國立臺灣師範大學 109 學年度碩士班招生考試試題

科目：**普通物理**　　適用系所：**物理學系**

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣分。

1. (15 points) In the arrangement shown in Figure 1, the mass and radius of the suspended uniform solid cylinder is m and R, respectively. Two bodies of mass, m_1 and m_2 ($m_1 > m_2$), are hanging over the cylinder by a massless wire and at the same height h above the ground. The slipping between the wire and the cylinder, and the friction in the axle of the cylinder are both negligible.
(a) Draw the free-body diagram for each body shown in Figure 1.
(b) Find the expression for the angular acceleration of the cylinder once the motion starts.
(c) If $m = 4.0$ kg, $m_1 = 3.6$ kg, $m_2 = 2.2$ kg, $R = 0.5$ m, and the height $h = 1.8$ m, what will be the maximum height (above the ground) that m_2 can reach?

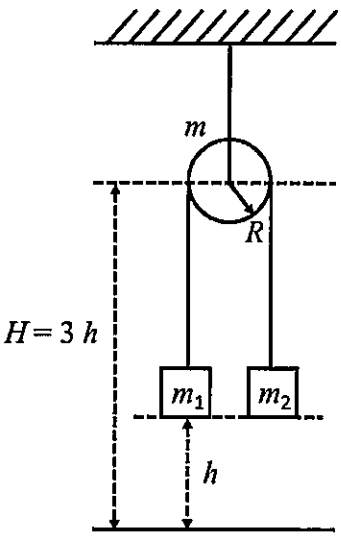

Figure 1.

2. (20 points) Two moles of an ideal diatomic gas are taken around the cycle of a heat engine shown in Figure 2. The segment ab is isothermal. Please find:
(a) the heat absorbed or rejected in each segment;
(b) the work done per cycle;
(c) the efficiency of this engine.

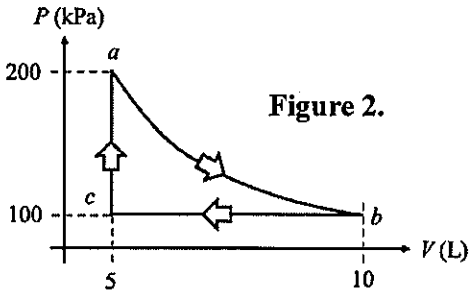

Figure 2.

3. (20 points) A rectangular loop of mass m, length h, width l, and resistance R falls vertically through a uniform horizontal field B, as shown in Figure 3.
(a) Find the terminal velocity v_T of the loop.
(b) At v_T, find the electrical power dissipation of the loop and compare it to the rate at which gravitational energy is being lost.

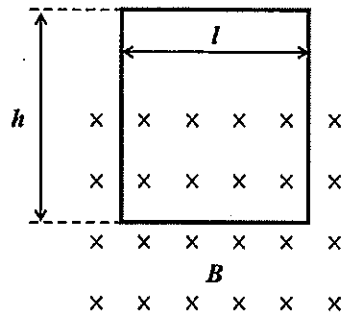

Figure 3.

4. (15 points) A thin uniform film of refractive index 1.25 is placed on a smooth glass slide of refractive index 1.50. At 20 °C, this film is just thick enough for light with wavelength 584.0 nm reflected off the top of the film to be canceled by light reflected from the top of the glass. After the glass is placed in an oven and slowly heated to 176 °C, you find that the thickness of the film happens to cancel the reflected light with

wavelength 587.0 nm. Assuming that the refractive index of the film does not change with the temperature, what is the coefficient of linear expansion of the film?

5. (15 points) A photon that has wavelength $\lambda = 0.110$ nm collides with a stationary electron. After the collision, the electron moves forward, and the photon recoils backward. The masses of proton and electron are 9.11×10^{-31} kg and 1.67×10^{-27} kg, respectively. Please find:
(a) the change in wavelength of the proton after the collision,
(b) the momentum, and (c) the kinetic energy of the electron after the collision.

6. (15 points) An electron with mass m_e is trapped in a square well of width L. The swell is infinitely deep. Its normalized wave function within the well for the n^{th} state is

$$\psi_n(x) = \sqrt{\frac{2}{L}}\sin(\frac{n\pi x}{L}).$$

(a) For n =1, what is the probability of finding this electron between $x = 0$ and $x = L/4$?

(b) A photon with wavelength λ is absorbed by this electron. As a result, the electron moves from state $n = 1$ to $n = 4$. Find the length L of this square well.

(c) Following (b), what is the wavelength of the photon emitted in the transition of that electron from the state $n = 4$ to the state $n = 2$?