

科目：普通物理(2002)

校系所組：中央大學光電科學與工程學系照明與顯示科技碩士班

交通大學電子物理學系(丙組)

交通大學物理研究所

清華大學物理學系

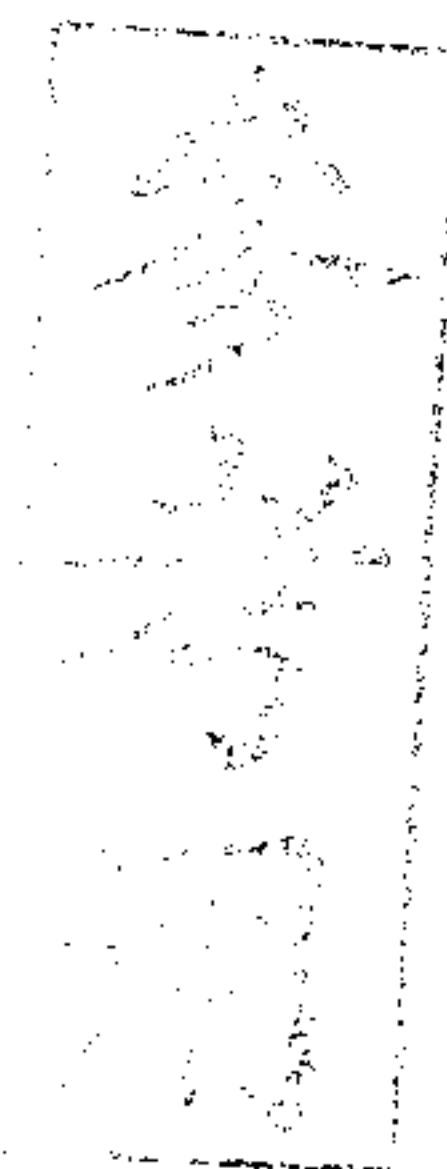
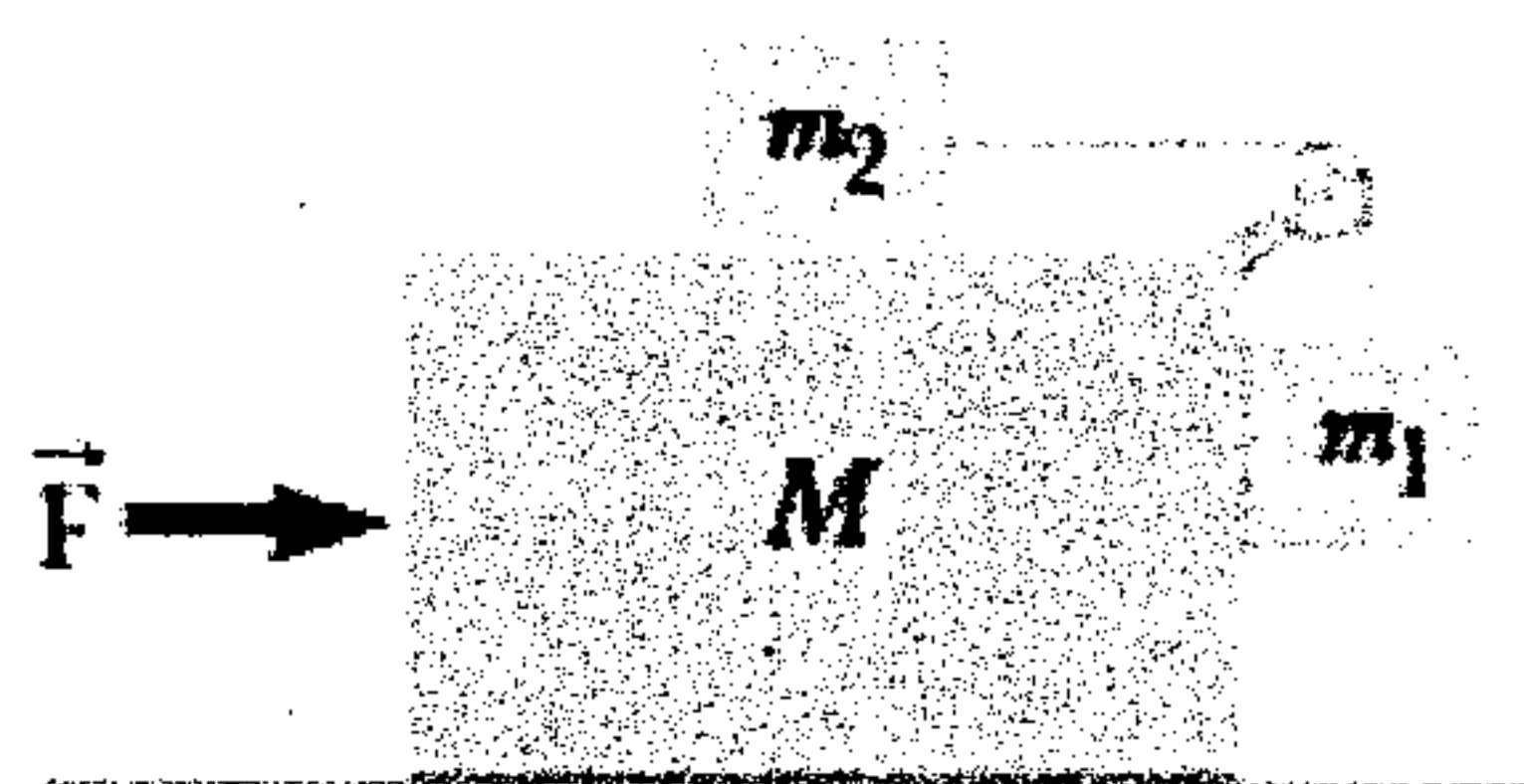
清華大學先進光源科技學位學程(物理組)

清華大學材料科學工程學系(乙組)

陽明大學生醫光電研究所(理工組)

清華大學天文研究所

1. (20%) In the following figure, a horizontal force  $F$  is applied to the larger block of mass  $M=10\text{kg}$  so that the two smaller blocks of masses  $m_1=5\text{kg}$  and  $m_2=3\text{kg}$  remain stationary relative to the larger block. (a) (10%) Assume all surfaces and the pulley are frictionless, give the value of  $F$  in terms of the magnitude of gravitational acceleration  $g$ . (b) (10%) If the surfaces between any two of the blocks have frictions with the same static coefficient  $\mu_s=0.1$  but the pulley is still frictionless, what are the maximum and minimum values of  $F$ ?



2. (10%) A solid cylinder and a hollow cylinder shell, both of mass  $M$  and radius  $R$ , roll without slipping on a ramp from at rest initially. The ramp has a length  $L$  and is inclined at an angle  $\theta$  with the horizontal ground. (a) (5%) Which one of the two cylinders reaches the ground first and why? (b) (5%)  $\tau_1$  and  $\tau_2$  are the times requiring for the solid cylinder and the hollow cylinder rolling down to the ground, respectively. What is the ratio  $\tau_1/\tau_2$ ?
3. (10%) (a) (5%) Write down the wave equation for a wave function  $y(x,t)$ , which represents the transverse displacement of the element at position  $x$  at time  $t$ , traveling along a one-dimensional string. (b) (5%) What is the rate of energy transfer by a sinusoidal traveling wave  $y(x,t)=A \sin(kx-\omega t)$  on a string with mass density  $\mu$  and a tension  $T$ .
4. (10%) An ideal gas of  $N$  particles at temperature  $T$  is initially restricted to a part of volume  $V$  in an insulated container. During a free expansion, the ideal gas is allowed to expand into the remainder of the container of total volume  $3V$ . What is the change in entropy of the ideal gas and give the reasons how you get your answer.

注意：背面有試題

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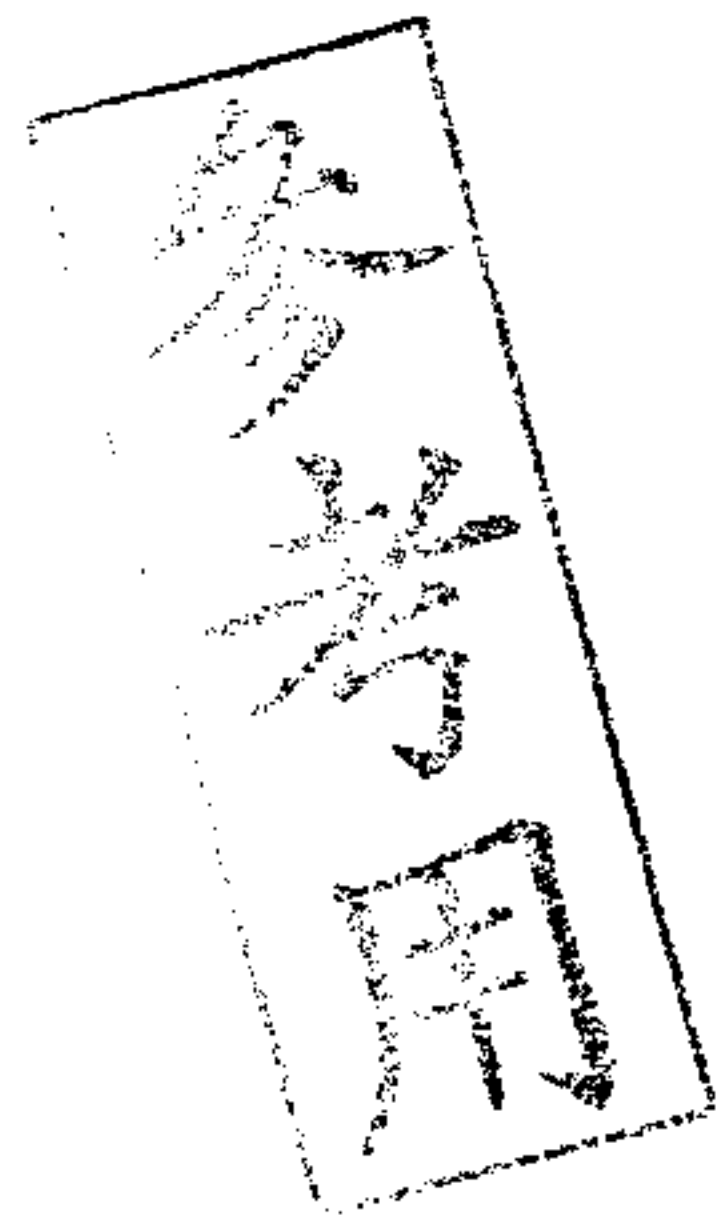
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5. (10%) For a point light source which radiates 100 Joules of energy per second, calculate the root-mean-square magnetic field strength at the point  $P$  which is 10 cm away from the source. What is the maximal strength of electric field at the same point?
6. (15%) (a) (5%) Write down the relation between current density  $J$  inside a strip of copper and the drift velocity  $v_d$  of the charge carriers in the copper. (b) (10%) Explain how one can measure the number of charge carriers per unit volume in the copper using Hall effect.
7. (10%) A parallel plate capacitor with  $C=0.15 \mu\text{F}$  has a separation between its plates of  $d=40.0 \mu\text{m}$ . The dielectric that fills the space between the plates has dielectric constant  $\kappa=2.5$  and resistivity  $\rho=4.0 \times 10^{12} \Omega\text{m}$ . What is the time constant for this capacitor?
8. (5%) Explain what Maxwell's displacement current is?
9. (10%) Two metal spheres of radii  $r_1=20 \text{ cm}$  and  $r_2=40 \text{ cm}$ , respectively, have been positively charged so that both have a total charge of  $400 \mu\text{C}$ . (a) (5%) What is the ratio of their surface charge densities? (b) (5%) If the two spheres are connected by a copper wire, how much charge flows through the wire before the system reaches equilibrium?