole.

6. The right figure shows two long parallel wires carrying equal and opposite steady currents I and separated by a distance $2a$.

- (a) Find an expression for the magnetic field strength at a point in the median plane (i.e. xz plane in the figure) lying a distance z from the plane containing the wires.
- (b) Find the ratio of the field gradient $d B_z / dz$ to the field strength B .



7. A waveguide is constructed so that the cross section of the guide forms a triangle with sides of length a , a , and $\sqrt{2} a$ (see the following figure). The walls are perfect conductors and $\epsilon = \epsilon_0, \mu = \mu_0$ inside the guide. Determine the allowed modes for TE, TM, and TEM electromagnetic waves propagating in the guide. For allowed modes find $\vec{E}(x, y, z, t)$, $\vec{B}(x, y, z, t)$ and the cutoff frequencies.

