

國立中央大學101學年度碩士班考試入學試題卷

所別：大氣科學學系大氣物理碩士班 不分組(一般生) 科目：普通物理 共 2 頁 第 1 頁  
大氣科學學系大氣物理碩士班 不分組(在職生)

本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

1. A particle of mass  $m$  is traveling at constant velocity  $\vec{v}_0$  in  $x$ -direction toward a rest uniform disk of mass  $M$  and radius  $R$  on  $(x-y)$  plane that is free to rotate about a pivot through  $z$ -axis at the center of the disk (as the origin). Before strikes the disk, the particle is traveling along a line  $y = b (R > b > 0)$  in  $(x-y)$  plane. The particle strikes the disk and sticks to a point on the disk with distance  $R$  from the center.
  - (a) Before collision what is the total angular momentum vector of the system. (5%)
  - (b) What is the angular velocity of the system just after the collision? (5%)
  - (c) What is the kinetic energy of the system after collision? (5%)
  - (d) How much mechanical energy is lost in this collision? (5%)
2. A balloon is used to lift a load of 10kg. The mass of the balloon's skin is 5kg. The volume of the balloon when fully inflated is  $30m^3$ . At altitude  $h = 0$ , the temperature of the air is  $0^\circ C$  and the atmospheric pressure is (1atm.), the air mass density is  $1.3kg/m^3$  and the gas density is  $0.18kg/m^3$ . The balloon is inflated with sufficient gas that the net force on the balloon and its load is 30N (Newton). Neglect changes of temperature with altitude  $h$ . The universal gas constant is  $R = 8.21 \times 10^{-3} m^3 \cdot atm / (mol \cdot K)$ . Following the law of atmosphere, the fractional decrease in atmospheric pressure is proportional to the change in altitude ( $\Delta P / P = -\Delta h / 8km$ ), temperature is constant in altitude, and the ideal gas law is applicable.
  - (a) How many moles of gas are contained in the balloon? (5%)
  - (b) At what altitude will the balloon be fully inflated? (5%)
  - (c) Determine the buoyant force on the balloon at the altitude that the balloon is fully inflated. (5%)
  - (d) Does the balloon reach the altitude at which it is fully inflated? (5%)
3. A transverse wave satisfies the wave equation  $\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 y}{\partial t^2}$  propagates down a string. Where  $y$  is the vertical displacement at the point  $x$  on the string and  $v$  is the wave speed. If the wave frequency is 20Hz, and two points 1cm apart are out of phase by  $\pi/3$ .
  - (a) What is the wavelength of the wave? (5%)
  - (b) At a given point, what is the phase difference between two displacements for times 0.005sec. apart? (5%)
  - (c) What is the wave velocity? (5%)
4. A box is divided into two identical partitions.
  - (a) If on one side is 1mole of ideal gas A, on the other side is empty. Calculate the change in entropy when the partition is lifted. (5%)
  - (b) If on one side is 1mole of ideal gas A, on the other side is 1mole ideal gas B which is different from gas A but at the same temperature. Calculate the change in entropy when the partition is lifted and the two gases mix together completely. (5%)
  - (c) If we repeat the process as in (b) with the same type of gas in each side. Calculate the change in entropy when the partition is lifted. (5%)

注意：背面有試題

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5. An infinitely long cylindrical shell is coaxial with the  $z$ -axis and has a radius of  $R$  carries a uniform surface charge density  $\sigma$ . A spherical shell of radius  $R$  is centered on the  $x$ -axis at  $x = 3R$  and carries a uniform surface charge density  $(-2\sigma)$ .
- (a) Calculate the electric field at the origin (inside the cylindrical shell). (5%)
  - (b) Calculate the electric field at the point  $x = 1.5R, z = 0.5R$  on the  $x$ - $z$  plane. (5%)
  - (c) Calculate the electric field at the point  $x = 3R, z = 0.5R$  on the  $x$ - $z$  plane. (5%)
6. A coaxial cable consists of two thin conducting cylinders of radii  $R_1$  and  $R_2 (> R_1)$ . Current  $I$  goes in one direction in the inner cylinder and in the opposite direction in the outer cylinder.
- (a) Calculate the magnetic field at the distance  $r (r < R_1)$  from the axis of the cable. (5%)
  - (b) Calculate the magnetic field at  $r (R_1 < r < R_2)$  in the region between the two thin conductors. (5%)
  - (c) Calculate the magnetic field at the distance  $r (r > R_2)$  from the axis of the cable. (5%)

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