臺灣綜合大學系統106學年度學士班轉學生聯合招生考試試題

科目名稱	電磁學	類組代碼	C01
		科目碼	C0101

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Useful information

$\frac{1}{4\pi\varepsilon_0} \approx 9.0\times10^9 N\cdot m^2/C^2$, $\mu_0 = 4\pi\times10^{-7} H/m$

In spherical coordinate $\nabla = \hat{e}_r \frac{\partial}{\partial r} + \hat{e}_\theta \frac{1}{r}\frac{\partial}{\partial\theta} + \hat{e}_\varphi \frac{1}{r\sin\theta}\frac{\partial}{\partial\varphi}$

Problem 1-10, 8 points each. 單選題

1. A 16-nC charge is distributed uniformly along the x axis from $x = 0$ to $x = 4$ m. Which of the following integrals is correct for the magnitude (in N/C) of the electric field at $x = +10$ m on the x axis?
(A) $\int_0^4 \frac{36dx}{(10-x)^2}$ (B) $\int_0^4 \frac{154dx}{(10-x)^2}$ (C) $\int_0^4 \frac{36dx}{x^2}$ (D) $\int_0^4 \frac{154dx}{x^2}$ (E) none of the above

2. Charge Q is distributed uniformly throughout an insulating sphere of radius R. The magnitude of the electric field at a point $R/2$ from the center is:
(A) $Q/(4\pi\varepsilon_0 R^2)$ (B) $Q/(\pi\varepsilon_0 R^2)$ (C) $3Q/(4\pi\varepsilon_0 R^2)$ (D) $Q/(8\pi\varepsilon_0 R^2)$ (E) none of the above

3. Identical point charges $(+50\mu C)$ are placed at the corners of a square with sides of 2.0-m length. How much external energy is required to bring a fifth identical charge from infinity to the geometric center of the square?
(A) 41 J (B) 16 J (C) 64 J (D) 10 J (E) 80 J

4. Two conducting spheres have radii of R_1 and R_2 with $R_1 > R_2$. If they are far apart the capacitance is proportional to:
(A) $R_1R_2/(R_1 - R_2)$ (B) $R_1^2 - R_2^2$ (C) $(R_1 - R_2)/R_1R_2$ (D) $R_1^2 + R_2^2$ (E) none of the above

5. Electrons (mass m, charge $-e$) are accelerated from rest through a potential difference V and are then deflected by a magnetic field $\vec{B}$ that is perpendicular to their velocity. The radius of the resulting electron trajectory is:
(A) $\left(\sqrt{2eV/m}\right)/B$ (B) $\left(B\sqrt{2eV}\right)/m$ (C) $\left(\sqrt{2eV/e}\right)/B$ (D) $\left(B\sqrt{2mV}\right)/e$
(E) none of the above

6. A loop of current-carrying wire has a magnetic dipole moment of 5×10^{-4} Am^2. The moment initially is aligned with a 0.5-T magnetic filed. To rotate the loop so its dipole moment is perpendicular to the field and hold it in that orientation, you must do work of:
(A) 0 (B) 2.5×10^{-4} J (C) -2.5×10^{-4} J (D) 1.0×10^{-3} J (E) -1.0×10^{-3} J

7. An ideal long narrow solenoid has length ℓ and a total of N turns, each of which has cross-sectional area A. Its inductance is:
(A) $\mu_0 N^2 A\ell$ (B) $\mu_0 N^2 A/\ell$ (C) $\mu_0 NA/\ell$ (D) $\mu_0 N^2\ell/A$
(E) none of the above

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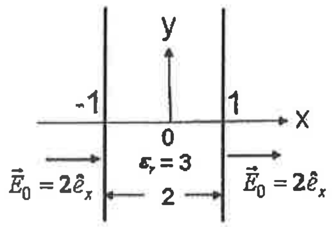
8. A 0.2-m radius cylinder, 4.0 m long, is wrapped with wire to form an inductor. At the instant the magnetic field in the interior is 5.0 T the energy stored in the field is:
(A) 0 (B) 5.0×10^6 J (C) 7.5×10^6 J (D) 1.0×10^7 J (E) 10.0 J

9. Given an electric field intensity distribution in vacuum $\vec{E}(\vec{r}) = \frac{\hat{e}_x}{x^2} + \frac{\hat{e}_y}{y^2} + \frac{\hat{e}_z}{z^2}$.
The charge density at position (1, 1, 1) is
(A) 2 (B) -2 (C) $2\varepsilon_0$ (D) $-2\varepsilon_0$ (E) $-\varepsilon_0$

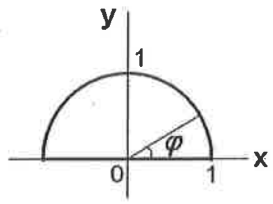
10. Following problem **9**, taking infinite away as zero point, the electric potential at point (2, 0, 0) is
(A) -1 (B) 1 (C) -1/2 (D) 1/2 (E) 1/4

Problem 11-15, 4 points each 單選題

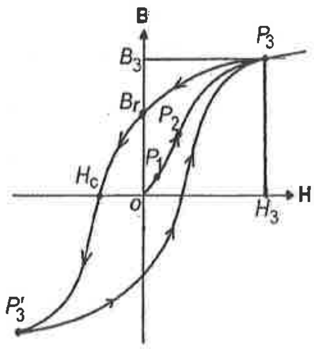
11. As shown in the figure consider a long uniform dielectric slab of dielectric constant ε_r=3 of thickness 2, with x-axis perpendicular to its surface. If a uniform electric field of intensity $\vec{E}_0 = 2\hat{e}_x$ is applied outside of the slab then the magnitude of the polarization vector $\vec{P}_i$ inside of the slab is
(A) $\frac{4\varepsilon_0}{3}$ (B) $\frac{2\varepsilon_0}{3}$ (C) $\frac{4}{3}$ (D) $\frac{2}{3}$ (E) 0



12. As shown in the figure a semi-circular conductor of resistance R is place on the x-y plane with it center at the origin. If there are time-dependent magnetic fields applied with vector potential, written in spherical coordinate $\vec{A}(\vec{r},t) = \varphi \cdot t\, \hat{e}_\varphi$ for $y \ge 0$, then the magnitude of the induced emf in the conductor is (A) π^2 (B) $\frac{\pi^2}{2}$ (C) π (D) $\frac{\pi}{2}$ (E) $\frac{\pi}{4}$



13. Shown in the figure is a hysteresis curve of a ferromagnetic material. The reading of P_3 is (H_3 = 40, B_3 = 550 μ_0). When the magnetic field intensity H is larger than H_3 the system saturates and thus the curve becomes a straight line. The slope of the straight line is
(A) 0 (B) 1 (C) μ_0 (D) $4\mu_0/55$ (E) $55\mu_0/4$



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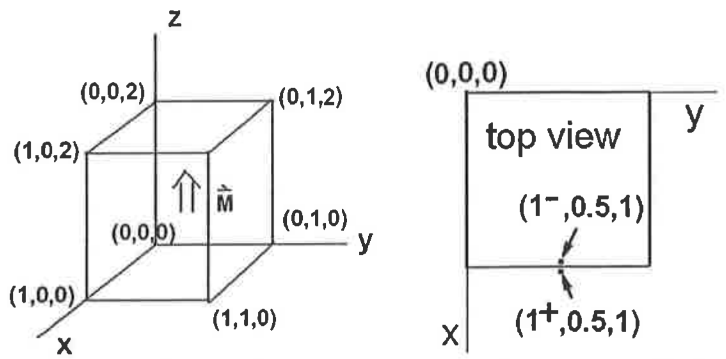

14. As shown in the figure above a ferromagnetic cuboid of height 2 and square cross section of area 1 is placed in vacuum in the first quadrant. The magnet is uniformly magnetized with magnetization vector $\vec{M} = 10\hat{e}_z$.
If the magnetic flux density at point $(1^-, 0.5, 1)$, which is right inside the magnet, is given by $\vec{B} = \mu_0 \hat{e}_x + 8\mu_0 \hat{e}_z$, then what is the $\vec{H}$ field at position $(1^+, 0.5, 1)$, which is right outside of the magnet.
(A) $\hat{e}_x + 8\hat{e}_z$　(B) $-\hat{e}_x + 8\hat{e}_z$　(C) $10\hat{e}_x + 8\hat{e}_z$　(D) $\hat{e}_x + 2\hat{e}_z$　(E) $\hat{e}_x - 2\hat{e}_z$

15. A grounded metal with flat bottom is placed on the x-y plane. The surface of the metal is smooth but with unknown shape. If the electric potential outside of the metal, in spherical coordinate, is given by $V(r,\theta,\varphi) = \frac{\cos\theta}{r^2}$, $0 \le \theta \le \frac{\pi}{2}$.
If point $P(1, \frac{\pi}{4}, \frac{\pi}{8})$ is on the metal surface, the charge density at point P is
(A) $\varepsilon_0\sqrt{7}$　(B) $2\varepsilon_0$　(C) $\varepsilon_0\frac{7}{2}$　(D) $\varepsilon_0\frac{\sqrt{7}}{2}$　(E) $\varepsilon_0\sqrt{\frac{7}{2}}$