國立臺灣大學113學年度碩士班招生考試試題

題號：47

科目：普通物理學

※每小題 5 分，請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

1. In Figure 1, the observer at *O* views two closely spaced lines through an angled piece of plastic. How do the lines appear to the observer? (A) shifted to the right. (B) shifted to the left. (C) spaced farther apart. (D) spaced closer together. (E) exactly as they do without the piece of plastic.

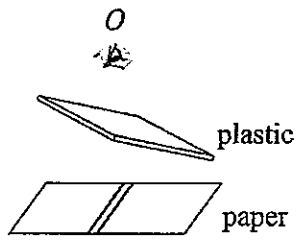

Figure 1

2. In Figure 2, monochromatic light with a wavelength in air of $\lambda = \lambda_0 =$ 500 nm shines normally on a pair of identical glass microscopic slides (l = 10.0 cm in length) that form a very narrow wedge (with thickness h = 0.0200 mm). The top surface of the upper slide and the bottom surface of the lower slide have special coatings on them so that they reflect no light. In the following, which position corresponds to a dark fringe? (A) x = 1.75 mm, (B) x = 1.00 mm, (C) x = 1.25 mm, (D) x = 2.20 mm, (E) x = 2.15 mm.

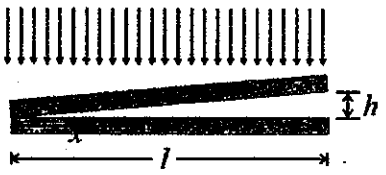

Figure 2

A periodic transverse wave travels along an x-axis. Figure 3(a) gives the displacements of elements as a function of x at time t = 0. Figure 3(b) gives the displacements of elements at x = 0 as a function of time t.

3. What is the wave velocity of the traveling wave? (A) −3 cm/s, (B) +3 cm/s, (C) −5 cm/s, (D) +5 cm/s, (E) 0 cm/s.
4. At t = 0, what is the transverse velocity of the element at x = 9 cm? (A) +2 cm/s, (B) −2 cm/s, (C) +10 cm/s, (D) −10 cm/s, (E) 0 cm/s.

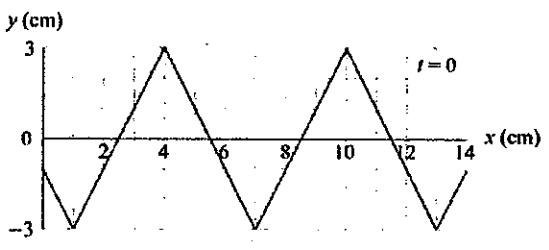

Figure 3(a)

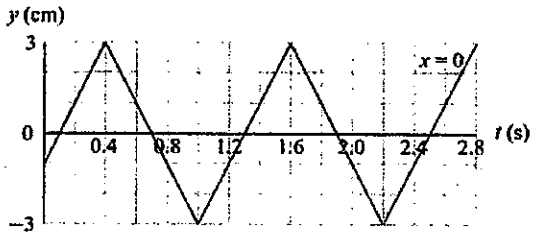

Figure 3(b)

5. Consider a heat engine operating in a closed cycle, as illustrated in Figure 4. The cycle begins at initial state i and involves a irreversible process leading to final state f, followed by an reversible process returning the system from state f back to i Choose the correct description from the following options, based on this cycle that commences from state i: (A) $\left(\int_i^f đQ/T\right)_{irreversible} > \left(\int_i^f đQ/T\right)_{reversible}$. (B) $\left(\int_i^f đQ/T\right)_{irreversible} < \left(\int_i^f đQ/T\right)_{reversible}$ (C) In the entire cycle $i \rightarrow$

見背面

$f \to i$ the cyclic integral $\oint dQ/T = 0$. (D) the integral $\left(\int_i^f dQ/T\right)_{irreversible} = \left(\int_i^f dQ/T\right)_{reversible}$. (E) In the process from *i* to *f*, the system releases heat.

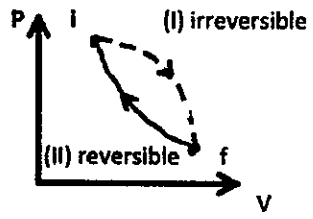

Figure 4

6. In an ideal Carnot engine cycle, 1500 J of heat is absorbed from a high-temperature heat source. If the efficiency of the engine is 30%, and the heat Q released to the low-temperature heat sink during this cycle is to be determined, what is the value of Q? (A) 1000 J, (B) 1050 J, (C) 1100 J, (D) 1150 J, (E) 1200 J.

7. What is the approximate temperature in Kelvin (order of magnitude is fine) corresponding to an energy of 1eV? (Given: Boltzmann's constant = 1.38×10^{-23} J/K, e = 1.60×10^{-19} coulomb) Choose from: (A) 10K, (B) 100K, (C) 1,000K, (D) 10,000K, (E) 10^6 K.

8. Which of the following statements about thermodynamic processes is correct? (A) An isentropic process is the same as an adiabatic process. (B) During isothermal expansion, the system releases heat. (C) In an adiabatic compression process, the temperature of the gas increases. (D) In a constant-volume pressurization process, the work done by the system is positive. (E) A substance at high temperature, high pressure, and high density can be approximated as an ideal gas.

9. A mass m object moves along a circular path with radius R in a vertical plane . At the beginning it locates at the bottom with an initial speed $v_0 > \sqrt{10gR}$, Ignoring air resistance, the speed v of the object at the top of the path is: (A) $\sqrt{v_0^2 - 4gR}$, (B) $\sqrt{v_0^2 - 2gR}$, (C) $\sqrt{v_0^2 - gR}$, (D) $\sqrt{v_0^2 + gR}$, (E) v_0.

10. A ballistic pendulum, a device for measuring the speed of a bullet, consists of a block of wood suspended by cords. When the bullet is fired into the block, the block is free to rise. How high does a 5.0 kg block rise when a 12 g bullet traveling at 350 m/s is fired into it? (A) 5.4 cm, (B) 24 cm, (C) 3.6 cm, (D) 36 cm, (E) 12cm.

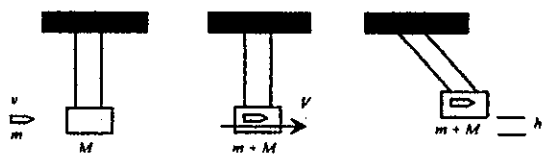

Figure 5

接次頁

11. In a binary star system, Star A, which has triple the mass of Star B, orbits their common center of mass in circular paths. Without external forces, what is the relationship between their orbital periods according to Newton's law of universal gravitation? (A) Star A's period is $1/\sqrt{2}$ of Star B's. (B) Star A's period is the same as Star B's. (C) Star A's period is $\sqrt{2}$ times Star B's. (D) Star A's period is twice Star B's. (E) Star A's period is half of Star B's.

12. What is the restoring constant (torsional constant) for a disk of mass 3.0 kg and radius 0.20 m oscillating with a period of 2.0 s? (A) 7.87 N · m, (B) 0.24 N · m, (C) 0.59 N · m, (D) 1.12 N · m, (E) 3.56 N · m.

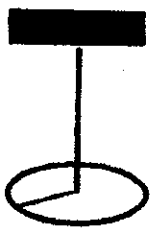

Figure 6

13. A 1.2 kg croquet ball moving at +2.0 m/s is struck from behind by the impulse force shown in Figure 7. What is the final velocity of the croquet ball? (A) 0.3 m s^{-1}, (B) 10.3 m s^{-1}, (C) 20.3 m s^{-1}, (D) 30.3 m s^{-1}, (E) 40.3 m s^{-1}.

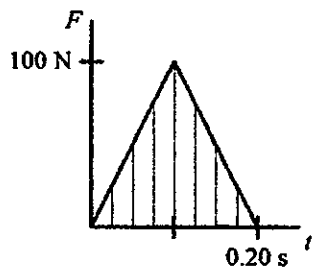

Figure 7

14. Given that the Earth's radius is 6400 km, the escape velocity at the Earth's surface is (A) $1.1 \times 10^3\ \mathrm{m\,s^{-1}}$, (B) $1.1 \times 10^4\ \mathrm{m\,s^{-1}}$, (C) $2.2 \times 10^4\ \mathrm{m\,s^{-1}}$, (D) $1.1 \times 10^5\ \mathrm{m\,s^{-1}}$, (E) $5.0 \times 10^5\ \mathrm{m\,s^{-1}}$.

15. An *LC* circuit, as shown in the diagram, reaches a certain state a moment after being energized. The circuit has an inductance value of $L = 4$ Wb/A and a capacitance value of $C = 4\ \mathrm{A \cdot s/V}$, with the assumption that the circuit's resistance can be ignored. Under these conditions, the circuit will ultimately exhibit: (A) no current flow. (B) oscillating current with a period of 16 seconds. (C) oscillating current with a period of 3.14 seconds. (D) oscillating current with a period of 12.56 seconds. (E) oscillating current with a period of 25.12 seconds.

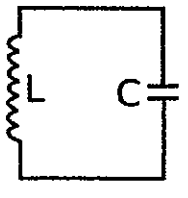

Figure 8

見背面

16. A circular ring with a diameter of 20 cm and a resistance of 0.01 Ω is subject to a uniform magnetic field of 2.0 T. Calculate the amount of charge that will flow through the ring when it is rotated from a position perpendicular to the magnetic field to one that is parallel to the field. (A) 3.14 C, (B) 6.28 C, (C) 2.50 C, (D) 4.62 C, (E) 10 C.

17. A coil with an inductance of 1.5 H and a resistance of 0.6 Ω is suddenly connected to a 12-V battery. Determine the time it takes for the current in the coil to reach 0.63 of its final value. (A) 0.5 s, (B) 1.0 s, (C) 2.5 s, (D) 4 s, (E) 5 s.

18. A particle with charge q and mass m is shot with kinetic energy K into the region between two plates as shown in Figure 9. If the magnetic field between the plates is B and as shown, how large must B be if the particle is to miss collision with the opposite plate? (A) $B = (2mK)^{1/2}/qd$, (B) $B = (2mK)^{1/2}/2qd$, (C) $B = (4mK)^{1/2}/3qd$, (D) $B = (3mK)^{1/2}/2qd$, (E) $B = (mK)^{1/2}/qd$.

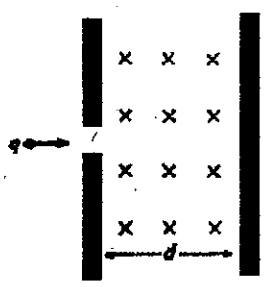

Figure 9

19. In a Hall effect experiment, the current is 2.0×10^{-3} A when 2.0 V is applied to a semiconductor of length 6.0 cm, width 3.0 cm, and depth 0.20 cm. A magnetic field of 2.0 T produces a Hall voltage of 2.0×10^{-4} V. (A) current density $j = 3.3\ \mathrm{A/m^2}$, (B) number carrier density $6.0 \times 10^{20}/\mathrm{m^3}$, (C) Hall Field $E_H = 6.7\times10^{-4}$ V/m, (D) resistivity $\rho = 1.0\ \Omega \cdot \mathrm{m}$, (E) All of the above are correct.

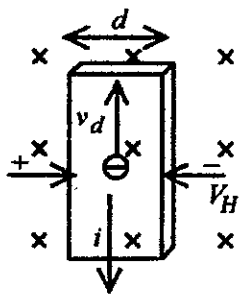

Figure 10

20. Maxwell added the concept of displacement current into Ampere's law, thereby completing the theory of electromagnetic waves. This modification suggests that equivalent currents can exist even in the absence of real currents under certain circumstances. The modified Maxwell's equations indicate: (A) Static magnetic fields can generate static electric fields. (B) Changing electric fields produce magnetic fields. (C) Static electric fields can generate static magnetic fields. (D) Electric and magnetic fields are completely independent and do not generate each other. (E) Changing magnetic fields do not produce electric fields.

試題隨卷繳回