

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

科目名稱：普通物理【物理系碩士班】

題號：423001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）

共 2 頁第 1 頁

選擇題（單選，每題 5 分）

1. A 2.0 kg particle moves along an x axis, being propelled by a variable force directed along that axis. Its position is given by $x=3.0 \text{ m}+(4.0 \text{ m/s})t+ct^2-(2.0 \text{ m/s}^3)t^3$, with x in meters and t in seconds. The factor c is a constant. At $t=3.0 \text{ s}$, the force on the particle has a magnitude of 36 N and is in the negative direction of the axis. What is c? (a) 1.0 m/s^2 (b) 3.0 m/s^2 (c) 9.0 m/s^2 (d) 27 m/s^2 (e) 81 m/s^2 .
2. Figure 1 (see page 2) shows a uniform disk that can rotate around its center. The disk has a radius of 2.00 cm and a mass of 20.0 grams and is initially at rest. Starting at time $t=0$, two forces are to be applied tangentially to the rim as indicated, so that at time $t=1.25 \text{ s}$ the disk has an angular velocity of 250 rad/s counterclockwise. Force F_1 has a magnitude of 0.100 N. What is the magnitude of F_2 ? (a) 0.060 N (b) 0.080 N (c) 0.100 N (d) 0.120 N (e) 0.140 N.
3. A steel ball of mass 0.6 kg is fastened to a cord that is 70.0 cm long and fixed at the far end. The ball is then released when the cord is horizontal (Fig. 2). At the bottom of its path, the ball strikes a 2.80 kg steel block initially at rest on a frictionless surface. The collision is elastic. Find the speed of the block just after the collision. (a) 0.50 m/s (b) 0.70 m/s (c) 0.90 m/s (d) 1.10 m/s (e) 1.30 m/s.
4. A Carnot engine operates between 200°C and 20°C . Its maximum possible efficiency is: (a) 90% (b) 100% (c) 38% (d) 72% (e) 24%.
5. An ideal gas is taken through a quasi-static process described by $P=\alpha V^2$, with $\alpha=5.00 \text{ atm/m}^6$, as shown in Fig. 3. The gas is expanded to twice its original volume of 1.00 m^3 . How much work is done on the expanding gas in this process? (a) -0.58 MJ (b) -0.78 MJ (c) -0.98 MJ (d) -1.18 MJ (e) -1.38 MJ.
6. A continuous line of charge lines along the x axis, expanding from $x=+x_0$ to positive infinity. The line carries positive charge with a uniform linear charge density λ_0 . What is the magnitude of the electric field at the origin? (a) $\frac{\lambda_0}{4\pi\epsilon_0 x_0}$ (b) $\frac{\lambda_0}{2\pi\epsilon_0 x_0}$ (c) $\frac{\lambda_0}{\pi\epsilon_0 x_0}$ (d) $\frac{2\lambda_0}{\pi\epsilon_0 x_0}$ (e) $\frac{4\lambda_0}{\pi\epsilon_0 x_0}$.
7. A spherically symmetry charge distribution has a charge density given by $\rho=a/r$, where a is a constant. What is the magnitude of the electric field within the charge distribution? (a) $\frac{a}{32\epsilon_0}$ (b) $\frac{a}{16\epsilon_0}$ (c) $\frac{a}{8\epsilon_0}$ (d) $\frac{a}{4\epsilon_0}$ (e) $\frac{a}{2\epsilon_0}$.
8. An ideal diatomic gas, with rotation but no oscillation, undergoes an adiabatic compression. Its initial pressure and volume are 1.20 atm and 0.200 m^3 . Its final pressure is 3.60 atm. How much work is done by the gas? (a) $2.23\times 10^4 \text{ J}$ (b) $2.43\times 10^4 \text{ J}$ (c) $2.63\times 10^4 \text{ J}$ (d) $2.83\times 10^4 \text{ J}$ (e) $3.03\times 10^4 \text{ J}$.
9. As a parallel-plate capacitor with circular plates 20 cm in diameter is being charged, the current density of the displacement current in the region between the plates is uniform and has a magnitude of 20 A/m^2 . What is the magnitude of the magnetic field at a distance $r=50 \text{ mm}$ from the axis of symmetry of this region? (a) $3.3\times 10^{-7} \text{ T}$ (b) $4.3\times 10^{-7} \text{ T}$ (c) $5.3\times 10^{-7} \text{ T}$ (d) $6.3\times 10^{-7} \text{ T}$ (e) $7.3\times 10^{-7} \text{ T}$.
10. The magnetic field inside a superconducting solenoid is 4.50 T. The solenoid has an inner diameter of 6.20 cm and a length of 26.0 cm. The energy stored in the magnetic field within the solenoid is (a) 5.32 kJ (b) 6.32 kJ (c) 7.32 kJ (d) 8.32 kJ (e) 9.32 kJ.
11. A 12.0 V battery is connected into a series circuit containing a 10.0Ω resistor and a 2.00 H inductor. In what time interval will the current reach 90% of its final value? (a) 0.361 s (b) 0.461 s (c) 0.561 s (d) 0.661 s (e) 0.761 s.
12. A material having an index of refraction of 1.30 is used as an antireflective coating on a piece of glass ($n=1.50$). What should the minimum thickness of this film be to minimize reflection of 500-nm light? (a) 76.2 nm (b) 81.2 nm (c) 86.2 nm (d) 91.2 nm (e) 96.2 nm.

非選擇題（每題 20 分）

1. A puck of mass $m=50.0 \text{ g}$ is attached to a taut cord passing through a small hole in a frictionless, horizontal surface (Fig. 4). The puck is initially orbiting with speed $v_i=1.5 \text{ m/s}$ in a circle of radius

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

科目名稱：普通物理【物理系碩士班】

題號：423001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）

共 2 頁第 2 頁

- $r_i=0.3$ m. The cord is then slowly pulled from below, decreasing the radius of the circle to $r=0.1$ m. (a) What is the puck's speed at the smaller radius? (6 points) (b) Find the tension in the cord at the smaller radius. (6 points) (c) How much work is done by the hand in pulling the cord so that the radius of the puck's motion changes from 0.3 m to 0.1 m? (8 points)
2. In Fig. 5, a uniform magnetic field decreases at a constant rate $dB/dt=-K$, where K is a positive constant. A circular loop of wire of radius a containing a resistance R and a capacitance C is placed with its plane normal to the field. (a) What is the potential difference between the two plates of the capacitor when it is fully charged? (5 points) (b) Find the charge Q on the capacitor when it is fully charged. (5 points) (c) Which plate, upper or lower, is at high potential? (5 points) (d) What is the force that causes the separation of charges? (5 points)

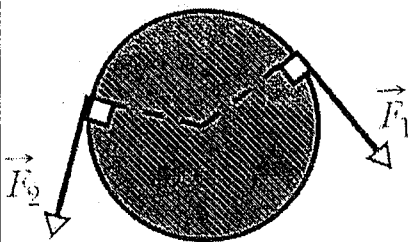


Fig. 1

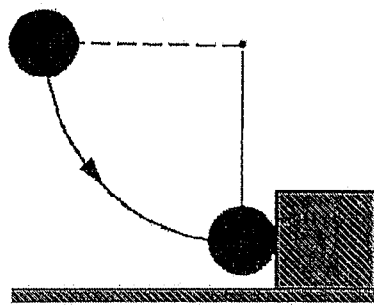


Fig. 2

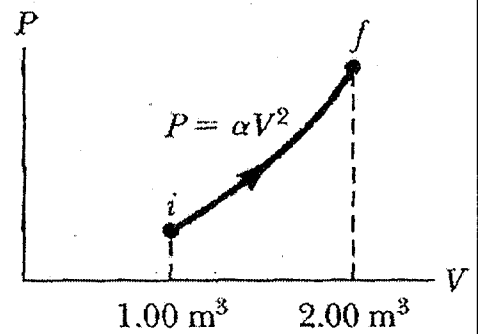


Fig. 3

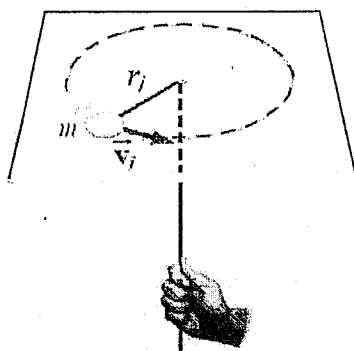


Fig. 4

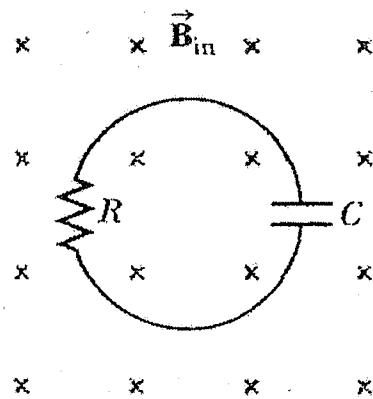


Fig. 5

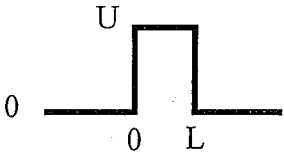
國立中山大學 102 學年度碩士暨碩士專班招生考試試題

科目名稱：近代物理【物理系碩士班】

題號：423002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）

共 1 頁第 1 頁

- (20%) Albert, at the age of 10, boards a spaceship and travels away from the Earth at a constant velocity $0.6c$. One year later on Earth clock, Bob, Albert's twin, boards a second spaceship and follows Albert at a constant velocity $0.9c$ in the same direction. What will be their ages (in their own reference frames) when Bob catches up to Albert?
- (15%) A photon with energy that equals the rest energy of the electron undergoes a Compton collision with an electron. The electron moves off at an angle of 45° to the original photon direction. Find the energy of the scattered photon in unit of MeV.
- (15%) A particle of mass m moves in a three-dimensional box with the length of each side that equals L . If the particle is at the third excited level, find (a) the energy of the particle, (b) the degenerate states that would give this energy, and (c) the wave functions for these different states.
- (20%) A particle with energy E is incident from the left on a square potential barrier of width L , as shown in the right figure, where $V=U$ for $0 < x < L$, and $V=0$ elsewhere. Find the transmission coefficient for the case $E < U$.
- (15%) Find the angle between the electron's orbital angular momentum and spin angular momentum for the following states: $P_{3/2}$ and $H_{9/2}$
- (a)(7%) Explain the Stern-Gerlach experiment.
(b)(8%) How did the classical physics and Max Planck explain the black-body radiation?