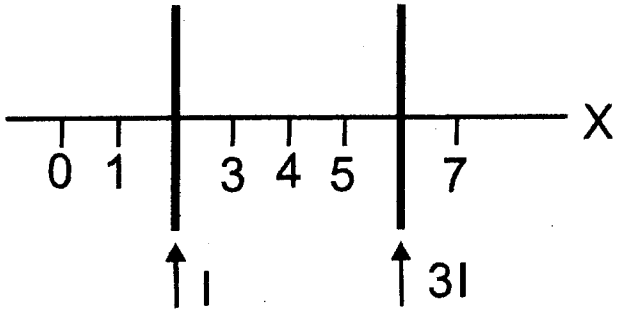
本試題是否可以使用計算機：☐可使用 ，☑不可使用 （請命題老師勾選）　　考試日期：0301，節次：2

☒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%)

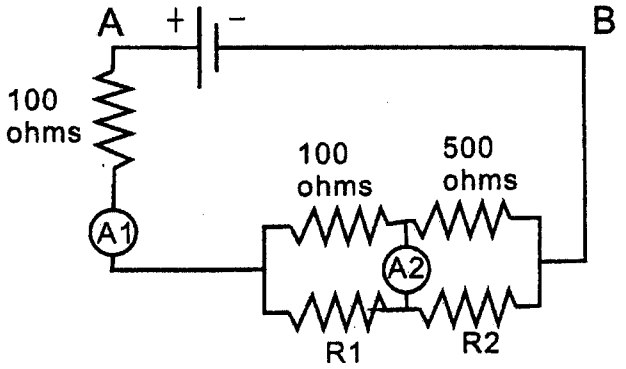
(1) Two long straight current-carrying parallel wires cross the x axis and carry currents I and 3I in the same direction, as shown. At what value of x is the net magnetic field zero?

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

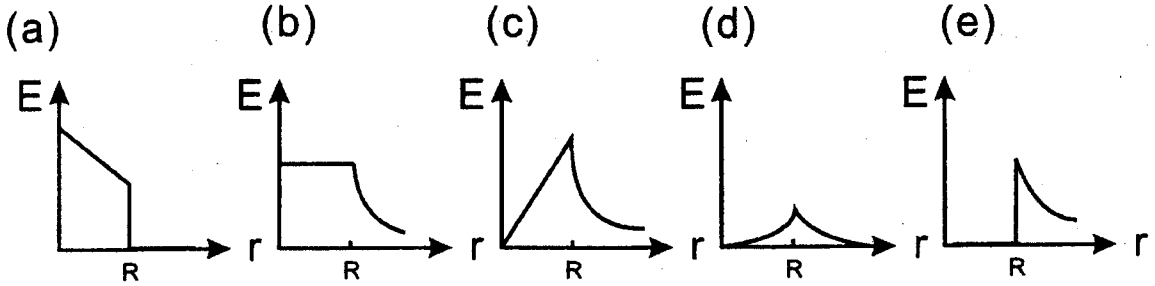


(2) A battery maintains two volts between points a and b. Ammeter A1 reads 8 mA and ammeter A2 reads zero. What is the value of R1?

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



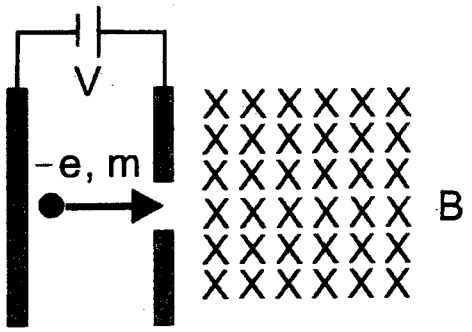
(3) A solid insulating sphere of radius R contains a uniform volume distribution of positive charge. Which of the graphs below correctly gives E as a function of r?



(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) $\frac{\sqrt{2mV/e}}{B}$

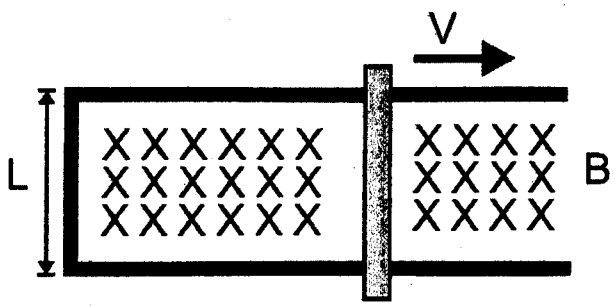
(d) $B\sqrt{2mV/e}$ (e) non of these



(背面仍有題目,請繼續作答)

(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 $\mu_0\varepsilon_0$ 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) $\nabla \times B = \mu_0 J + \mu_0 \varepsilon_0 \frac{\partial E}{\partial t}$

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

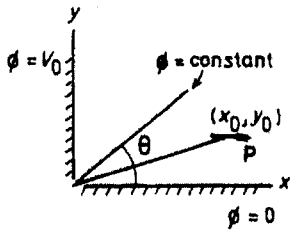
(a) The component of E tangent to the surface has the same value and the component of B tangent to the surface has the same value
(b) The component of E tangent to the surface has the same value and the component of B normal to the surface has the same value
(c) The component of E normal to the surface 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 $E(z,t)=a_xE_{10}\sin(\omega t-kz)+a_yE_{20}\sin(\omega t-kz+\varphi)$. (a) show it is elliptically polarized, and (b) draw the polarization ellipse

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 $y_0 > 0$.

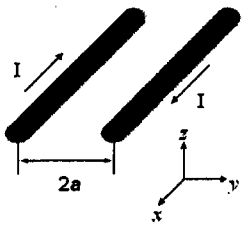
The planes $x = 0$ and $y = 0$ are conducting plates with a tiny gap at the origin. The potential of the plate at $x = 0$ is maintained at V_0 with respect to the plate $y = 0$. The dipole is sufficiently weak so that you can ignore the charges induced on the pates. The right figure is a sketch of the 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 dB_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 $\varepsilon = \varepsilon_0, \mu = \mu_0$ 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.