

試述卡諾引擎(循環) “Carnot's engine (cycle)”之定義與特性，並推導卡諾引擎(循環)之工作效能  $e=1-(T_c/T_h)$ 。其中  $T_c$  及  $T_h$  分別為低溫及高溫熱庫之溫度。(15 分)

Eyeglass lenses can be coated on the inner surfaces to reduce the reflection of stray light to the eye. If the lenses are medium flint glass of refractive index 1.62 and the coating is fluorite of refractive index 1.432.

- (a) What minimum thickness of film is needed on the lenses to fully cancel light of wavelength 550 nm reflected toward the eye at normal incidence? [8%]
- (b) Why will (or will not) other wavelengths of visible light (400-700nm) be totally cancelled or enhanced in the reflected light? [7%]

Write down the four Maxwell's equations in a vacuum. Explain what is the phenomenon described in these four laws of electromagnetism. (10-points)

In "your" inertial frame  $S$ , a ruler of  $L_0 = 20.0$  cm is lying still on your desk.

- (a) (5 pts) Another inertial frame  $S'$  is moving at velocity  $v = 0.200c$  of your frame  $S$ , along the ruler (let's take it to be the  $x$ -axis). What does the ruler's length become ( $L$ ) in frame  $S'$ ?
- (b) (5 pts) By the definition of "length measurement", the 2 ruler-end measurement events are done in frame  $S'$  simultaneously, i.e.,  $(x'_1, t'_1) = (0, 0)$ ,  $(x'_2, t'_2) = (L, 0)$ , and  $\Delta t' = 0$ . However, these 2 events are not simultaneous in your frame  $S$ . What is  $\Delta t \equiv t_2 - t_1$ ?
- (c) (5 pts) Is it possible to find an inertial frame  $S''$  where these 2 events happen at the same position? Why or why not?

- (a) The energy levels of a non-relativistic electron of mass  $m$  in a 1D trap of length  $L$  are given by  $E_n = \left(\frac{h^2}{8mL^2}\right)n^2$ ,  $n = 1, 2, 3, \dots$ , where  $h$  is the Planck constant. A transition happens where the electron jumps from the energy level  $n = 2$  to  $n = 1$ . Find an expression for the wavelength of the photon emitted in this transition. [30%]
- (b) The mean lifetime of a muon is  $2.2\mu\text{s}$  (the lifetime in its own rest frame). If a muon velocity in the laboratory is  $v = 0.9994c$ , where  $c$  is the speed of light, find the muon mean lifetime as measured in the laboratory. [20%]

In a certain binary-star system, each star has the same mass as our Sun, and they revolve about their center of mass. The distance between them is the same as the distance between Earth and the Sun. What is their period of revolution in years?