

九十二學年度 八系聯招 化學 生科 原科 系轉學生招生考試

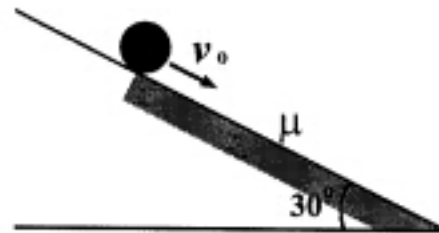
科目 普通物理 科號 0004, 0043, 0153, 0163 共 3 頁第 1 頁 *請在試卷【答案卷】內作答

* 請注意 -- 第一部分為計算題，共六大題。答案請標示題號，依序排列，並詳列計算過程。
第二部分為填充題，共十個空格。答案請標示空格編號，依序排列，不必寫計算過程。

Part I:

1. [8%] Show that in an elastic glancing collision (i.e. not a head-on collision) between two equal masses, both on a frictionless and horizontal table and one initially at rest, the final velocities are perpendicular to each other.
2. [10%] Consider a non-conducting sphere of radius b with a cavity of radius a at its center. Suppose charge is uniformly distributed in the body of this shell-like object, that is, a constant charge density ρ in the region between radius a and b . What are the electric potential $V(r)$ and the electric field $E(r)$ established by this charge distribution? r is the distance from the sphere center. Consider all the cases of $r < a$, $a < r < b$, and $b < r$.
3. [10%] Consider a particle, moving at speed v , bounces back and forth inside a one-dimensional box between $x=0$ and $x=L$.
 - (a) [3%] If the motion is classical, calculate the probability density $P_v(x)$ to detect the particle at x .
 - (b) [4%] In the quantum case, the situation is quite different. Due to the wave property of the particle, only a discrete set of velocities v_n is allowed. Calculate the corresponding probability density $P_n(x)$.
 - (c) [3%] Does Bohr's correspondence principle apply here? Why or Why not? (Explain your answer in detail. A simple answer of "Yes" or "No" is not considered complete.)
4. [10%] One mole of ideal gas is thermally isolated and contained in volume V . The initial temperature of the system is T and the universal gas constant is R .
 - (a) [4%] Suppose the system undergoes a sudden free expansion to the final volume $6V$. Compute the entropy change ΔS .
 - (b) [3%] Does the familiar relation $T\Delta S = \Delta Q$ hold here? Why or Why not? T is the temperature and ΔQ is the heat change. (Explain your answer in detail. A simple answer of "Yes" or "No" is not considered complete.)
 - (c) [3%] Now compress the volume of the ideal gas gradually from $6V$ to $2V$. Compute the entropy change ΔS again.
5. [10%] A long coaxial cable consists of two thin concentric conducting cylinders with radii a and b ($a < b$). The inner cylinder carries a steady current I and the outer one provides the return path. Calculate the stored energy for a length L of the cable by integrating the magnetic energy density.

6. [12%] A solid sphere slides down a 30° incline and encounters a rough surface, friction coefficient $\mu = \sqrt{3}/6$, when its speed reaches v_0 and starts to roll, as shown in the figure. Find: (a) the time, (b) the speed of the sphere center, and (c) the total energy dissipated by the friction when pure rolling starts. Express your answers in terms of M (the mass of the sphere), R (the radius of the sphere), v_0 and the gravitational field strength g . The inertia moment of the sphere is $2MR^2/5$ about its center.



Part II:

[total 40%; each blank 4%]

7. A parallel-plate capacitor is with a capacitance of C_0 . (A) When the capacitor is filled in equal size of two different dielectric, which have dielectric constants k_1, k_2 respectively (see Figure 1). The capacitance is (1) (B) Being filled a two equal layer (see Figure 2). The capacitance is (2) . (Give the answers in terms of C_0, k_1, k_2).



Figure 1

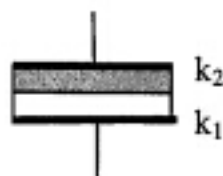


Figure 2

8. A proton (mass m and charge e) is accelerated from rest by a potential V . Assuming the final speed of the proton is much less than the speed of light. The de Broglie wavelength is (3) . If the final speed of the proton is close to the speed of light, taking into account the relativity effect, the de Broglie wavelength is (4) . The wave function ψ of the proton must be normalized. So, the integral of the probability over all space: $\int \psi^2 dV =$ (5) .

9. A traveling harmonic wave function is $y = 0.006 \sin[\pi(0.01x - 4t + 0.02)]$, where x and y are in meters and t is in seconds . The period is (6) sec. The wave velocity is (7) m/s .

10. A long, straight wire carries a constant current I . A metal rod of length L moves at velocity v relative to the wire, as shown in Figure 3. The potential difference between the ends of the rod is (8) .

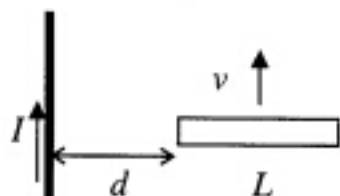


Figure 3

11. A monatomic ideal gas (such as He) has molar specific heat at constant volume C_1 . And, a diatomic molecule (such as N_2) is considered as a rigid rotator, whose molar specific heat at constant volume is C_2 . We have $C_2/C_1 =$ (9) .

12. A ship sails along the equator at speed v relative to the surface. A particle of mass m is suspended on a spring scale. It was weighted as S_1 . After the ship making a U-turn, the scale reads as S_2 . Find $|S_1 - S_2| =$ (10) .

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