國立成功大學
113學年度碩士班招生考試試題

編　號：38

系　所：物理學系

科　目：普通物理學

日　期：0202

節　次：第 2 節

備　註：不可使用計算機

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

※作答所用物理常數符號

Electric constant (permittivity constant) : ϵ_0　　　Magnetic constant (permeability constant) : μ_0

Gas constant : R　　　　　　　　　　　　　　Gravitational acceleration on earth : g

※作答所用對數值

ln2=0.7,　ln3=1.1

第一部分 ： 簡答題 (65 分)

共 13 題，每題 5 分，請在答案卷上標明題號並依序作答。(請直接寫下答案，不用列出計算過程，數值答案需寫上單位)

1. A ball moves in a straight line with a constant velocity of magnitude 2 m/s. It enters a dusty medium. If the force acting on the ball at any instant is 10^{-4} N, find the rate of change of the mass of the ball due to the dust adherence to its surface.

2. A thin massless rod of length ℓ is pivoted at one end. A circular ring of mass M and radius $\ell/5$ is attached to the free end of the rod and set oscillating with small amplitude, as shown in Fig. 1. Find the equation of motion.

3. A ball of mass M and radius R that rolls without slipping up an incline, speed of center is v_{CM} as shown in Fig. 2. Its moment of inertia of the ball about a central axis is $2MR^2/5$. If the angular velocity of the ball at time $t = 0$ is ω_0, find the time taken by the ball to reach its maximum height.
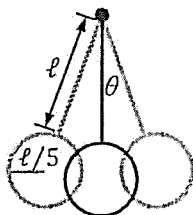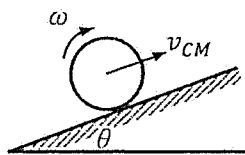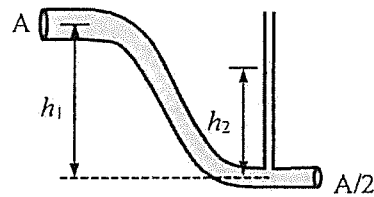

Fig. 1　　　　　　　　　Fig. 2　　　　　　　　　Fig. 3

4. In Fig. 3 a horizontal pipe of cross-sectional area A is jointed to a pipe of cross-sectional area $A/2$ lowered by h_1. The entire pipe is full of liquid with density ρ, and the left end is at atmospheric pressure P_0. A small open tube extends upward from the lower pipe. Find the height h_2 of liquid in the small tube when the liquid flows with speed v in the upper pipe. (Assume the pressure is constant over the cross-section of the lower pipe.)

5. A transverse wave is described by $y(x,t) = (at^2 + bxt + cx^2 + d)$ m, where a, b, c and d are positive constants, what is the wave speed?

6. Antireflection coatings consist of a thin layer of dielectric material, with a specially chosen thickness and refractive index such that interference effects in the coating cause the wave reflected from the top surface of the antireflection coating to be out of phase perfectly with the wave reflected from the glass surface. An engineer wants to complete an antireflection coating at $\lambda = 560$ nm in air with minimum coating thickness 100 nm, which material should he use? (see Table 1)

Table 1

Material	CuO	MgF$_2$	Al$_2$O$_3$	SiC	BiFeO$_3$
Refractive Index	0.864	1.39	1.726	2.657	3.118

7. The pressure of n moles ideal monatomic gas changes from P_i to P_f at constant volume process, find the change in entropy.

8. A capacitor consists of two interleaving sets of plates, partially filled with dielectric slabs of constant κ, as shown in Fig. 4. The plate separations and the effective area of overlap are shown in the figure. What is the capacitance of this arrangement?
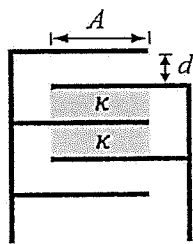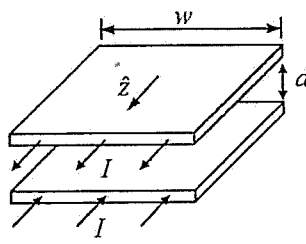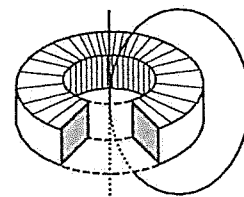

Fig. 4　　　　　　　　Fig. 5　　　　　　　　Fig. 6

9. Two long (in z direction), parallel conducting sheets of width w and spacing d carry equal but opposite currents I distributed uniformly, as shown in Fig. 5. Assume the B field outside the sheets is zero for $d \ll w$. Find the inductance per unit length in z direction.

10. A toroidal coil has inner radius R and a square cross section of side h, the portion of the coil is shown in Fig. 6. It is wound with N turns of wire, and carries a current $I(t) = I_0(1 + 2\cos\omega t)$. A single-turn wire loop encircles the toroid, passing through its center hole. Find an expression for the peak emf induced in the loop.

11. A cylindrical solenoid of radius R and height h consists of N windings. The current increases with time as $I(t) = \alpha t$, where α is a constant. Assuming this solenoid to be ideal, determine the magnitude of the Poynting vector S at a radial distance R from the center of the long center axis of the solenoid.

12. A long, straight wire carries a constant current I. A metal rod of length ℓ moves at velocity v relative to the wire, as shown in Fig. 7. What is the potential difference between the ends of the rod?
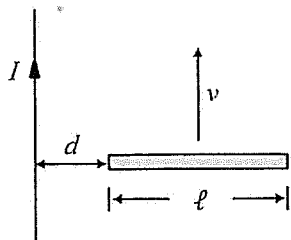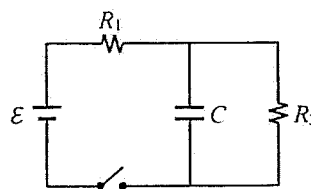

Fig. 7　　　　　　　　　　　　　　　　Fig. 8

13. In Fig.8 the capacitor is initially uncharged. The currents through R_1 immediately after the switch is closed and a long time after the switch has been closed are I_0 and I_∞ respectively. Find the magnitude of ratio I_0/I_∞.

第二部分：計算題 (共 35 分) 請在答案卷上標明題號依序作答，並詳列出計算過程。

14. The plates of a parallel-plate capacitor have area A, separation a, and are connected to a battery with voltage V. While connected to the battery, the plates are pulled apart until they are separated by $3a$.

　(5%) (a) Find the potential energy difference ΔU？

　(5%) (b) Does potential energy decrease or increase? Why?

　(5%) (c) Calculate the work is required to pull the plates apart from the equation $W = \int \vec{F} \cdot d\vec{\ell}$ (assume constant speed).

15. One mole of an ideal gas with $\gamma = 1.4$ is taken through the cyclic process depicted in Fig. 9. From A to B it undergoes an isothermal expansion.

　(5%) (a) Calculate the total work done by the gas.

　(10%) (b) Find the heat absorbed per cycle by calculating the heat transferred in each segment.

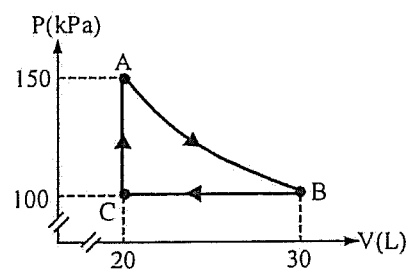　(5%) (c) Consider the relationship (">", "<" or "=") between the answers of parts (a) and (b), explain it by the 1st law.

Fig. 9