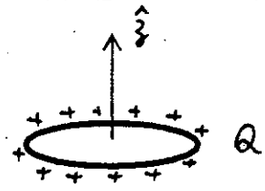
本試題是否可以使用計算機：☑可使用，□不可使用　（請命題老師勾選）

Part I: 選擇題 (每題五分，題目可能是單選或複選，答錯不倒扣。複選題全對才給分。)

1. A time-dependent voltage source $V(t) = \pi t^3 + 2$ Volt is connected across a parallel-plate capacitor with separation $d = 3$ mm and surface area $S = 1$ m^2. What is the displacement current between the plates at $t = 6$ sec? **(a)** 10^{-5} A **(b)** 10^{-6} A **(c)** 10^{-7} A **(d)** 10^{-8} A **(e)** 10^{-9} A.
2. For the following two-dipole systems, which configuration has the lowest electrostatic energy? In each case, two identical electric dipoles separate with a distance R from each center point.
(a) → → **(b)** → ← **(c)** ↑ ↑ **(d)** ↑ ↓ **(e)** ↑ →
3. A total positive charge Q is uniformly distributed on a ring of radius a. An electron with charge e and mass m is released from the point $z << a$ along the axis of the ring. The motion of the electron can be described as a simple harmonic oscillation with angular frequency **(a)** $\sqrt{Qe/2\pi m\varepsilon_0 a^3}$. **(b)** $\sqrt{Qe/4\pi m\varepsilon_0 a^3}$. **(c)** $\sqrt{Qe/8\pi m\varepsilon_0 a^3}$. **(d)** $\sqrt{Qe/2\pi m\varepsilon_0 a^2}$. **(e)** $\sqrt{Qe/4\pi m\varepsilon_0 a^2}$.



4. The x-polarized uniform plane wave with frequency 150 MHz propagates in air along the z-direction and impinges on a perfectly conducting plane at $z = 0$. Assuming the amplitude of the $\vec{E}$ field for the incident wave is 12 (mV/m), what is the expression for the reflected $\vec{H}(t,z)$ field in A/m? **(a)** $(10^{-4}/\pi)\cos(1.5\times10^7 t - \pi z)y$ **(b)** $(10^{-4}/\pi)\cos(1.5\times10^7 t + \pi z)y$ **(c)** $(10^{-4}/\pi)\cos(3\pi\times10^8 t + 2\pi z)y$ **(d)** $(10^{-4}/\pi)\cos(3\pi\times10^8 t - \pi z)y$ **(e)** $(10^{-4}/\pi)\cos(3\pi\times10^8 t + \pi z)y$
5. In the following, what are the correct units for the *Poynting vector*? **(a)** Tesla · Volt/m **(b)** Watt/m^3 **(c)** J/(sec · m^2) **(d)** Amp · Volt/m^2 **(e)** Watt/(sec · m^2)
6. In an air-filled rectangular cavity resonator has dimensions $a = b = 1.5$ cm and $d = 3$ cm. The z-component H-field for the TE modes in a Cartesian coordinate is

$H_z(x,y,z) = H_o \cos(\frac{m\pi}{a}x)\cos(\frac{n\pi}{b}y)\sin(\frac{p\pi}{d}z)$, where m, n, and p are integrals. The resonant frequency is given as $f_{mnp} = \frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{(\frac{m}{a})^2+(\frac{n}{b})^2+(\frac{p}{d})^2}$. What is the lowest resonant frequency of the TE modes? **(a)** 5 GHz **(b)** 10 GHz **(c)** $5\sqrt{5}$ GHz **(d)** $10\sqrt{2}$ GH **(e)** 15 GHz

(背面仍有題目,請繼續作答)

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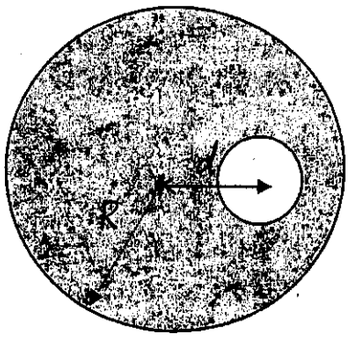
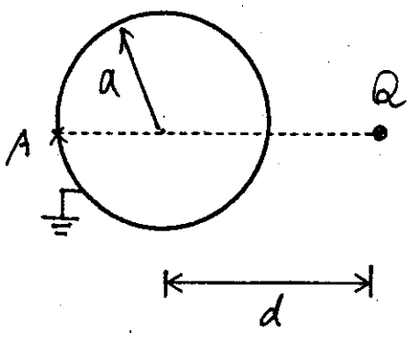
Part II: 計算題

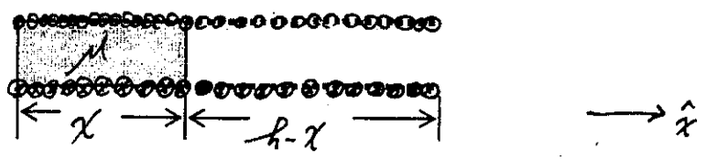
1. **(10 Points)** Find the magnitude and direction of $\vec{E}$ field in the spherical cavity whose center is displaced from that of the solid part by a distance d. The uniform charge density is ρ_0.



2. **(15 Points)** A positive point charge Q is located at a distant $d = 2a$ outside a grounded conducting sphere of radius a, as shown below.
   (a) Determine the magnitude and location of the image charge inside the sphere.
   (a) Evaluate the electric field $\vec{E}$ and surface charge density induced on the point A.



3. **(15 Points)** A constant current I flows in a long solenoid of length h with n closely wound coil-turns per unit length. The cross sectional area of its iron core, which has permeability μ, is S. (a) Determine the total magnetic energy stored in this solenoid. (b) Calculate the self-inductance of this case. (c) Find the force (magnitude and direction) acting on the core.



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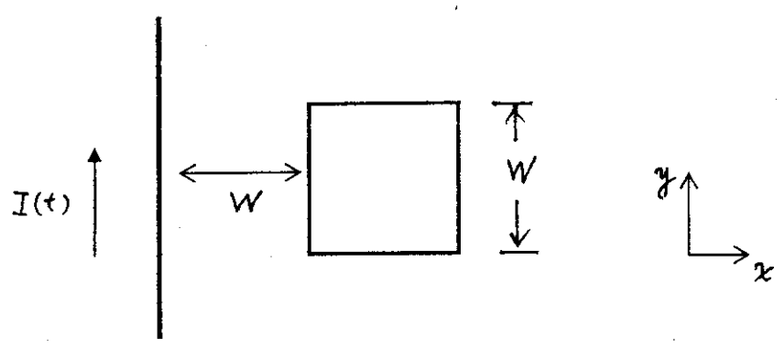
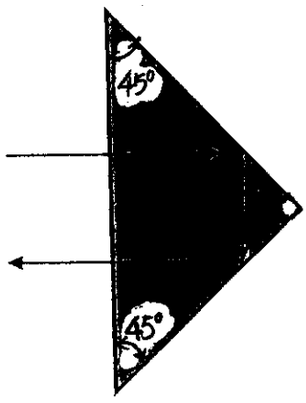
4. (15 Points) A very long, straight wire with a time-dependent current I points to $+y$ direction. The current I varies with time as $I(t) = 3t^2 + 2$ Amp. (a) Find the total magnetic flux on the square loop with side W located at the right hand side of the straight wire, as shown below. Express your answer in terms of μ_0, I, and W. (b) If the square loop has a total resistance $R = 1.2\ \Omega$ and the side $W = 1$ m, calculate the induced current on the loop at $t = 1$ sec (magnitude and direction (clockwise or counterclockwise). (c) Determine the magnetic dipole moment $\vec{m}$ of the loop (magnitude and direction) at this instantaneous time $t = 1$ sec. (d) Roughly plot the direction of the corresponding Poynting vector on the sides of the loop.



5. (15 Points) A triangular prism shown below has a relative dielectric constant $\varepsilon_r = 4$ and $\mu_r = 1$.

(a) Find the index of refraction, n, of the prism, and the critical angle θ_c for the incident light from the prism to air.

(b) Calculate the percentage of the incident light power reflected back by the prism. The transmission coefficient for a normal incident light is $\tau = 2\eta_2/(\eta_2 + \eta_1)$.



**Useful values:*

* $\varepsilon_0 = (36\pi \times 10^9)^{-1}$ F/m
* $\mu_0 = 4\pi \times 10^{-7}$ H/m