國立中山大學103學年度轉學考招生考試試題

科目名稱：電磁學【物理系三年級】　　題號：723003

※本科目依簡章規定「不可以」使用計算機　　

A. 選擇題（單選，每題5分，共70分）

1. A hollow metal sphere is charged to a potential V. The potential at its center is:
A) V, B) 0, C) $-V$, D) $2V$, E) πV

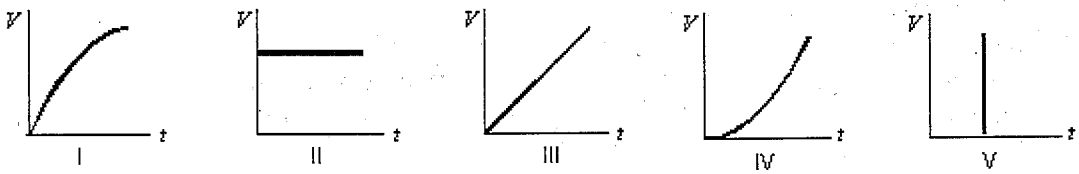
2. Two conducting spheres, one having twice the diameter of the other, are separated by a distance large compared to their diameters. The smaller sphere (1) has charge q and the larger sphere (2) is uncharged. If the spheres are connected by a long thin wire:

A) 1 and 2 have the same potential
B) 2 has twice the potential of 1
C) 2 has half the potential of 1
D) 1 and 2 have the same charge
E) all of the charge is dissipated

3. In the diagram, the current in the 3-Ω resistor is 4 A. The potential difference between points 1 and 2 is:

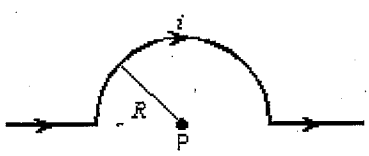
A) 0.75 V, B) 0.8 V, C) 1.25 V, D) 12 V, E) 20 V

4. Suppose the current charging a capacitor is kept constant. Which graph below correctly gives the potential difference V across the capacitor as a function of time?



A) I, B) II, C) III, D) IV, E) V

5. The magnitude of the magnetic field at point P, at the center of the semicircle shown, is given by:



A) $2\mu_0 i/R^2$, B) $\mu_0 i/2\pi R$, C) $\mu_0 i/4\pi R$, D) $\mu_0 i/2R$, E) $\mu_0 i/4R$

6. If R is the distance from a magnetic dipole, then the magnetic field it produces is proportional to:

A) R, B) $1/R$, C) R^2, D) $1/R^2$, E) $1/R^3$

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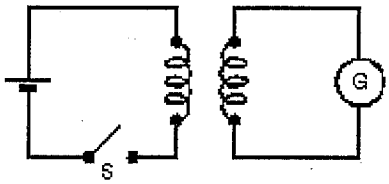
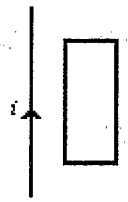
7. In the circuit shown, there will be a non-zero reading in galvanometer G:



A) only just after S is closed
B) only just after S is opened
C) only while S is kept closed
D) only just after S is opened or closed
E) never

8. A long straight wire is in the plane of a rectangular conducting loop. The straight wire carries an increasing current in the direction shown. The current in the rectangle is:



A) zero
B) clockwise
C) counterclockwise
D) clockwise in the left side and counterclockwise in the right side
E) counterclockwise in the left side and clockwise in the right side

9. The energy of a magnetic dipole in an external magnetic field is least when:
A) the dipole moment is parallel to the field
B) the dipole moment is antiparallel to the field
C) the dipole moment is perpendicular to the field
D) none of the above (the same energy is associated with all orientations)
E) none of the above (no energy is associated with the dipole-field interaction)

10. A magnetic field $\vec{B}_0$ is applied to a diamagnetic substance. In the interior the magnetic field produced by the magnetic dipoles of the substance is:

A) greater than $\vec{B}_0$ and in the opposite direction
B) less than $\vec{B}_0$ and in the opposite direction
C) greater than $\vec{B}_0$ and in the same direction
D) less than $\vec{B}_0$ and in the same direction
E) the same as $\vec{B}_0$

11. A 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 these

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12. Displacement current exists wherever there is:
A) a magnetic field
B) moving charge
C) a changing magnetic field
D) an electric field
E) a changing electric field

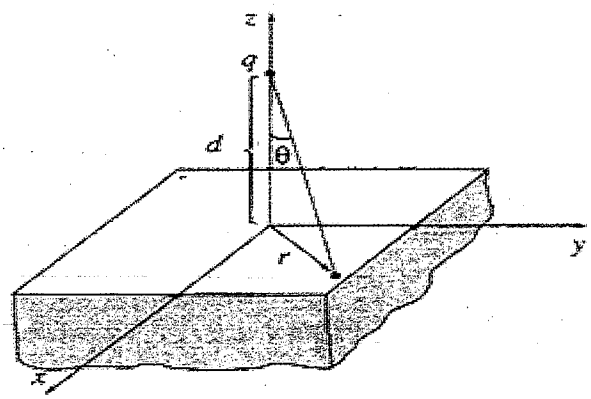
13. Consider the four Maxwell equations:
I. $\oint \vec{E} \cdot d\vec{A} = q / \varepsilon_0$
II. $\oint \vec{B} \cdot d\vec{A} = 0$
III. $\oint \vec{E} \cdot d\vec{\ell} = -d\Phi_B / dt$
IV. $\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I + \mu_0 \varepsilon_0 d\Phi_E / dt$
Which of these states that the magnetic monopole does not exist?

A) only I
B) only II
C) only III
D) only IV
E) only II, III

14. Maxwell's great contribution to electromagnetic theory was his hypothesis that:
A) work is required to move a magnetic pole through a closed path surrounding a current
B) a time-varying electric flux acts as a current for purposes of producing a magnetic field
C) the speed of light could be determined from simple electrostatic and magnetostatic experiments (finding the values of μ_0 and $\in_0$)
D) the magnetic force on a moving charge particle is perpendicular to both $\vec{v}$ and $\vec{B}$
E) magnetism could be explained in terms of circulating currents in atoms

B. 非選擇題（共 30 分）

1. 【10%】Suppose the entire region below the plane z = 0 in **(Figure 1)** is filled with uniform linear dielectric material of susceptibility χ_e. Calculate the force on a point charge **q** situated a distance **d** above the origin.



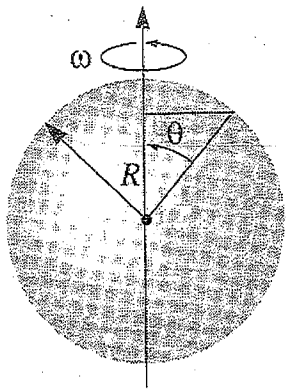
(Figure 1)

2. 【20%】A uniformly magnetized sphere, of radius **R**, carrying a uniform surface charge σ, is set spinning at angular velocity ω. (**Figure 2**).

(a)(4%) Find the $\vec{J}_{surf}$ (surface current) and the equivalent **volume magnetization**.

(b)(8%) What is the volume magnetic charge density $\rho_m(\mathbf{r})$ and the surface magnetic charge density $\sigma_m(\mathbf{r})$.

(c)(8%) Show that the internal magnetic field is uniform and obtain its value.



(Figure 2)

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計算題及說明題, 共 5 題. 每題 20 分. 須明確寫出所有計算過程以所需概念, 否則將部分扣分.

1. See Figure 1. (a) Calculate the rotational inertia about the pivot point. (b) Find the angular velocity and period of oscillation of a solid sphere of mass m and radius R about a point on its surface.(20 points)

2. Write down the Kepler's three laws.(20 points)

3. See Figure 2. A rocket with a mass m, moves in free space at velocity v at time t. In the time interval dt, as mass dm' is ejected from the rocket engine with velocity u with respect to the rocket ship. Let m_0 and v_0 be the initial mass and speed of the space ship. Find the relation between m and v. (20 points)

4. See figure 3. Find the horizontal deflection from the plumb line cause by the Coriolis force acting on a particle falling freely in Earth's gravitational field, g, from a height h about the Earth's surface. Let ω is the angular velocity of earth, and λ is the latitude. (20points)

5. See Figure 4. Tow coupled Harmonic oscillator. Find the Characteristic frequencies (or eigenfrequencies) of the system and the respective oscillation modes. (20 points)

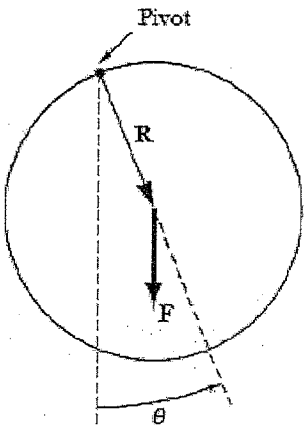

Figure 1

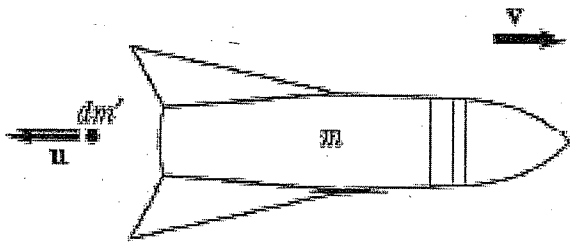

Figure 2

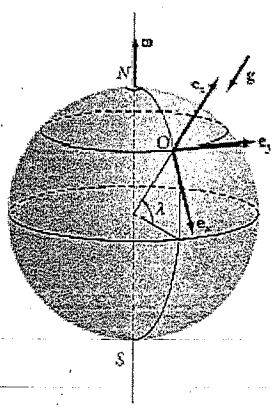

Figure 3

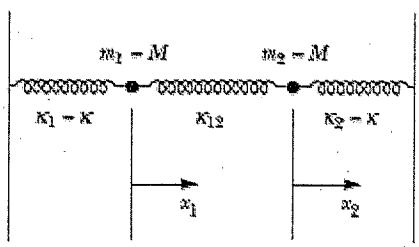

Figure 4