

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 會考試題

考試日期：114.05.27(星期二)

考試時間：16：40-18：40

系所：_____ 姓名：_____ 學號：_____

規定事項：

1. 請攜帶學生證（或有照片之證件）準時應考，以便身分核對。
2. 應試時請依當日公告之座位表入座。
3. 遲到逾 20 分鐘者，不得入場；已入場應試者，60 分鐘內不得出場。
4. 答案卡應以 2B 鉛筆作答，攜帶軟性品質較佳之橡皮擦備用。
5. 禁止使用電子產品（如：手機）
6. 電子計算器：僅限簡易型電子計算機（限僅有數字鍵 0~9 及 $+$ $-$ $\times$ $\div$ $\sqrt{}$ $\%$ M 等功能）”



<第一部份-基礎題型 1-20 共 20 題，每題 2.5 分，共 50 分>

1. Of the charge Q initially on a tiny sphere, a portion q is to be transferred to a second, nearby sphere. Both spheres can be treated as particles and are fixed with a certain separation. For what value of q/Q will the electrostatic force between the two spheres be maximized?
(A) 0.3
(B) 0.4
(C) 0.5
(D) 0.6
(E) 0.7
2. What must be the distance between point charge $q_1 = 25 \times 10^{-6} \text{ C}$ and point charge $q_2 = -60 \times 10^{-6} \text{ C}$ for the electrostatic force between them to have a magnitude of 15.0 N ? ($\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$)
(A) 0.158 m
(B) 0.365 m
(C) 0.682 m
(D) 0.726 m
(E) 0.948 m
3. A 15.0 g block with a charge of $2.5 \times 10^{-5} \text{ C}$ is placed in an electric field $\vec{E} = (2000\hat{i} - 1000\hat{j}) \text{ N/C}$. What is the magnitude of the electrostatic force on the block?
(A) 0.0275 N
(B) 0.0559 N
(C) 0.0631 N
(D) 0.0788 N
(E) 0.0923 N
4. Two charged concentric spherical shells have radii 10.0 cm and 15.0 cm . The charge on the inner shell is $5.00 \times 10^{-8} \text{ C}$, and that on the outer shell is $8.00 \times 10^{-8} \text{ C}$. Find the electric field at $r = 12 \text{ cm}$. ($\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$)
(A) $3.1 \times 10^4 \text{ N/C}$
(B) $4.2 \times 10^4 \text{ N/C}$
(C) $5.7 \times 10^4 \text{ N/C}$
(D) $7.9 \times 10^4 \text{ N/C}$
(E) $9.6 \times 10^4 \text{ N/C}$

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試題

5. A particle of charge $4.0 \times 10^{-7} \text{ C}$ is at the center of a Gaussian cube 60 cm on edge. What is the net electric flux through the surface? ($\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$)
- (A) $1.2 \times 10^4 \text{ N} \cdot \text{m}^2/\text{C}$
(B) $2.8 \times 10^4 \text{ N} \cdot \text{m}^2/\text{C}$
(C) $3.3 \times 10^4 \text{ N} \cdot \text{m}^2/\text{C}$
(D) $4.5 \times 10^4 \text{ N} \cdot \text{m}^2/\text{C}$
(E) $5.9 \times 10^4 \text{ N} \cdot \text{m}^2/\text{C}$
6. The electric potential at points in an xy plane is given by $V = (2.0 \text{ V/m}^2)x^2 - (3.0 \text{ V/m}^2)y^2$. In unit-vector notation, what is the electric field at the point (1.0 m, 2.0 m)?
- (A) $\vec{E} = (-4.0 \text{ V/m})\hat{i} + (12.0 \text{ V/m})\hat{j}$
(B) $\vec{E} = (3.0 \text{ V/m})\hat{i} + (10.0 \text{ V/m})\hat{j}$
(C) $\vec{E} = (2.0 \text{ V/m})\hat{i} + (-12.0 \text{ V/m})\hat{j}$
(D) $\vec{E} = (5.0 \text{ V/m})\hat{i} + (9.0 \text{ V/m})\hat{j}$
(E) $\vec{E} = (-2.0 \text{ V/m})\hat{i} + (-8.0 \text{ V/m})\hat{j}$
7. A $2.0 \times 10^{-6} \text{ F}$ capacitor and a $4.0 \times 10^{-6} \text{ F}$ capacitor are connected in parallel across a 100 V potential difference. Calculate the total energy stored in the capacitors.
- (A) 0.01 J
(B) 0.03 J
(C) 0.07 J
(D) 0.12 J
(E) 0.25 J
8. If the current in a wire is 3 A, how many coulombs of charge flow through the wire in 10 seconds?
- (A) 3 C
(B) 10 C
(C) 13 C
(D) 30 C
(E) 300 C
9. What is the equivalent resistance of three 6 ohm resistors connected in parallel?
- (A) 2 ohm (B) 4 ohm (C) 6 ohm (D) 8 ohm (E) 10 ohm
10. A 9 V battery is connected to a circuit with total resistance 3Ω . What is the power dissipated?
- (A) 3 (B) 9 (C) 18 (D) 27 (E) 81

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試題

11. A wire has resistance R . If its length is doubled and the cross-sectional area is halved, what is the new resistance?
- (A) R
(B) $2R$
(C) $4R$
(D) $R/2$
(E) $R/4$
12. A proton moves at 2×10^6 m/s perpendicular to a magnetic field of 0.01 T. What is the magnetic force on it? ($q = 1.6 \times 10^{-19}$ C)
- (A) 1.6×10^{-19} N
(B) 3.2×10^{-15} N
(C) 2.0×10^{-13} N
(D) 6.4×10^{-17} N
(E) 0 N
13. A current of 10 A flows through a circular loop of radius 0.1 m. What is the magnetic field at the center of the loop? ($\mu_0 = 4\pi \times 10^{-7}$ T-m/A)
- (A) $2\pi \times 10^{-7}$ T
(B) $4\pi \times 10^{-7}$ T
(C) $2\pi \times 10^{-6}$ T
(D) $4\pi \times 10^{-6}$ T
(E) $2\pi \times 10^{-5}$ T
14. What is the force on a wire of length 0.5 m carrying 2 A at 30 degrees to a 0.4 T magnetic field?
- (A) 0.1 N
(B) 0.2 N
(C) 0.4 N
(D) 0.6 N
(E) 0.8 N
15. The speed of light is given by the value of
- (A) $\mu_0 \epsilon_0$ (B) $\sqrt{\mu_0 \epsilon_0}$ (C) $1/\sqrt{\mu_0 \epsilon_0}$ (D) $1/\mu_0 \epsilon_0$ (E) $(\mu_0 \epsilon_0)^2$
16. In an oscillating LC circuit, the total stored energy is U , and the maximum charge on the capacitor is Q . When the charge on the capacitor is $Q/2$, the energy stored in the inductor is:
- (A) $U/2$ (B) $U/4$ (C) $3U/2$ (D) $(4/3)U$ (E) $3U/4$

17. With these idealizations— zero resistance and no radiation— the oscillations in an LC series circuit persist indefinitely. Which of the following statements is false?

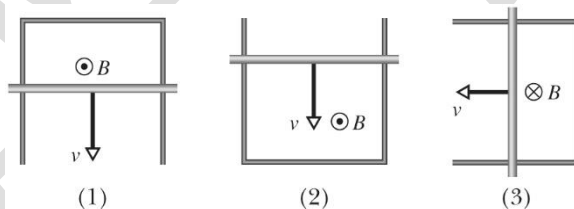
- (A) The natural frequency of the oscillation is $\omega = 1/\sqrt{LC}$
- (B) If charges on the capacitor oscillate with a period of T , energy stored in the capacitor oscillates with a period of $T/2$.
- (C) If the current flow in the inductor oscillates with a period of T , energy stored in the inductor oscillates with a period of $T/2$.
- (D) The total energy stored in each the capacitor and inductor oscillates with a period of T .
- (E) None of the above.

18. In Maxwell's equations, the displacement current is:

- (A) $d\Phi_E/dt$
- (B) $\epsilon_0 d\Phi_E/dt$
- (C) $\mu_0 d\Phi_E/dt$
- (D) $-d\Phi_B/dt$
- (E) $\mu_0 \epsilon_0 d\Phi_E/dt$

19. The figure shows three circuits in which a conducting bar slides along a U-shaped wire and through a uniform magnetic field (the field direction is indicated). The direction of travel is indicated. In which circuit is the induced current clockwise?

- (A) (1) only
- (B) (2) only
- (C) (3) only
- (D) (1) and (2)
- (E) (1) and (3)

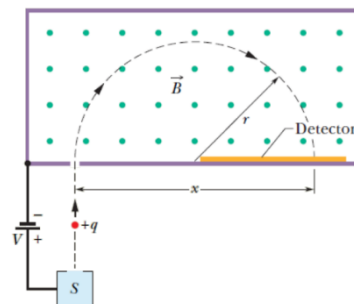


20. An electron traveling with speed v around a circle of radius r is equivalent to a current of:

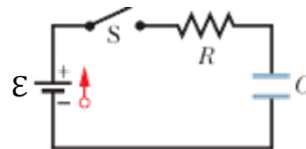
- (A) $2\pi ev/r$
- (B) $evr/2$
- (C) $ev/2\pi r$
- (D) $2\pi er/v$
- (E) ev/r

<第二部份：進階題型 1-10 共 10 題，每題 5 分，共 50 分>

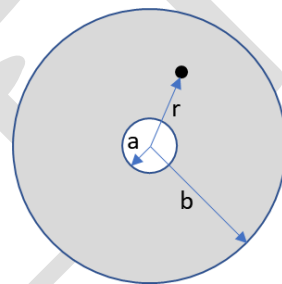
1. A long, nonconducting, solid cylinder of radius 5.0 cm has a nonuniform volume charge density ρ that is a function of radial distance r from the cylinder axis: $\rho = Ar^2$. For $A = 2.5 \times 10^{-6} \text{ C/m}^3$, what is the magnitude of the electric field at $r = 3.0 \text{ cm}$? ($\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$)
(A) 1.9 N/C (B) 2.8 N/C (C) 4.3 N/C (D) 5.5 N/C (E) 7.6 N/C
2. A nonuniform linear charge distribution given by $\lambda = bx$, where b is a constant, is located along an x axis from $x = 0$ to $x = 0.10 \text{ m}$. If $b = 2.0 \times 10^{-8} \text{ C/m}^2$ and $V = 0$ at infinity, what is the electric potential at the origin? ($\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$)
(A) 11.5 V
(B) 17.9 V
(C) 25.2 V
(D) 39.6 V
(E) 46.9 V
3. The space between two concentric conducting spherical shells of radii $b = 1.50 \text{ cm}$ and $a = 1.30 \text{ cm}$ is filled with a substance of dielectric constant $\kappa = 23.5$. Determine the capacitance of the device. ($\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$)
(A) $1.05 \times 10^{-10} \text{ F}$
(B) $1.58 \times 10^{-10} \text{ F}$
(C) $1.91 \times 10^{-10} \text{ F}$
(D) $2.55 \times 10^{-10} \text{ F}$
(E) $3.41 \times 10^{-10} \text{ F}$
4. An ion, with charge $q = 3.2 \times 10^{-19} \text{ C}$, is accelerated by the electric field due to a potential difference $V = 1000 \text{ V}$. The ion then enters a separator chamber in which a uniform magnetic field $B = 100 \text{ mT}$ is perpendicular to the path of the ion. A wide detector lines the bottom wall of the chamber, and the B causes the ion to move in a semicircle and thus strike the detector at a point that lies at $x = 2 \text{ m}$. What is the mass of the ion?
(A) $4.0 \times 10^{-25} \text{ kg}$
(B) $8.0 \times 10^{-25} \text{ kg}$
(C) $1.6 \times 10^{-24} \text{ kg}$
(D) $3.2 \times 10^{-24} \text{ kg}$
(E) $6.4 \times 10^{-24} \text{ kg}$



5. Switch S in Figure below is closed at time $t = 0$, to begin charging an initially uncharged capacitor of capacitance $C = 30 \mu\text{F}$ through a resistor of resistance $R = 10 \Omega$. At what time is the potential across the capacitor equal to that across the resistor? ($\ln 0.5 = 0.693$)



- (A) 0.104 ms
(B) 0.208 ms
(C) 0.312 ms
(D) 0.416 ms
(E) 0.520 ms
6. Figure shows the cross section of a long conducting cylinder with inner radius $a = 1.0 \text{ cm}$ and outer radius $b = 5.0 \text{ cm}$. The cylinder carries a current out of the page, and the magnitude of the current density in the cross section is given by $J = cr$, with $c = 2.0 \times 10^6 \text{ A/m}^3$ and r in meters. What is the magnetic field B at the dot in the Figure, which is at radius $r = 3.0 \text{ cm}$ from the central axis of the cylinder?

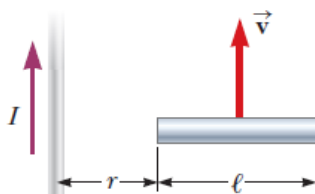


- (A) $8.052 \times 10^{-3} \text{ T}$
(B) $3.705 \times 10^{-4} \text{ T}$
(C) $7.261 \times 10^{-4} \text{ T}$
(D) $2.000 \times 10^{-5} \text{ T}$
(E) $5.072 \times 10^{-5} \text{ T}$
7. Which of the following statements regarding the oscillations in an RLC series circuit with an alternating source (ac) is false?
- (A) The RLC series circuit in resonance has a resonance frequency not equal to the natural frequency in an LC circuit.
(B) The current of an RLC series circuit in resonance is in phase with the applied voltage.
(C) The current of an RLC series circuit in resonance has its maximum value.
(D) The current at all points in an RLC series circuit with an ac source has the same amplitude and phase.
(E) For a sinusoidal applied voltage, the current in a capacitor always leads the voltage across the capacitor by 90° .

8. When a switch is closed, completing an LR series circuit with a battery $emf(\epsilon)$, the relation between the time t needed for the current to reach three-quarters its maximum value and the time constant $\tau (= L/R)$ is ? (Hint: $\ln 0.25 = -1.38$, $\ln 0.33 = -1.1$, $\ln 0.37 = -1$, $\ln 0.5 = -0.69$, $\ln 0.75 = -0.29$)
- (A) $t = 1.38 \tau$ (B) $t = 1.1 \tau$ (C) $t = \tau$ (D) $t = 0.69 \tau$ (E) $t = 0.29 \tau$

9. A conducting rod of length ℓ , moves with velocity $\vec{v}$ parallel to a long wire carrying a steady current I . The axis of the rod is maintained perpendicular to the wire with the near end a distance r away, as shown in the Figure below. Calculate the magnitude of the *emf* induced in the rod.

- (A) $|\varepsilon| = [\mu_0 I v \ln((r - \ell)/\ell)]/2\pi$
- (B) $|\varepsilon| = [\mu_0 I v \ln(\ell/(r + \ell))]/2\pi$
- (C) $|\varepsilon| = [\mu_0 I v \ln(\ell/(r + \ell))]$
- (D) $|\varepsilon| = [\mu_0 I v \ln((r + \ell)/\ell)]/2\pi$
- (E) $|\varepsilon| = [\mu_0 I v \ln((r - \ell)/\ell)]$



10. Which of the following statements regarding an electromagnetic wave is correct?

- (A) The energy in an electromagnetic wave is described by a vector $\mathbf{S}$, called the Poynting vector.
- (B) A Poynting vector's direction is opposite to an electromagnetic wave propagation's direction.
- (C) The magnitudes of $\mathbf{E}$ and $\mathbf{B}$ in empty space are related by the expression $E/B = c$ (c = light speed)
- (D) For an electromagnetic wave, the instantaneous energy density associated with the magnetic field equals $\mu_0 B^2/2$
- (E) For an electromagnetic wave, the instantaneous energy density associated with the electric field equals $\varepsilon_0 E^2$