103 學年第二學期 普通物理 B 第二次段考試題

[Wolfson Ch. 25-29] 2015/05/19, ***8:20AM – 09:50AM***

A

(i)答案卷第一張正面為封面。第一張正、反兩面不要寫任何答案。

(ii)依空格號碼順序在第二張正面寫下所有填充題答案，不要寫計算過程。

(iii)依計算題之題號順序在第二張反面以後寫下演算過程與答案，**每題從新的一頁寫起**。

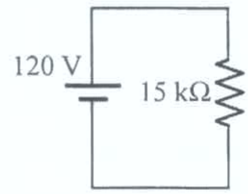
Note: For electron: mass $m_e = 9\times10^{-31}$ kg, charge $q = -1.6\times10^{-19}$ C. Light speed $c = 3.00\times10^{8}$ m/s.

$\epsilon_0 = (4\pi k)^{-1} = 8.85\times10^{-12}\ \mathrm{C^2\cdot N^{-1}\cdot m^{-2}}$, $\mu_0 = 4\pi\times10^{-7}\ \mathrm{N/A^2}$.

$\frac{I_{原}}{I_{後}} = \frac{\cancel{120}/15000}{\cancel{120}/\ldots}$

Part I. Filling the blank (4 points per blank)

$I_{原} = \frac{120}{15000}$ $I_{後} = \frac{120}{(15000+150)}$



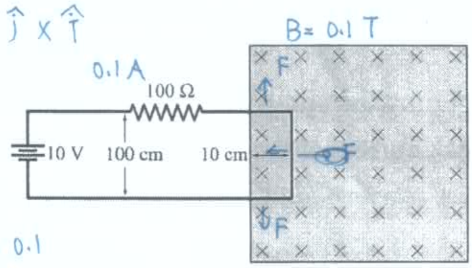
• An ammeter with 150 Ω resistance is inserted in the circuit as right figure. By what percentage is the measured current in error because of the nonzero meter resistance? 【1】.

$L = 50\times10^{-3}$ $X_L = \omega L = 16\times50\times2\pi = 1600\pi$

• A 50-mH inductor is connected to an AC power at 10-V rms and 16 kHz. The current through inductor is (in rms). 【2】 mA. $I = \frac{10}{1600\pi}$

• The fields of an electromagnetic wave are $\vec{\mathbf{E}} = E_p\cdot\sin(kz+\omega t)\hat{\jmath}$ and $\vec{\mathbf{B}} = B_p\cdot\sin(kz+\omega t)\hat{\imath}$. Give a unit vector in the wave's propagation direction 【3】.

$\hat{\jmath}\times\hat{\imath}$



• The right circuit with a current flowing is partially located in a magnetic field of 100 mT with the field showing out of the plan. The total force on the circuit is 【4】 N. (including direction)

$F = 0.1\times1\times0.1$

$\frac{1.44\times25}{60}$

• The receiver at a cell tower can handle signal with peak electric fields as weak as 1.2×10^{-3} V/m. If a cell phone is 5 km away from the cell tower, the minimum average radiation power of the cell phone to have a cell phone reception is 【5】 W.

$\frac{P}{4\pi r^2} = \frac{EB}{2\mu_0} = \frac{E^2}{2\mu_0 c}$ $P = \frac{\cancel{4\pi r^2}\,E^2}{2\mu_0 c} = \frac{(1.2\times10^{-3})^2\times5^2\times10^6}{2\times30}$

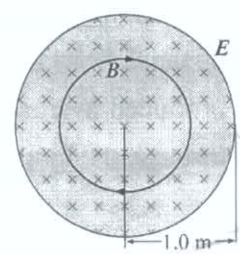
• Consider a *LC* circuit with a 500 mF capacitor and a 100 H inductor. If the capacitor is initially charged to 400 V before it is connected to the inductor. The peak current of the inductor is 【6】 A. $\frac{1}{2}CV^2 = \frac{1}{2}LI^2$

• A photon rocket emits a beam of light instead of hot gas. If a photon rocket yields a thrust of F = 3.50×10^{7} N, the power of the light beam is 【7】 W.

• A parallel-plate capacitor has square plates 10 cm on a side and 0.50 cm apart. The voltage across the plates is increasing at 200 $\mathrm{V\cdot m^{-1}\cdot s^{-1}}$. The displacement current in the capacitor is 【8】 A.

• A current of 1 A is flowing through an infinite straight wire. The magnetic field strength at a distance of 20 cm is 【9】 T.

$\frac{\mu_0\times1}{2\pi(0.2)} = \frac{\cancel{4\pi}\times10^{-7}}{\cancel{2\pi}\times0.1} = 10^{-6}$



• An electric field points into the page and occupies a circular region of radius 1.0 m as shown in the figure. There are no electric charges in the region, but there is a magnetic field forming closed loops pointing clockwise. The magnetic-field strength 50 cm from the center of region is 2.0 mT. The rate of change of the electric field is 【10】 $\mathrm{V\cdot m^{-1}\cdot s^{-1}}$

5×10^3

• An electron moves with a velocity of $v = 1.0\times10^{6}$ m/s perpendicular to a magnetic field of 1.0 T. The acceleration of the electron is 【11】 $\mathrm{m/s^2}$.

$5\times10^3 = \varepsilon_0\frac{dE}{dt}A$ $\frac{5\times10^3}{8.85\times10^{-12}\times(0.5)^2\pi} = 7.193\times10^{14}$ $F = qv\times B = ma$ $a = \frac{q}{m}vB$

• How large is the magnetic force on an electron, moving with a velocity of $v = 10^5$ km/s parallel to a magnetic field of $B = 5$ T ? 【12】 N

• A current of $I = 100$ A is flowing through a conducting rod of 20 cm length, 2.0 mm diameter, and a weight of 100 g. The rod is placed horizontally inside a magnet field. How large must be the magnetic field strength to balance the weight of the rod? 【13】 T ($g = 9.8$ m/s^{-2})

22

• A 45 kΩ resistor and a 30 kΩ resistor are in parallel, and the pair is in series with a 22 kΩ resistor. What's the resistance of the combination? 【14】 Ω

45 30

• Electrons are circulating in the magnetic field of a microwave. The circulation frequency is 2.4 GHz. What is the strength of the magnetic field? 【15】 T

$f = \frac{qB}{2\pi m}$

• A current (10 A) flows through a solenoid (diameter = 10 mm). The solenoid is formed of a 1.0 m wire (wire diameter is 1.0 mm) as closely spaced as possible. The strength of the magnetic field generated inside the solenoid is 【16】 T.

$B = \mu_0 n I$ $n = \cancel{10^{-3}}\ \frac{1}{10^{3}} = 1000 =$

• A 3.0 A current is flowing in a 15 H inductor. A switch opens, interrupting the current in 1.0 ms. The induced emf in the inductor is 【17】 V.

$4\pi\times10^{-7}\times10^{3}\times10 = 4\pi\times10^{-3}$ $I = \frac{\varepsilon}{R}(1-e^{-\frac{R}{L}t})$

$L =$

Part II Problems (10 points per problem)

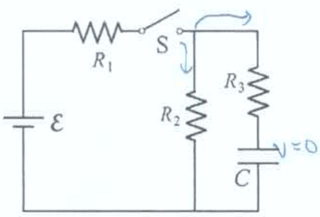
3.0×15 $\varepsilon = L\frac{dI}{dt}$ $= 3(1-e$

1.

We have a *RLC* circuit with $C = 9$ mF, $L = 12$ mH, and $R = 10\Omega$. (a) What is the angular resonance frequency? (b) Find the circuit's lowest impedance. (c) If the peak current at twice the resonance frequency is half of the peak current at the resonance frequency, what is the value of the resistance R?

2.

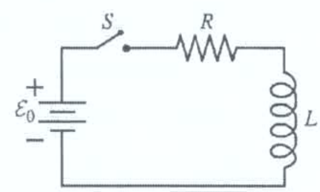
In the circuit as right figure, $\mathcal{E} = 1.2$ kV, $C = 6.5$ μF, $R_1 = R_2 = R_3 = 0.73$ MΩ. With C completely uncharged, the switch S is suddenly closed (t = 0). Determine the currents through R_2 for (a) t = 0 and (b) t = ∞.



10^{-3}

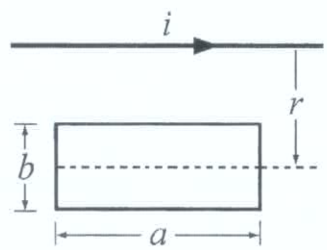
3.

A series *RL* circuit like right figure has $\mathcal{E}_0 = 75$ V, $R = 25$ Ω, and $L = 2.5$ H. Find (a) the current and (b) the rate of change of the current 100 ms later after the switch is closed.



4.

A rectangular loop of wire with length a, width b, and resistance R is placed near an infinitely long wire carrying current i, as shown in right figure. The distance from the long wire to the center of the loop is r. Ignore the flux produced by current in the loop. Find the magnitude of the magnetic flux through the loop.



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