

臺灣綜合大學系統 105 學年度學士班轉學生聯合招生考試試題

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| 科目名稱 | 普通物理 C | 類組代碼 | E00 |
| | | 科目碼 | E0016 |

※本項考試依簡章規定各考科均「不可以」使用計算機

本科試題共計 3 頁

第一部分：簡答題（60分）

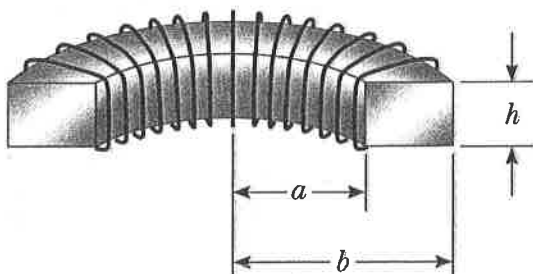
共 12 題，每題 5 分，請於答案卷上標明題號並依序作答（中英文作答均可，無需詳列計算過程）。

1. The potential energy shared by two atoms separated by a distance r in a diatomic molecule is given by the Lennard-Jones function (U_0 and r_0 are constants):

$$U(r) = U_0 \left[\left(\frac{r_0}{r} \right)^{12} - 2 \left(\frac{r_0}{r} \right)^6 \right]$$

Where is $F_r = 0$?

2. A body of uniform cross-sectional area A and of mass density ρ floats in a liquid and at equilibrium displaces a volume V . Calculate the period of **small oscillations** about the equilibrium position by using g as the gravity acceleration.
3. Three objects of uniform density—a solid sphere, a solid cylinder, and a hollow cylinder, are placed at the top of an incline. They are all released from rest at the same elevation and **roll without slipping**. Which object reaches the bottom **last**?
4. Please use a PV (pressure-volume) diagram to describe the difference between **adiabatic** and **isothermal** processes.
5. Please give the **Kelvin-Planck form (heat engine statement)** of the second law of thermodynamics.
6. A water film ($n=1.33$) in air is 320-nm thick. If it is illuminated with white light at normal incident, what color will it appear to be in the reflected light?
7. Use a plot of B versus r to describe the magnitude of magnetic field versus distance r from the center of a **long current-carrying wire** of radius R .
8. The toroid in the following figure consists of N turns and has a rectangular cross section. Its inner and outer radii are a and b , respectively. Please calculate the inductance of the toroid.



9. What is the physical meaning of **Gauss's law in magnetism**?

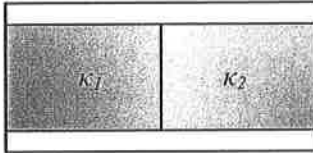
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10. The space between the plates of a parallel-plate capacitor is filled with two dielectrics of equal size, as shown in the following figure. What is the resulting capacitance in terms of κ_1 , κ_2 , and C_0 , the capacitance with a vacuum between the plates?



11. A crew on a spacecraft watches a movie that is three hours long. The spacecraft is moving at high speed through space. Does an **earth-based observer** watching the movie screen on the spacecraft through a powerful telescope measure the duration of the movie to be longer than, shorter than, or equal to three hours?
12. There are four stars shown in a telescope color photograph. Start A appears to glow red, start B appears to glow yellow, start C appears to glow blue, whereas start D looks green in color. Please rank the stars by their surface temperatures **from lowest to highest**.

第二部分：計算題（40 分）

共 3 題，請於答案卷上標明題號依序作答，並詳列計算過程（中英文作答均可）。

1. In Millikan's oil drop experiment, the drops are first held motionless by application of a uniform field E . Next, the field is switched off and the drops are allowed to fall in air until they reach the terminal speed v_T . The fluid resistance is given by Stokes law, $F=6\pi\eta r v_T$, where η is the coefficient of viscosity and r is the radius. The condition for falling at the terminal speed is $6\pi\eta r v_T = m_{\text{eff}} g$. The effective mass of a drop is $m_{\text{eff}} = 4/3\pi r^3 (\rho - \rho_A)$, where ρ is the density of the drop and ρ_A is the density of the air, which has a buoyant effect. Show that the charge on a drop is given by

$$q = \frac{18\pi}{E} \sqrt{\frac{\eta^3 v_T^3}{2(\rho - \rho_A)g}}. \quad (10 \text{ points})$$

2. (a) Show a graphical and physical description of an LC circuit by using the mechanical analog of a block-spring system in one cycle oscillation. (Hint: Try to discuss the energies stored in the circuit and mechanical systems) (5 points)

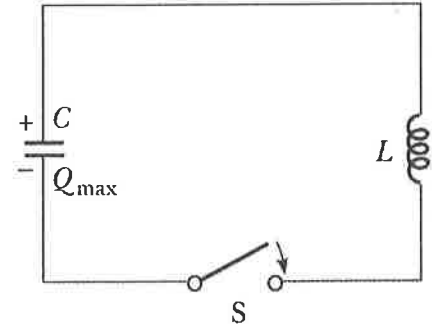
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(b) Following above description, what are the time relations of charge in the capacitor and current in the circuit? (Hint: Use the rule of energy conservation in one cycle oscillation) **(5 points)**



(c) If the resistance of the wires in an LC circuit were not zero, would the oscillation persist? Please explain. **(5 points)**

3. An electron is confined to move in the xy plane in a two-dimensional box of side L . The energy is determined by two quantum numbers n_x and n_y :

$$E = \frac{h^2}{8mL^2} (n_x^2 + n_y^2)$$

(a) What values of n_x and n_y correspond to the ground state and the first excited state? **(5 points)**

(b) What is the energy difference between the ground state and the second excited state? **(5 points)**

(c) What is the wavelength of a photon that will cause the transition between the ground state and the second excited state? **(5 points)**