

## Physics 102– Pledged Problem 2

Time allowed: **2 hours at a single sitting**

**Due 5PM Monday, January 29, 2007**, in the boxes marked Phys 101-102 in the physics lounge. You may use your own textbook, your notes, and a non-programmed calculator. You may also consult the on-line solutions to the corresponding suggested problems. You should consult no other help. Show how you arrived at your answer; the correct answer by itself may not be sufficient.

Further instructions:

- Write legibly on **one** side of 8.5" x 11" white or lightly tinted paper.
  - Staple all sheets together, including this one, in the upper left corner.
  - Make one vertical fold.
  - On the outside, staple side up, print your name in capital letter, your LAST NAME first followed by your FIRST NAME.
  - Below your name, print the phrase "Pledged Problem 2", followed by the due date.
  - Also indicate **start time** and **end time**.
  - Write and sign the pledge, with the understanding that you may consult the materials noted above.
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I. Two insulating rods, each of length  $L$ , carry uniform linear charge density along their length. One carries a total positive charge  $+Q$ , and the other carries a total negative charge  $-Q$ . The rods are each bent into a semi-circle and joined to form a full circle, with an insulator between them so that no charge moves from one to the other. The upper part of the circle has positive charge, and the lower half has negative charge, as shown in the sketch below. Determine the electric field  $\vec{E}$  at  $C$ , the center of the semi-circle.

II. A very large, thin mesh is stretched flat so that it forms a planar surface. It carries a uniform positive charge density  $+\sigma$ . An electron moves near the surface of this material and is able to pass freely through the mesh without hitting it. The electron is released from rest a distance  $d$  above the surface, as shown below. Express your answers in terms of the charge of the electron  $-e$ , the mass of the electron  $m_e$ , the charge density on the mesh  $\sigma$ , the distance  $d$ , and possibly other constants.

- Determine the electric field at the location of the electron before it is released.
- Considering only the electric force (neglecting gravity) write down Newton's second law for the electron.
- Based on the form of your answer in (b), do you expect the electron to undergo simple harmonic motion?
- Taking  $t = 0$  to be the time at which the electron is released from rest, determine the time at which the electron first reaches the mesh.
- When the electron reaches the mesh, it freely passes through. Describe the subsequent motion of the electron after it passes through the mesh.