PRELIMINARY EXAMINATION

DEPARTMENT OF PHYSICS
UNIVERSITY OF FLORIDA
Part B, 17 August 2001, 14:00 - 17:00

B1. An extra electron is added to one atom of a tri-atomic molecule. The electron has equal probability to jump to either of the other two atoms.

(a) (6 points) Find the eigen-energies for the system. Assume that the new electron energy $\overline{E_0}$ is close to the non-hopping case energy E_0. Draw an energy level diagram.

(b) (4 points) Find one normalized eigenstate for the system.

B2. A right circular cylinder of 4 cm (inner) radius and 19.9 cm (inner) length contains 4×10^{14} Argon atoms (atomic number 18). The cylinder is maintained at room temperature, nominally 300 K.

(a) (4 points) Estimate the momentum transfer per square meter per second to the curved wall due to gas collisions.

(b) (3 points) Estimate the mean speed of an Argon atom in the container.

(c) (3 points) Estimate the mean free path of an Argon atom in the container.

Show the formulas used, reasoning, and work for full credit. You may wish to recall that $k_B = 1.38 \times 10^{-23}$ J/K, 1 amu = 1.66×10^{-27} kg. You make take the atomic weight of Argon to be 40 amu.

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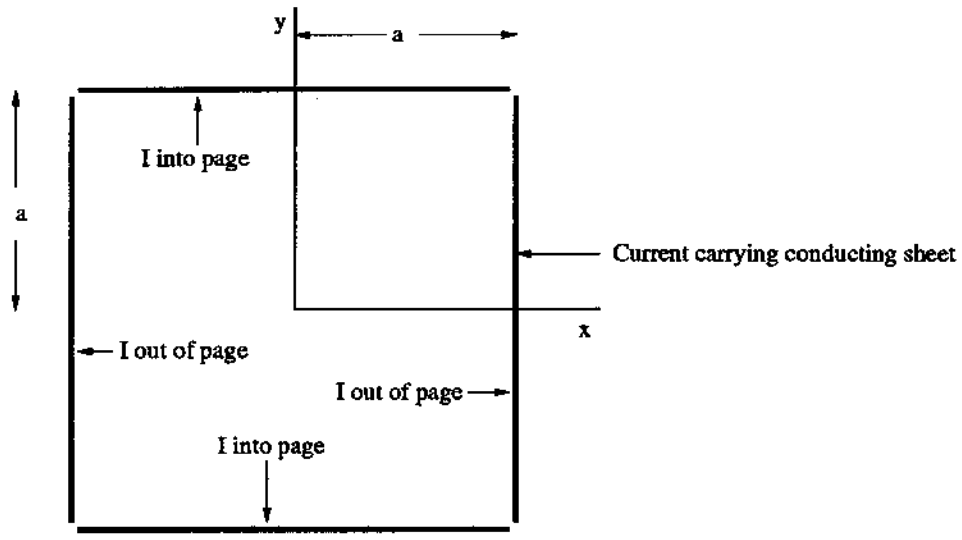
B3. A magnetic lens is made by placing four long, thin current carrying conducting sheets of width $2a$ on the sides of a square, as shown in the figure. The currents in the conducting sheets are distributed uniformly over the sheets, and are directed either into or out of the plane of the page, as shown in the figure. *You may neglect the effects of ends and corners.*



(a) (2 points) What are the values of $H_x(a^-, y)$ and $H_y(a^-, y)$ along the boundary just to the left of the current sheet at $x = a$? Likewise, what are the values of $H_x(x, a^-)$ and $H_y(x, a^-)$ along the upper boundary just below the current sheet at $y = a$?

(b) (2 points) What are H_x and H_y at the origin?

(c) (2 points) Find H_x and H_y in the interior region $-a < x < a$ and $-a < y < a$.

(d) (2 points) Derive the equation which describes the field lines in the interior region.

(e) (2 points) Suppose that a beam of positively charged particles is injected into the interior region of the lens so that their velocities are initially along the z axis (out of the page). Discuss how the lens can act to focus the beam. Try to be as quantitative as possible.