B

九十四學年第二學期 普通物理 B 第二次段考試題

[Benson Ch. 29 – 32] 2006/5/5, ***8:30AM – 10:00AM***

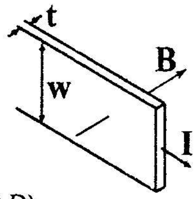
0.【5%】**依下面說明在答案卷上作答者，可得 5 分**

(i) 答案卷第一張爲封面。第一張正反兩面**不要作答**。

(ii)由第二張紙開始算起，第一頁依空格號碼順序寫下所有塡充題答案，**寫在其他頁不記分**。

(iii)計算題之演算過程與答案依題號順序寫在第二頁以後，**每題從新的一頁寫**。

Fig. 1



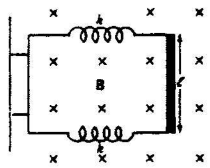
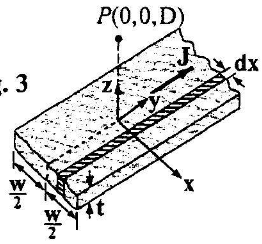


Fig. 2

Fig. 3



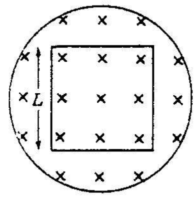


Fig. 4

■ Two parallel wires carry currents into the page. $I_1 = 8$ A is at (0, 0), while $I_2 = 3$ A is at (4m, 0). The resultant magnetic field at (4m, 3m) is 【1】. Find the position 【2】 (in format of (x,y)) where the resultant magnetic field is zero.

■ In country A, the earth's magnetic field is horizontal and directed due north. The direction of the force on an electron moving horizontally due east is 【3】. In another country B, the earth's magnetic field is directed north and downward at 60° to horizontal. The direction of the force on a proton moving vertically up is【4】.

■ A coaxial cable consists of an inner cylindrical conductor of radius a and an outer cylindrical shell of radius b. The inner cylindrical conductor carries a current I download, while the outer carries a current I upward. Find the magnetic field (a) inside the inner conductor 【5】; (b) between the inner and outer conductor【6】; and (c) outside the outer conductor 【7】. Find the self-inductance of a coaxial cable of length l. 【8】.

■ Fig. 1 shows a flat metal strip, of width w and thickness t, in which a current I is flowing. A uniform magnetic field B is directed as shown in the figure. The Hall potential difference in this configuration is V_H. When the thickness t is doubled, the new Hall potential difference is 【9】. When the charge of the carrier changes its sign, the new Hall potential difference 【10】.

■ A mass spectrometer consists of two parts. The front part is a velocity selector in which the magnetic field is B_1 and the electric field is E. The second part has only a magnetic field B_2. When a particle is going to enter the second part, its speed is 【11】. Assume that the radius of the path is r for a particle of mass m and charge q. When B_2 is tripled, the new radius is 【12】.

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■ A conducting loop is formed with two springs of spring constant k and a rod of length l and mass m, as shown in Fig.2. A uniform magnetic field is directed perpendicular to the plane of the loop. At $t=0$, the rod is release with the springs extended by A. Then the induced emf (as a function of time) is 【13】. The maximum value of the emf is 【14】. The position of the rod when the emf reachs the maximum value is 【15】.

Part II. 計算題 (共 55%)

1. An infinitely long thin metal plate of width w and thickness t carries a uniform current density J, as shown in Fig 3. By dividing the plate into infinitesimal strips and using the result for the field due to an infinite wire, (a) find the magnetic field at point P. (b) What is the magnetic field at point P when the width w become infinite? (7%, 6%)

2. Consider a metal wire of resistivity ρ and of radius a. Now wrap the wire tightly around a paper cylinder of radius r to make an ideal solenoid of length X. (a) Find the resistance of the solenoid. (b) Find the self-inductance of the solenoid. (c) What is the time constant? (6%, 7%, 5%)

3. Fig. 4 shows a square loop of side L perpendicular to the uniform field of a solenoid, which has n turns/meter. The current in the solenoid varies according to $I(t) = 4 + 5t^2$. (a) Evaluate $\oint \vec{E} \cdot d\vec{l}$ around the loop. (b) Find the induced electric potential difference between two adjacent corners of the loop. (7%, 5%)

4. A disk of radius R has a charge density $\sigma(r) = \sigma_0 r$ C/m^2 where r is the distance to the center. It rotates about its central axis at ω rad/s with its axis normal to a uniform field B. (a) Find its magnetic moment. (b) Find the torque on the disk. (7%, 5%)

A:

【1】垂直向下	【2】水平向西	【3】 $V_H/2$	【4】 $-V_H$
【5】 $2\times10^{-7}\left(\frac{49}{25},\frac{-32}{25}\right)T$	【6】 $\left(\frac{32}{11},0\right)$	【7】0	【8】 $\frac{\mu_0 I}{2\pi r}$
【9】0	【10】 $\frac{\mu_0 l}{2\pi}\ln\frac{b}{a}$	【11】 $BlA\sqrt{\frac{2k}{m}}\sin(\sqrt{\frac{2k}{m}}t)$	【12】 $BlA\sqrt{\frac{2k}{m}}$
【13】unextended point	【14】 E/B_1	【15】r/3	

B:

【1】 $2\times10^{-7}\left(\frac{49}{25},\frac{-32}{25}\right)T$	【2】 $\left(\frac{32}{11},0\right)$	【3】垂直向下	【4】水平向西
【5】0	【6】 $\frac{\mu_0 I}{2\pi r}$	【7】0	【8】 $\frac{\mu_0 l}{2\pi}\ln\frac{b}{a}$
【9】 $V_H/2$	【10】 $-V_H$	【11】 E/B_1	【12】r/3
【13】 $BlA\sqrt{\frac{2k}{m}}\sin(\sqrt{\frac{2k}{m}}t)$	【14】 $BlA\sqrt{\frac{2k}{m}}$	【15】unextended point	

1. (a) $B_x=\int_{-w/2}^{w/2}\frac{\mu_0 tJdx}{2\pi\sqrt{D^2+x^2}}\frac{D}{\sqrt{D^2+x^2}}=\frac{\mu_0 tJ}{\pi}\tan^{-1}\frac{w}{2D}$

(b) $\tan^{-1}\infty=\frac{\pi}{2}$, therefore $B=\frac{\mu_0 tJ}{2}$,

or $\mu_0(Lt)J=2BL$, therefore $B=\frac{\mu_0 tJ}{2}$

2. (a) $R=\dfrac{\rho 2\pi r\dfrac{X}{2a}}{\pi a^2}=\dfrac{\rho r X}{a^3}$

(b) $$B=\mu_0\frac{X/(2a)}{X}I=\frac{\mu_0 I}{2a}$$
$$N\Phi=\frac{X}{2a}\pi r^2\frac{\mu_0 I}{2a}=LI\rightarrow L=\frac{\pi r^2\mu_0 X}{4a^2}$$

(c) $\tau=\dfrac{L}{R}=\dfrac{\dfrac{\pi r^2\mu_0 X}{4a^2}}{\dfrac{\rho r X}{a^3}}=\dfrac{\mu_0\pi a r}{4\rho}$

3.(a) $B=\mu_0 nI=\mu_0 n(4+5t^2)\therefore\oint E\cdot dl=\dfrac{d\Phi}{dt}=\dfrac{d}{dt}[\mu_0 n(4+5t^2)L^2]=10\mu_0 ntL^2$

(b) $\Delta V=\dfrac{10\mu_0 ntL^2}{4}=2.5\mu_0 ntL^2$

4. (a) $\mu=\int_0^R\pi r^2\dfrac{dq}{T}=\int_0^R\pi r^2\dfrac{2\pi r\sigma(r)dr}{2\pi/\omega}=\int_0^R\sigma_0\omega\pi r^4dr=\dfrac{1}{5}\sigma_0\omega\pi R^5$

(b) $\vec{\tau}=\vec{\mu}\times\vec{B}$, and $\vec{\mu}\perp\vec{B}\therefore\tau=\mu B=\dfrac{1}{5}\sigma_0\omega\pi R^5 B$