

## 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

科目名稱	普通物理 C	類組代碼	<u>E00</u>
		科目碼	<u>E0016</u>

※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)

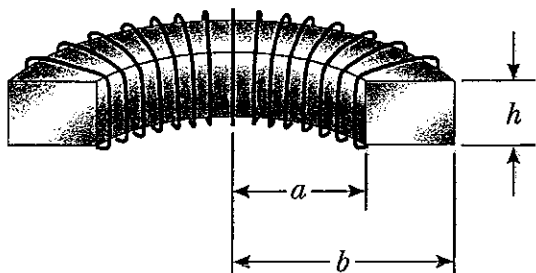
共 12 題，每題 5 分，請於答案卷上標明題號並依序作答 (中英文作答均可，無需詳列計算過程)。

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  $\rho$  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  $\kappa_1$ ,  $\kappa_2$ , 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  $\eta$  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  $\rho$  is the density of the drop and  $\rho_A$  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)

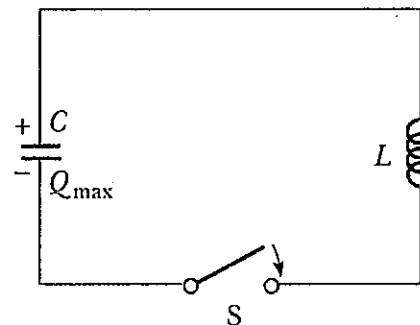
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(b) Following above description, what are the time relations of charge in the capacitor and current in the circuit? (Hint: Use the rule of energy conservation in one cycle oscillation) (5 points)



(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)