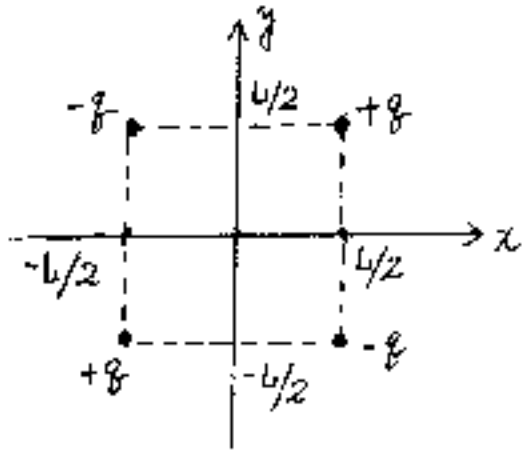
八十五學年度 物理 系（所） 物理 組碩士班研究生入學考試

科目 古典物理 科號 0402 共 二 頁第 一 頁 *請在試卷【答案卷】內作答

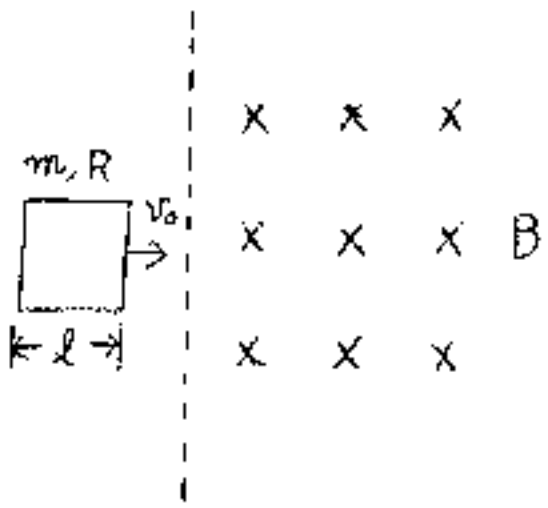
1. (12%) Consider ${}^3H \rightarrow {}^3He + e + \bar{\nu}$. Denote the masses of ${}^3H$ and ${}^3He$ by m_1, m_2. If the electron and the neutrino are considered massless, what is the maximum energy of the electron in the rest frame of ${}^3H$?

2. (10%) N particles of equal mass, m, are distributed evenly on a circle of radius R, what are the moments of inertia tensor (N>3), I_{ij}?

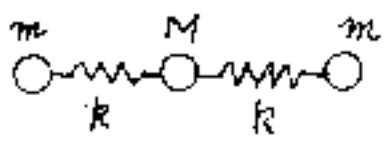
3. Consider the following static charge distribution as in the Figure
   (6%) (a) Work out the potential at r>> L.
   (6%) (b) Work out the electric field on x axis for any x.



4. Consider a square wire loop with resistance R and mass m moving with velocity v_0 toward a region of uniform magnetic field , B, as shown in the Figure. The direction of the magnetic field is into the page and perpendicular to the loop. At t=0 the loop starts entering into the region with magnetic field.
   (4%) (a) Work out the velocity of the loop as a function of time under the influence of the Lorentz force.
   (4%) (b) Work out the final velocity of the loop
   (4%) (c) Work out the time T when the loop enters into the region of magnetic field completely.
   (3%) (d) Work out the total energy dissipated in the loop.



5. Three particles connected by springs of spring constant k as shown in the Figure. Assume that particles are constrained to move on a line(x-axis) and assume that the amplitudes of oscillation are small.



   (3%) (a) Write down the equation for eigen frequencies of normal modes
   (3%) (b) How many of the three normal modes have zero frequency ?
   (3%) (c) Derive the eigen vectors
   (3%) (d) Derive eigen frequencies
   (3%) (e) If the particles are allowed to move on a plane, how many extra zero and non-zero modes are allowed ?
   (3%) (f) Write down the eigen vectors of the modes in (e)

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6. Taking the rotational and vibrational motion of the molecule into consideration,
   (5%) (a) What is the specific heat, C_p, of a gas of HD molecule at temperature higher than its rotational and vibrational energies.
   (5%) (b) What is C_p at temperature between its rotational and vibrational energies.
   (6%) (c) What is the answer to (a) and (b) for the collinear CO_2 the molecule ?

7. Consider a lattice in which each site can have 0, 1, or 2 electrons. If a site is occupied by one electron, its energy increased by ε_1 ; if occupied by two electrons its energy is ε_2 relative to an empty site which is taken to have zero energy.
   (8%) (a) What is the condition on the chemical potential such that the average number of electron per site, $\langle n \rangle$, is unity ?
   (9%) (b) If $\varepsilon_2 = 2\varepsilon_1 + \delta$ and δ is small relative to $k_B T$ and ε_1, what is the average energy per site when $\langle n \rangle \sim 1$? (Expand to the lowest nontrivial order in δ).