

1. (15分) An automobile has a total mass of 1700 kg . It accelerates from rest to 40 km/h in 10 s . Assume each wheel is a uniform 32 kg disk. Find, for the end of the 10 s interval, (a) the rotational kinetic energy of each wheel about its axle, (b) the total kinetic energy of each wheel, and (c) the total kinetic energy of the automobile.
2. (20分) One mole of an ideal monatomic gas, at an initial pressure of 5.00 kPa and initial temperature of 600 K , expands from initial volume $V_i=1.00\text{ cm}^3$ to final volume $V_f=2.00\text{ cm}^3$. During the expansion, the pressure p and the volume V of the gas are related by $p=5.00\exp[(V_i-V)/a]$, where p is in kilopascals, V_i and V are in cubic meters, and $a=1.00\text{ m}^3$. What are (a) the final pressure and (b) the final temperature of the gas? (c) How much work is done by the gas during the expansion? (d) What is the change in entropy of the gas during the expansion? (Hint, use two simple reversible processes to find the entropy change.)
3. (14分) A solid nonconducting sphere of radius R has a nonuniform charge distribution of volume charge density $\rho=\rho_s r/R$, where ρ_s is a constant and r is the distance from the center of the sphere. Show (a) that the total charge in the sphere is $Q = \pi\rho_s R^3$ and (b) that

$$E = \frac{1}{4\pi\epsilon_0} \frac{Q}{R^4} r^2$$

gives the magnitude of the electric field inside the sphere.

4. (16分) (a) What is the magnetic field at any radius r inside a toroid carrying a current i of totally N turns? (b) Show that as you move from any point just inside a toroid to a point just outside, the magnitude of the change in \vec{B} that you encounter is just $\mu_0\lambda$. Here λ is the current per unit length along a circumference of radius r within the toroid.

(背面仍有題目,請繼續作答)

5. (10 分) Suppose that one of the slits of a double-slit interference experiment is wider than the other, so the amplitude of the light reaching the central part of the screen from one slit acting alone, is twice that from the other slit, acting alone. Derive an expression for the light intensity I at the screen as a function of θ .
6. (10 分) (a) A photon and an electron both have a wavelength of 1.00 nm , What are the energy of the photon and the kinetic energy of the electron?
(b) Repeat for a wavelength of 1.00 fm ?
(Hint: Basic physical constants $hc=1240 \text{ nm}\cdot\text{eV}$, $m_e c^2=0.511 \text{ MeV}$, and $1.00 \text{ fm} = 10^{-6} \text{ nm}$, and for short λ , the electron must be considered as a relativistic particle)
7. (15 分) An armada of spaceships that is 1.00 ly long (in its rest frame) moves with speed $0.800c$ relative to ground station S . A messenger travels from the rear of the armada to the front with a speed of $0.950c$ relative to S . How long does the trip take as measured (a) in the messenger's rest frame, (b) in the armada's rest frame, and (c) by an observer in frame S ?