

淡江大學九十二學年度碩士班招生考試試題

系列：物理學系

科目：古典物理

准帶項目請打「○」否則打「×」
簡單型計算機 X

本試題共 1 頁

1. Consider a block of mass m connected to a spring of force constant k . It moves on the frictionless plane under the influence of a restoring force given by $F(x) = -kx$, as in Figure 1. (20%)
 - a. Find the equation of motion.
 - b. Find the solution $x(t)$ if at $t = 0$, $x(0) = x$, and $v(0) = 0$.
 - c. Show that the average values, over a complete cycle, of both the kinetic and potential equal half the maximum value.
 - d. Find the complete solution $x(t)$ if additional constant force $F(x) = F_0$ is applied.

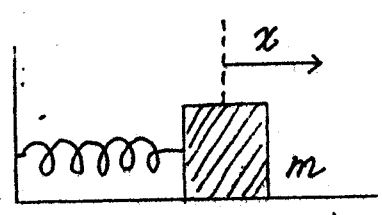


Figure 1.

2. A particle of mass m starts at rest on top of a smooth fixed hemisphere of radius a as in Figure 2. (30%)
 - a. Write down the Lagrangian of the system.
 - b. Find the equations of motion.
 - c. Determine the angle at which the particle leaves the hemisphere.
 - d. Find the force of constraint.
 - e. Determine the Hamiltonian.
 - f. Find the Hamilton's equations of motion.

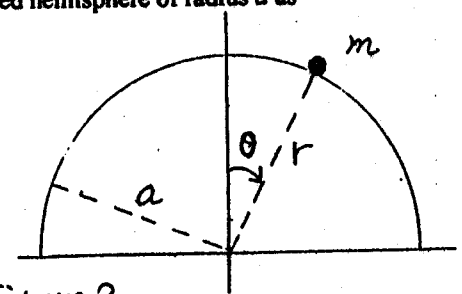


Figure 2

3. Consider a uniformly charged circular disk of radius a and the surface charge density σ as in Figure 3. (15%)
 - a. Find the electric potential at P on the axis of the disk.
 - b. Find the electric field at P.
 - c. Find the electric potential at P if P is moved far away from the disk.

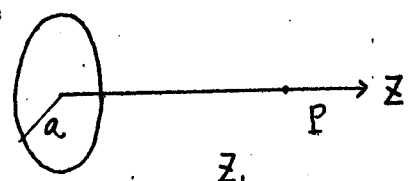


Figure 3

4. Consider a charged hollow sphere of radius a and uniform surface charge density σ . The sphere is rotating about its axis with constant angular velocity ω as in Figure 4. (20%)
 - a. Determine the magnetic field on the axis inside the sphere.
 - b. Determine the magnetic field on the axis outside the sphere.
5. Two kinds of ideal gases at equal pressure and temperature, initially separated in two containers, are mixed by diffusion. Show that the entropy is increased in this process by an amount

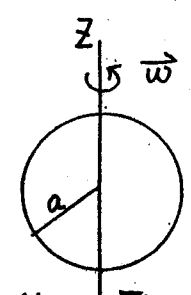


Figure 4

$$\Delta S = -R \left(n_1 \log \frac{n_1}{n_1+n_2} + n_2 \log \frac{n_2}{n_1+n_2} \right),$$

where n_1 and n_2 are the moles of component gases. Assume that no change in pressure and temperature occurs due to the diffusion and the partial pressure of each gas in the mixture is proportional to the molar concentration.