題號： 60
科目： 普通物理學
節次： 6

國立臺灣大學 108 學年度碩士班招生考試試題

題號：60
共 2 頁之第 1 頁

一、填空題：每格 3 分 (共 54 分)

1. Consider a solid cylinder of mass m and radius r moving down from the top of a wedge of mass M. The plane of the wedge is inclined at an angle θ with respect to the horizontal plane.
   (a) Suppose that the cylinder is sliding without rolling down the smooth inclined face of the wedge, and the wedge is free to move on a horizontal plane with friction. How far has the wedge moved by the time the cylinder has descended from a rest a vertical distance h? Ans.: __(1)__
   (b) Now suppose that the cylinder is free to roll down the wedge without slipping. The horizontal plane is still without friction. How far does the wedge move in this case? Ans.: __(2)__

2. A particle of mass m with a velocity of v collides elastically with the end of a uniform thin rod of mass M. (The other end of the rod is fixed.) The length of M is L. After the collision, m is stationary. In the case, determine the mass of M. Ans.: __(3)__

3. A girl holds a tuning fork vibrating at 400 Hz and walks at 10 m/s away from a wall. What beat frequency does he hear between the fork and the echo? The speed of sound is 330 m/s. Ans.: __(4)__

4. Calculate the minimum coefficient of friction necessary to keep a thin circular ring from sliding as it rolls down a plane inclined at an angle θ with respect to the horizontal plane. Ans.: __(5)__

5. An idea gas with N atoms are contained in a cylinder with insulating walls, closed at one end by a piston. The initial volume is V1 and the initial temperature T1. If the volume was suddenly expanded freely from V1 to V2, and the temperature was changed from T1 to T2. Questions: The temperature T1 is larger, lower, or the same to T2? Ans.: __(6)__. During the expansion, the pressure was changed from P1 to P2. The pressure P1 is larger, lower, or the same to P2? Ans.: __(7)__ Find the change in entropy that would occur. Ans.: __(8)__

6. An electric dipole consists of two equal and opposite charges (+q) separated by a distance d. Find the approximate electric potential at point P. ($d \ll r$) Ans.: __(9)__

7. The total energy of a uniformly charged spherical shell of total charge q and radius R. Ans.: __(10)__

8. An insulating sphere of radius a has a uniform volume charge density ρ, and carries a total positive charge Q. Find *electric field* at a point inside. Ans.: __(11)__, and outside the sphere. Ans.: __(12)__

9. A long, straight coaxial cable, show in figure, has an inner wire of radius a with a surface charge density σ_1 and an outer cylindrical shall of radius b with σ_2. Find the relationship between σ_1 and σ_2 for the field strength to be zero outside the cable. Ans.: __(13)__

10. The space between the plates of a parallel-plate capacitor is filled with two dielectrics κ_1, κ_2 of equal size, as shown in figure. What is the resulting capacitance in terms of κ_1, κ_2, and C_0, the capacitance with a vacuum between the plates? (κ_1, κ_2 are dielectric constants) Ans.: __(14)__

11. The current density in a cylinder of radius R is given by $J = Kr$, where K is a constant. What is the magnetic field within the cylinder? Ans.: __(15)__

12. Place a DVD on a flat surface. A laser, with a wavelength of λ, points to the DVD and the ray is perpendicular to the DVD. First-

見背面

題號： 60
科目： 普通物理學
節次： 6

國立臺灣大學 108 學年度碩士班招生考試試題

題號：60
共 2 頁之第 2 頁
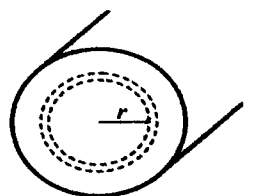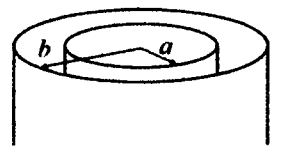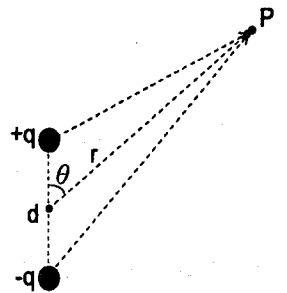
order maxima appeared on a wall at a distance of x cm from the DVD and at a height of d cm. What is the distance between two adjacent recording tracks on the DVD? Ans.: __(16)__

13. A plane wave of monochromatic light with wavelength λ in vacuum is incident on two slits of equal width w, as shown schematically blow. A pattern is observed on a screen a large distance away. The intensity of the light at the central ($\theta = 0$) is initially I. If one slit is blocked, the intensity is __(17)__
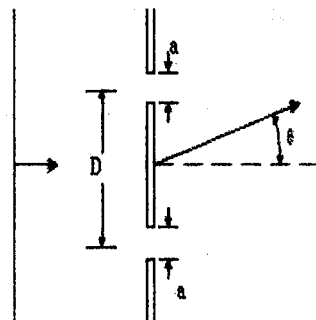
14. An LED is constructed from a p-n junction based on a certain Ga-As-P semiconducting material whose energy gap is E_g. What is the wavelength of the emitted light? Ans.: __(18)__

二、計算題：(共 46 分)

A. Damped Simple Harmonic Oscillation: [6%]
A car's suspension system acts like a damped simple harmonic oscillating system. The damped mass-spring system is with mass m=100 kg and the spring constant k = 50 N/m. A car's shock absorber system provides a damping constant b = 200 kg/s. If the car hits an accident, how many oscillations will it make before the amplitude drops to half its initial value?

B. Thermodynamics: [20%]
1. (10%) One mole idea gas is changed from temperature T1 and molar volume V1 to T2 and V2. Write down the change in entropy.
2. (10%) An ideal gas undergoes a path from A (P1, V1) to B (P2, V2) adiabatically, B (P2, V2) to C (P2, V1) isobarically, and C to A at constant volume V1. Plot the P-V figure (2%) and calculate the efficiency of the cycle (8%).

C. Electromagetism: [10%]
Describe is the physical significance of the <u>Maxwell's equations</u>, and Describe <u>physical meaning of</u> "Displacement current".

D. Quantum Physics: [10%]
Solve Schrödinger's equation for an electron trapped in a one-dimensional infinite potential well of width *L* and impose the boundary condition that the solutions be zero at the infinite walls.

試題隨卷繳回