國立中央大學102學年度碩士班考試入學試題卷

所別：太空科學研究所碩士班 不分組(一般生)　科目：普通物理　共 2 頁 第 1 頁
太空科學研究所碩士班 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

參考用

1. A particle of mass m is dropped onto the top of a vertical spring with the force constant k. If the particle is released from a height h above the top of spring.
   (a) What is the maximum kinetic energy of the particle? (5%)
   (b) What is the maximum compression of the spring? (5%)
   (c) At what compression is the particle kinetic energy half its maximum value? (5%)
2. A particle of mass m sliding on a frictionless table is attached to a string that passes through a hole in the table. Initially, the particle is sliding with speed v_i in a circle of radius r_i.
   (a) Find the tension in the string in terms of the angular momentum of the particle. (5%)
   (b) If the string is pulled downward very slowly. How much work is required to reduce the radius of the circle $r_f = r_i/2$? (5%)
3. A large spherical helium weather balloon with the radius $3m$ and the total mass $18kg$ (balloon, helium and equipment). The air mass density is $1.3kg/m^3$ at sea level where the atmospheric pressure is $1atm$.
   (a) What is the initial upward acceleration of the balloon when it is released from sea level? (5%)
   (b) If the drag force on the balloon is given by $f_d = \frac{\pi r^2}{2}\rho v^2$, where r is the balloon radius, ρ is the density of air, and v is the ascension speed of the balloon, determine the terminal velocity of the ascending balloon. (5%)
   (c) Estimate the time will it take for the balloon to ascend to a height of 20km. (5%)
4. Two sources separated by some distance emit harmonic waves of the same frequency with wavelength λ. At some point P, the intensity of the wave due to each source separately is I_0. The path distance from P to one of the sources is $\lambda/2$ greater than that from to the other source. What is the intensity at P for each case,
   (a) the sources are coherent and in phase. (5%)
   (b) the sources are incoherent. (5%)
   (c) the sources are coherent but have a phase difference of π rad. (5%)
5. One mole of an ideal gas with the ratio of the heat capacities $\gamma = 1.4$ and the heat capacities of constant volume $C_V = \frac{5}{2}R$ initially at a pressure of 1 atm and a temperature of $T_1 = 0^\circ C$, where the gas constant $R = 8.314 J/mol \cdot K$. The gas is heated at constant volume to $T_2 = 100^\circ C$ and is then expanded adiabatically until its pressure is again 1 atm. It is then compressed at constant pressure back to its original state.
   (a) Find the temperature T_3 after the adiabatic expansion. (5%)
   (b) Calculate the heat entering or leaving the system during each process. (5%)
   (c) Estimate the efficiency of this cycle. (5%)

注意：背面有試題

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6. A ring of radius R that lies in the x-y plane carries a positive charge Q uniformly distributed over its length. A particle of mass m that carries a negative charge magnitude q is at the center of the ring.
   (a) Find the electric field along the axis of the ring (z-axis). (5%)
   (b) Let the charge particle of mass m moving in z-axis with coordinates $z << R$, Find the force on it as a linear function of z. (5%)
   (c) Estimate the period T of the harmonic moving particle near the center of the ring along z-axis. (5%)
7. A ray of light passes from one medium to another medium, striking the surface of the boundary. Which of the following quantities change as the light enters the second medium:
   (1) wavelength, (2) frequency, (3) speed of propagation, (4) direction of the propagation,
   (5) the polarizing angle for which the reflected light is completely polarized. (5%)
8. A ray of light is incident in air of the refraction index $n = 1$ and the polarizing angle for a certain substance is 30°.
   (a) What is the angle of refraction of light incident at this angle? (5%)
   (b) What is the index of refraction of this substance? (5%)

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