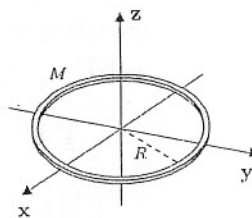


Part I. 單選題 (每題 6 分, 共 60 分, 答錯不倒扣)。

1. The Kepler's second law of planetary motion is that the line joining the sun to a planet sweeps out equal areas in equal times. Which one of the following principles is the fundamental of the Kepler's second law?
- (A) second law of thermal dynamics
 (B) Hooke's law
 (C) conservation of energy
 (D) conservation of linear momentum
 (E) conservation of angular momentum

2. A ring of mass M and radius R is shown in the right. What is the moment of inertia along the x -axis?

- (A) πMR^2 (B) $\frac{\pi}{2}MR^2$ (C) $2MR^2$ (D) MR^2 (E) $\frac{1}{2}MR^2$



3. The position of a block attached to a string oscillates as $x(t) = x_0 \cos(\omega t)$, where x_0 is the amplitude, ω is the angular frequency, and t is time. Therefore, the kinetic energy of the block is also a periodic function of time. What is the period of the kinetic energy?

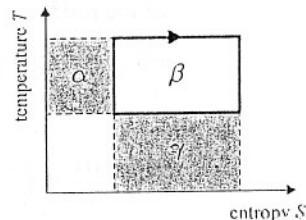
- (A) $\frac{1}{\omega}$ (B) $\frac{1}{2\omega}$ (C) $\frac{2\pi}{\omega}$ (D) $\frac{\pi}{\omega}$ (E) $\frac{\pi}{2\omega}$

4. A wire is stretched from L to $L + \Delta L$. The Young's modulus of the wire is Y and the density of the wire is ρ . What is the speed of a transverse wave propagated through the wire?

- (A) $\sqrt{\frac{Y \Delta L}{\rho L}}$ (B) $\sqrt{\frac{2Y \Delta L}{\rho L}}$ (C) $\sqrt{\frac{2Y}{\rho}} \left(\frac{\Delta L}{L}\right)$ (D) $\sqrt{\frac{\rho \Delta L}{2Y L}}$ (E) $\sqrt{\frac{\rho \Delta L}{Y L}}$

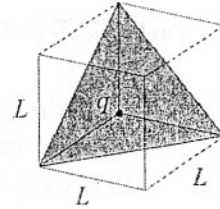
5. The Temperature(T)-Entropy(S) diagram of the Carnot cycle is shown in the right figure (solid line). What area in the T - S diagram represents the work done by the system in each cycle?

- (A) α (B) β (C) γ (D) $\alpha + \beta$ (E) $\beta + \gamma$



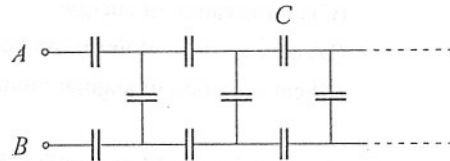
注意：背面有試題

6. A charge q sits at the back corner of a cube, as shown. The length of the edge of the cube is L and the permittivity constant is ϵ_0 . What is the flux of electric field E through the shaded surface of the figure?



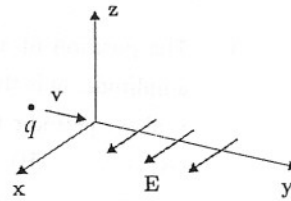
- (A) $\frac{1}{4} \frac{q}{\epsilon_0}$ (B) $\frac{1}{6} \frac{q}{\epsilon_0}$ (C) $\frac{1}{8} \frac{q}{\epsilon_0}$ (D) $\frac{1}{10} \frac{q}{\epsilon_0}$ (E) $\frac{1}{12} \frac{q}{\epsilon_0}$

7. The pattern of capacitors of equal value C shown in the right figure is repeated indefinitely. What is the effective capacitance between the terminals A and B ?



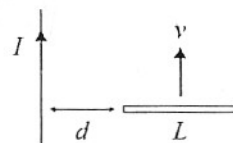
- (A) $\left(\frac{\sqrt{5}}{2}\right) C$ (B) $\left(\frac{\sqrt{5}+1}{2}\right) C$ (C) $\left(\frac{3}{2}\right) C$
 (D) $\left(\frac{5}{2}\right) C$ (E) $\left(\frac{\sqrt{3}-1}{2}\right) C$

8. As shown, a charge particle q is inject into a space with uniform electric field $\mathbf{E} = E_0 \mathbf{x}$, where E_0 is the absolute value of the electric field and \mathbf{x} is the unit vector along the x -axis. The initial velocity of the particle is $\mathbf{v} = v_0 \mathbf{y}$, where \mathbf{y} is the unit vector along the y -axis. A magnetic field \mathbf{B} is applied into the same space to maintain the velocity of the particle. Which one of the following fields is the correct one?



- (A) $\mathbf{B} = \frac{E_0}{v_0} \mathbf{x}$ (B) $\mathbf{B} = \frac{-E_0}{v_0} \mathbf{z}$ (C) $\mathbf{B} = \frac{v_0}{E_0} \mathbf{z}$ (D) $\mathbf{B} = \frac{-v_0}{E_0} \mathbf{x}$ (E) $\mathbf{B} = \frac{-E_0}{v_0} \mathbf{x}$

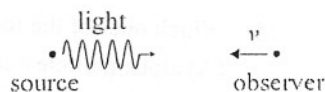
9. A long, straight wire carries a constant current I . A metal rod of length L moves at velocity v relative to the wire, as shown. The distance between the wire and rod is d . What is the potential difference between the ends of the rod?



- (A) $\frac{\mu_0 I v}{2\pi} \ln\left(\frac{d+L}{d}\right)$ (B) $\frac{\mu_0 I v}{2\pi} \ln\left(\frac{d+L}{d}\right)$ (C) $\frac{\mu_0 I v}{\pi} \ln\left(\frac{d+L}{d}\right)$
 (D) $\frac{\mu_0 I v}{\pi} \ln\left(\frac{d+L}{d}\right)$ (E) $\frac{\mu_0 I v}{\pi} \exp\left(\frac{d+L}{d}\right)$

注意：背面有試題

10. A light source emits a light wave with frequency f_0 to an observer. At the same time, the observer moves toward the light source with speed $v = 1/2 c$, where c is the speed of light. What is the frequency observed by the observer?



- (A) $\frac{1}{\sqrt{3}}f_0$ (B) $\frac{1}{2}f_0$ (C) f_0 (D) $\sqrt{2}f_0$ (E) $\sqrt{3}f_0$

Part II. 複選題 (每題 8 分，共 40 分，每個選項答對得 1.6 分，答錯倒扣 1.6 分)。

11. Consider an ideal gas system. Which ones of the following physical quantities are “state variables”?
- (A) internal energy (B) volume (C) entropy (D) temperature (E) pressure
12. Which ones of the following statements of the second law of thermodynamics are wrong?
- (A) No cyclical heat engine has a greater efficiency than a reversible engine operating between the same two temperatures.
- (B) It is impossible for a cyclical device to transfer heat continuously from a hot body to a cold body without the input of work or other effect on the environment.
- (C) It is impossible for a heat engine that operates in a cycle to convert its work input completely into heat.
- (D) In a reversible process the entropy of an isolated system stays constant; in an irreversible process the entropy decreases.
- (E) In a reversible process the entropy of an isolated system increases; in an irreversible process the entropy stays constant.
13. Which ones of the following principles can be used to explain the propagation of light?
- (A) Fermat's principle of least time
- (B) Hooke's law of elasticity
- (C) Pauli's exclusion principle
- (D) Heisenberg's uncertainty principle
- (E) Huygens' principle of wave
14. Which ones of the following concepts must be applied to explain the features the Compton scattering effect?
- (A) quantization of the bound electron energy levels in atom
- (B) quantization of the electron spin
- (C) quantization of the energy of the electromagnetic field
- (D) quantization of the angular momentum of the electromagnetic field
- (E) quantization of the linear momentum of the electromagnetic field

注意：背面有試題

15. Which ones of the following process are nuclear reactions?

(A) alpha particle emission from ^{226}Ra

(B) proton emission from ^{87}Br

(C) fusion of ^1H to be ^4He

(D) ionization of ^1H to be electron and proton

(E) combination of H_2 and O_2 to be water