

國立高雄大學 114 學年度  
第 2 學期理學院

普通物理學基礎能力  
會考詳解

考試日期：115.06.09(星期二)

考試時間：16：40-18：40

| 第一部份-基礎題型，共 20 題<br>每題 2.5 分，共 50 分 |     | 16                                | C |
|-------------------------------------|-----|-----------------------------------|---|
| 題 號                                 | 答 案 | 17                                | C |
| 1                                   | A   | 18                                | C |
| 2                                   | C   | 19                                | A |
| 3                                   | E   | 20                                | A |
| 4                                   | E   | 第二部份-進階題型，共 10 題<br>每題 5 分，共 50 分 |   |
| 5                                   | C   | 21                                | A |
| 6                                   | D   | 22                                | B |
| 7                                   | B   | 23                                | D |
| 8                                   | B   | 24                                | A |
| 9                                   | D   | 25                                | E |
| 10                                  | B   | 26                                | C |
| 11                                  | A   | 27                                | D |
| 12                                  | A   | 28                                | C |
| 13                                  | D   | 29                                | B |
| 14                                  | E   | 30                                | C |
| 15                                  | B   |                                   |   |

(答案請檢附詳解於后，謝謝。)

## 答案詳解

1. A

電通量為  $E \times \pi R^2$ .

2. C

Each charge is a distance  $\sqrt{a^2 + a^2}/2 = a/\sqrt{2}$  from the center.

$$V = k_e \sum_i \frac{q_i}{r_i} = 4k_e \left( \frac{Q}{a/\sqrt{2}} \right) = \boxed{4\sqrt{2}k_e \frac{Q}{a}}$$

3. E

Neither, because the voltage increases when the plates are pulled apart.

4. E

For an ideal parallel-plate capacitor, the electric field is uniform, and the electric potential varies linearly with position between the plates.

5. C

From Example 23.2, the electric field due to a uniformly charged ring is given by

$$E = \frac{k_e Q x}{(x^2 + a^2)^{3/2}}$$

For a maximum, we differentiate  $E$  with respect to  $x$  and set the result equal to zero:

$$\frac{dE}{dx} = Qk_e \left[ \frac{1}{(x^2 + a^2)^{3/2}} - \frac{3x^2}{(x^2 + a^2)^{5/2}} \right] = 0$$

solving for  $x$  gives

$$x^2 + a^2 - 3x^2 = 0 \quad \text{or} \quad x = \frac{a}{\sqrt{2}}$$

6. D

The potential difference across the capacitor decreases to  $V_0/k$ .

7. B

The electric flux through the Gaussian surface depends only on the charge enclosed within radius  $r$ .

8. B

$$\begin{aligned}
 I &= \int J \, dA = \int 2 \times 10^{10} \cdot r^3 \cdot 2\pi r \, dr = 4\pi \cdot 10^{10} \int r^4 \, dr \\
 &= 4\pi \cdot 10^{10} \cdot \frac{r^5}{5} \Big|_{3 \times 10^{-3}}^{5 \times 10^{-3}} = 0.8\pi \cdot 10^{10} \cdot (5^5 - 3^5) \cdot 10^{-15} \\
 &= 7114 \times 10^{-5} \cong 7.2 \times 10^{-2}
 \end{aligned}$$

9. D

$$\begin{aligned}
 J &= \frac{i}{A} = nev_d \\
 \frac{8}{2.5 \times 10^{-5} m^2} &= 8.49 \times 10^{28} \cdot 1.6 \times 10^{-19} \cdot v_d \\
 v_d &= \frac{3.2}{8.49 \times 1.6} \cdot 10^{-4} = 2.3 \times 10^{-5} \\
 t &= \frac{6}{2.3 \times 10^{-5}} \, sec = \frac{6}{2.3 \times 10^{-5} \cdot 60 \cdot 60} \, hour = 70.8 \, hour
 \end{aligned}$$

10. B

$$\begin{aligned}
 v_c(t) &= E(1 - e^{-\frac{t}{RC}}) \\
 2 &= 12(1 - e^{-\frac{t}{600 \cdot 6 \times 10^{-6}}}) \\
 t &= 6.56 \times 10^{-4}
 \end{aligned}$$

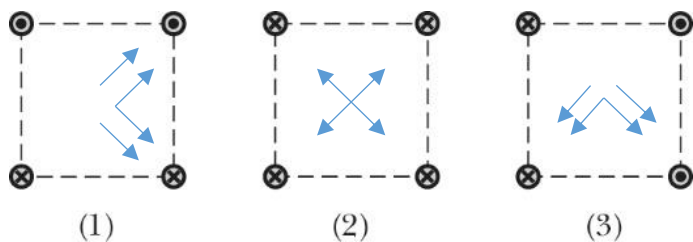
11. A

$$P = \frac{V^2}{R} = \frac{12^2}{6} = 24$$

12. A

$$\begin{aligned}
 K &= \frac{1}{2}mv^2 = 4.8 \times 10^{-22} J \\
 \text{向心力 } F &= m \frac{v^2}{r} \\
 1.2 \times 10^{-17} &= \frac{2 \times 4.8 \times 10^{-22}}{r} \\
 r &= 8 \times 10^{-5} \, m
 \end{aligned}$$

13. D (1,3) > 2



14. E

$$B = \frac{\mu_0 i}{2\pi R}, \mu_0 = 4\pi \times 10^{-7}$$

$$B_1 = \frac{\mu_0}{2\pi} \frac{4}{0.02} T \times$$

$$B_2 = \frac{\mu_0}{2\pi} \frac{5}{0.03} T \uparrow$$

$$B = \sqrt{B_1^2 + B_2^2} = 52\mu T$$

15.  $1.6 \times 10^{-4} \text{ H/m}$

Sol: 單位長度自感  $L/l = \mu_0 n^2 A = (4\pi \times 10^{-7})(800)^2(2.0 \times 10^{-4}) \approx 1.6 \times 10^{-4} \text{ H/m} \circ$

16. 4.0 J

Sol: 電感能量  $U = \frac{1}{2} LI^2 = \frac{1}{2}(0.50)(4.0)^2 = 4.0 \text{ J} \circ$

17.  $7.9 \times 10^3 \text{ rad/s}$

Sol:  $\omega = 1/\sqrt{LC} = 1/\sqrt{[(2.0 \times 10^{-3})(8.0 \times 10^{-6})]} \approx 7.9 \times 10^3 \text{ rad/s} \circ$

18.  $60 \Omega$

Sol:  $XL = \omega L = 300 \times 0.20 = 60 \Omega \circ$

19.  $1.77 \times 10^{-6} \text{ A}$

Sol: 位移電流  $I_d = \epsilon_0 d\Phi E/dt = (8.85 \times 10^{-12})(2.0 \times 10^5) = 1.77 \times 10^{-6} \text{ A} \circ$

20.

(A)  $2.7 \times 10^{-8} \text{ Pa}$

Sol: 完全吸收時輻射壓  $p = I/c = 8.0/(3.0 \times 10^8) = 2.7 \times 10^{-8} \text{ Pa} \circ$

### <第二部份：進階題型>

21.  $C_2$  is in parallel with  $C_3$ , and that parallel pair is in series with  $C_1$ .

$C_{23} = C_2 + C_3 = 10 + 20 = 30 \mu\text{F}$ . Series equivalent:  $C_{eq} = \frac{C_1 C_{23}}{C_1 + C_{23}} = \frac{15 \times 30}{15 + 30} = 10 \mu\text{F}$  Series

charge:  $Q = C_{eq} V_0 = 10 \mu\text{F} \times 18 \text{ V} = 180 \mu\text{C}$

Voltage across  $C_2$  and  $C_3$ :  $V_{23} = \frac{Q}{C_{23}} = \frac{180}{30} = 6 \text{ V}$

Energy stored in  $C_2$ :  $U_2 = \frac{1}{2} C_2 V_{23}^2 = \frac{1}{2} 10 \times 10^{-6} \times 6^2 = 1.8 \times 10^{-4} \text{ J} = 0.18 \text{ mJ}$

故答案為 A.

22. Take a tiny charge element  $dq$  on the arc. The electric field produced by  $dq$  at the

center is  $dE = \frac{k dq}{R^2}$ . For a line charge,  $dq = \lambda dl = \lambda R d\theta$

$$dE = \frac{k dq}{R^2} = \frac{k \lambda R d\theta}{R^2} = \frac{k \lambda d\theta}{R}, \quad dE_y = dE \sin \theta = \frac{k \lambda d\theta}{R} \sin \theta$$

$$E = \int_0^\pi \frac{k \lambda d\theta}{R} \sin \theta = 2 \frac{k \lambda}{R} \text{ 故答案為 B.}$$

23. 答案是 D.

$$V = k_e \int_{\text{all charge}} \frac{dq}{r} = k_e \int_{-3R}^{-R} \frac{\lambda dx}{-x} + k_e \int_{\text{semicircle}} \frac{\lambda ds}{R} + k_e \int_R^{3R} \frac{\lambda dx}{x}$$

$$V = -k_e \lambda \ln(-x) \Big|_{-3R}^{-R} + \frac{k_e \lambda}{R} \pi R + k_e \lambda \ln x \Big|_R^{3R}$$

$$V = k_e \lambda \ln \frac{3R}{R} + k_e \lambda \pi + k_e \lambda \ln 3 = \boxed{k_e \lambda (\pi + 2 \ln 3)}$$

24. A

$$R_{34} = R_3 + R_4 = 6 + 2 = 8$$

$$R_{2\parallel 34} = \frac{2 \cdot 8}{2 + 8} = 1.6$$

$$i = \frac{12}{1.4 + 1.6} = 4A$$

$$V_{R_2} = 12 - 1.4 \cdot 4 = 6.4V$$

$$i_{R_2} = \frac{6.4V}{2\Omega} = 3.2A$$

25. E

$$U = -\vec{\mu} \cdot \vec{B} = -\mu B \cos \theta$$

$$U_{max} \Rightarrow \cos \theta = -1$$

$$\therefore \theta = 180^\circ$$

26. C

$$\text{半圈 } (\phi = \pi) \Rightarrow B = \frac{\mu_0 i \phi}{4\pi R} = \frac{\mu_0 i \pi}{4\pi R} = \frac{\mu_0 i}{4R}$$

$$R = 2r$$

$$B_1 = \frac{\mu_0 i}{4R} - \frac{\mu_0 i}{4r} = \frac{\mu_0 i}{4R} - \frac{2\mu_0 i}{4R} = -\frac{\mu_0 i}{4R}$$

$$B_2 = \frac{\mu_0 i}{4R} + \frac{\mu_0 i}{4r} = \frac{\mu_0 i}{4R} + \frac{2\mu_0 i}{4R} = \frac{3\mu_0 i}{4R}$$

$$\therefore \frac{B_2}{B_1} = 3$$

27.  $180\ \Omega$

Sol:  $X_L = \omega L = 1000(0.20) = 200\ \Omega$  ,  $X_C = 1/(\omega C) = 1/[1000(50 \times 10^{-6})] = 20\ \Omega$  。  $Z = \sqrt{[R^2 + (X_L - X_C)^2]} = \sqrt{(30^2 + 180^2)} \approx 182\ \Omega$  , 最接近  $180\ \Omega$  。

28.  $1.2\ \text{A}$

Sol:  $V_s = V_p(N_s/N_p) = 120(100/500) = 24\ \text{V}$  。 副線圈電流  $I_s = V_s/R = 24/4.0 = 6.0\ \text{A}$  。 理想變壓器功率守恆  $V_p I_p = V_s I_s$  ,  $I_p = (V_s I_s)/V_p = (24 \times 6.0)/120 = 1.2\ \text{A}$  。

29.  $4.0 \times 10^{-8}\ \text{N}$

Sol: 完全反射的輻射壓  $p = 2I/c = 2(12)/(3.0 \times 10^8) = 8.0 \times 10^{-8}\ \text{Pa}$  。  
力  $F = pA = (8.0 \times 10^{-8})(0.50) = 4.0 \times 10^{-8}\ \text{N}$  。

30.  $100\ \text{V}$

Sol: 總阻抗  $Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{40^2 + 30^2} = 50\ \Omega$  。  $V_{\text{rms}} = I_{\text{rms}} Z = 2.0 \times 50 = 100\ \text{V}$  。