

國立高雄大學 113 學年度第 2 學期
理學院普通物理學基礎能力會考答案詳解

第一部份-基礎題型，共 20 題 每題 2.5 分，共 50 分		16	E
題 號	答 案	17	D
1	C	18	B
2	E	19	A
3	B	20	C
4	A	第二部份-進階題型，共 10 題 每題 5 分，共 50 分	
5	D	1	A
6	A	2	B
7	B	3	D
8	D	4	C
9	A	5	B
10	D	6	C
11	C	7	A
12	B	8	A
13	E	9	D
14	B	10	C
15	C		

（答案詳解請詳閱下頁）

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第一部分

$$1. F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \quad q_1 = Q - q, q_2 = q$$
$$= \frac{1}{4\pi\epsilon_0} \frac{q(Q - q)}{r^2}$$

$$\frac{dF}{dq} = \frac{1}{4\pi\epsilon_0} \frac{Q - 2q}{r^2} = 0 \quad Q - 2q = 0$$

$$q/Q = 0.5$$

$$2. F = \frac{1}{4\pi\epsilon_0} \frac{|q_1| |q_2|}{r^2}$$

$$r = \sqrt{\frac{1}{4\pi\epsilon_0} \frac{|q_1| |q_2|}{F}}$$

$$= \sqrt{8.99 \times 10^9 \cdot \frac{25 \times 10^{-6} \times 60 \times 10^{-6}}{15}}$$

$$= 0.948 \text{ m}$$

$$3. F = \sqrt{F_x^2 + F_y^2} = \sqrt{(2.5 \times 10^{-5} \times 2000)^2 + (2.5 \times 10^{-5} \times 1000)^2}$$

$$= 0.0559 \text{ N}$$

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$$\begin{aligned} 4. \quad E(r) &= \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \\ &= 8.99 \times 10^9 \frac{5 \times 10^{-8}}{(0.12)^2} \\ &= 3.1 \times 10^4 \text{ N/C} \end{aligned}$$

$$\begin{aligned} 5. \quad \epsilon_0 \Phi &= q \\ \Phi &= \frac{q}{\epsilon_0} = \frac{4 \times 10^{-7}}{8.85 \times 10^{-12}} = 4.5 \times 10^4 \text{ N}\cdot\text{m}^2/\text{C} \end{aligned}$$

$$\begin{aligned} 6. \quad E_x &= -\frac{\partial V}{\partial x} = -2(2.0 \text{ V/m}^2)x = -4.0x \text{ V/m} \\ E_y &= -\frac{\partial V}{\partial y} = 2(3.0 \text{ V/m}^2)y = 6.0y \text{ V/m} \\ \vec{E}(x=1.0\text{m}, y=2.0\text{m}) &= (-4.0 \text{ V/m})\hat{i} + (12 \text{ V/m})\hat{j} \end{aligned}$$

$$\begin{aligned} 7. \quad U &= \frac{1}{2}(C_1 + C_2)V^2 \\ &= \frac{1}{2}(2.0 \times 10^{-6} + 4.0 \times 10^{-6}) \times (100)^2 \\ &= 0.03 \text{ J} \end{aligned}$$

$$8. \quad Q = I \cdot t = 3\text{A} \cdot 10\text{s} = 30 \text{ C}$$

$$9. \quad 1/R_{eq} = 1/6 + 1/6 + 1/6 = 3/6 = 1/2 \rightarrow R_{eq} = 2 \text{ ohm}$$

$$10. \quad P = V^2 / R = 9^2 / 3 = 81 / 3 = 27 \text{ W}$$

$$11. \quad R_{new} = \rho (2L) / (A/2) = \rho (4L) / A = 4R$$

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12. $F = qvB = (1.6 \times 10^{-19})(2 \times 10^6)(0.01) = 3.2 \times 10^{-15} \text{ N}$
13. $B = (\mu_0 * I) / (2R) = (4\pi \times 10^{-7} * 10) / (2 * 0.1) = 2\pi \times 10^{-5} \text{ T}$
14. $F = ILB \sin(\theta) = 2 * 0.5 * 0.4 * \sin(30^\circ) = 0.4 * 0.5 = 0.2 \text{ N}$
15. $c = 1/\sqrt{\mu_0 \epsilon_0}$
16. The total stored energy is U , and the maximum charge on the capacitor is Q . Therefore, $U = Q^2/2C$. When the charge on the capacitor is $Q/2$, the energy stored in the capacitor is $U_C = Q^2/8C$, so the energy stored in the inductor is $U_L = U - U_C = Q^2/2C - Q^2/8C = 3Q^2/8C = 3U/4$.
17. The total energy stored in the capacitor and inductor is constant.
18. In Maxwell's equations, the displacement current is $\epsilon_0 d\Phi_E/dt$.
19. 只有(1)圖中磁通量的增加導致感應電流方向是順時針的 (clockwise).
20. An electron traveling with speed v around a circle of radius r is equivalent to a current of $e/T = e \cdot v/2\pi r$

(第二部份詳解請見下頁)

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1132 第二部份

$$1. \oint \vec{E} \cdot d\vec{s} = \frac{q_{enc}}{\epsilon_0}$$

$$\oint \vec{E} \cdot d\vec{s} = |\vec{E}| 2\pi r L$$

$$\frac{q_{enc}}{\epsilon_0} = \frac{1}{\epsilon_0} \int_0^r A r^2 \cdot 2\pi r L dr = \frac{\pi}{2\epsilon_0} A L r^4$$

$$|\vec{E}| \cdot 2\pi r L = \frac{\pi}{2\epsilon_0} A L r^4$$

$$|\vec{E}| = \frac{A r^3}{4\epsilon_0}$$

$$= \frac{2.5 \times 10^{-6} - (3 \times 10^{-2})^3}{4 \cdot 8.85 \times 10^{-12}}$$

$$= 1.9 \text{ N/C}$$

$$2. V = \frac{1}{4\pi\epsilon_0} \int \frac{dq}{x} \quad dq = b x dx$$

$$V = \frac{1}{4\pi\epsilon_0} \int_0^{0.1} \frac{b x dx}{x}$$

$$= \frac{1}{4\pi\epsilon_0} b (0.1)$$

$$= 8.99 \times 10^9 \cdot 2 \times 10^{-8} \cdot 0.1$$

$$= 129 \text{ V}$$

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$$3. \oint \vec{E} \cdot d\vec{A} = \frac{q}{\epsilon_0}$$

$$E \cdot 4\pi r^2 = \frac{q}{\epsilon_0}$$

$$E = \frac{1}{4\pi\epsilon_0 k} \frac{q}{r^2}$$

$$V = -\frac{1}{4\pi\epsilon_0 k} \int_b^a \frac{dr}{r^2} = \frac{1}{4\pi\epsilon_0 k} \frac{b-a}{ab}$$

$$C = \frac{q}{V} = 4\pi\epsilon_0 k \frac{ab}{b-a}$$

$$= \frac{23.5}{8.99 \times 10^9} \frac{0.013 \times 0.015}{0.015 - 0.013}$$

$$= 2.55 \times 10^{-10} \text{ F}$$

4. From $(1/2)mv^2 = qV$ and $r = mv/qB$

$$\rightarrow x = 2r = (2/B)(2mV/q)^{0.5}$$

$$\rightarrow m = B^2 q x^2 / 8V = 0.1^2 \times (3.2 \times 10^{-19}) \times 2^2 / (8 \times 1000) = 1.6 \times 10^{-24} \text{ kg}$$

5. $V_c = \mathcal{E} \left(1 - e^{-\frac{t}{RC}} \right) = \frac{\mathcal{E}}{2}$

$$-\frac{t}{RC} = \ln(0.5)$$

$$t = \ln(0.5) \times R \times C = 0.693 \times 10 \times 30 \times 10^{-6} = 0.208 \text{ ms}$$

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6.

$$i_{enc} = \int_a^r cr(2\pi r dr) = 2\pi c \int_a^r r^2 dr = 2\pi c \left[\frac{r^3}{3} \right]_a^r \\ = \frac{2\pi c}{3} (r^3 - a^3)$$

$$\oint \vec{B} \cdot d\vec{s} = B(2\pi r) = \frac{2\mu_0\pi c}{3} (r^3 - a^3)$$

$$B = \frac{\mu_0 c}{3r} (r^3 - a^3) = \frac{4\pi \times 10^{-7} \times 2 \times 10^6}{3 \times 0.03} (0.03^3 - 0.01^3) =$$

$$7.261 \times 10^{-4} \text{T}$$

7. The *RLC* series circuit in resonance has a resonance frequency **equal to** the natural frequency in an *LC* circuit.

$$8. I = \varepsilon(1 - e^{-Rt/L})/R = I_{max}(1 - e^{-t/\tau})$$

$$e^{-t/\tau} = 0.25, \quad -t/\tau = \ln 0.25,$$

9. The magnetic field at a distance x from wire is $B = \frac{\mu_0 I}{2\pi x}$

The emf induced in an element in the bar of length dx is

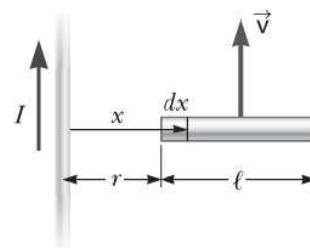
$$|d\mathcal{E}| = Bv dx.$$

The total emf induced along the entire length of the bar is then

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$$|\mathcal{E}| = \int_r^{r+\ell} Bv dx = \int_r^{r+\ell} \frac{\mu_0 I}{2\pi x} v dx = \frac{\mu_0 Iv}{2\pi} \int_r^{r+\ell} \frac{dx}{x} = \frac{\mu_0 Iv}{2\pi} \ln x \Big|_r^{r+\ell}$$

$$|\mathcal{E}| = \frac{\mu_0 Iv}{2\pi} \ln\left(\frac{r+\ell}{r}\right)$$



10. The magnitudes of E and B in empty space are related by the expression $E/B = c$