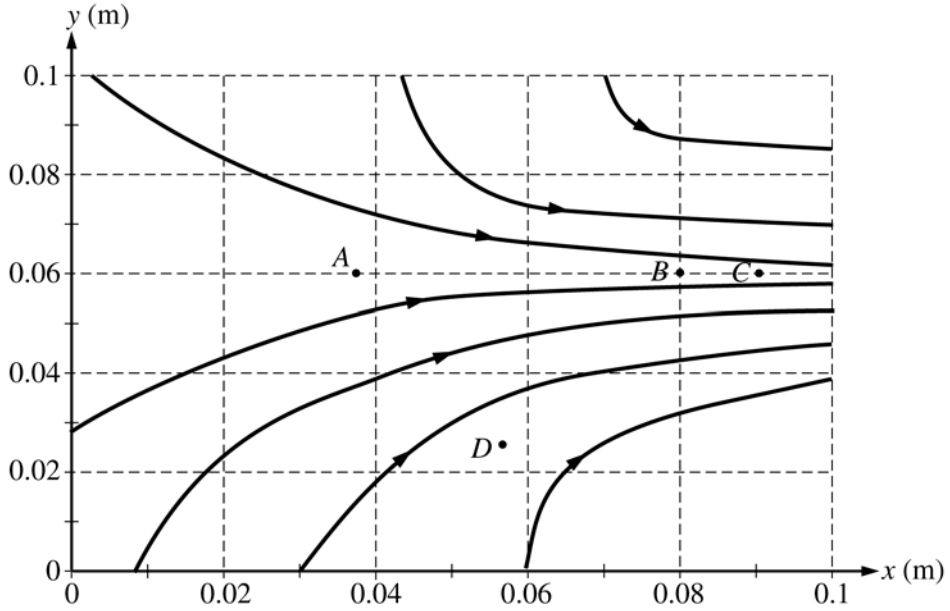
2005 AP® PHYSICS C: ELECTRICITY AND MAGNETISM
FREE-RESPONSE QUESTIONS

PHYSICS C

Section II, ELECTRICITY AND MAGNETISM
Time—45 minutes
3 Questions

Directions: Answer all three questions. The suggested time is about 15 minutes for answering each of the questions, which are worth 15 points each. The parts within a question may not have equal weight. Show all your work in the pink booklet in the spaces provided after each part, NOT in this green insert.



E&M. 1.

Consider the electric field diagram above.

(a) Points *A*, *B*, and *C* are all located at $y = 0.06$ m .

i. At which of these three points is the magnitude of the electric field the greatest? Justify your answer.

ii. At which of these three points is the electric potential the greatest? Justify your answer.

(b) An electron is released from rest at point *B*.

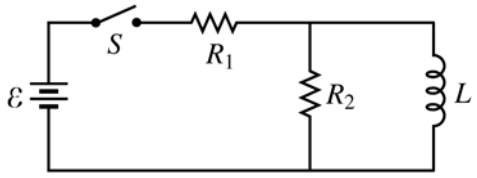
i. Qualitatively describe the electron's motion in terms of direction, speed, and acceleration.

ii. Calculate the electron's speed after it has moved through a potential difference of 10 V.

(c) Points *B* and *C* are separated by a potential difference of 20 V. Estimate the magnitude of the electric field midway between them and state any assumptions that you make.

(d) On the diagram, draw an equipotential line that passes through point *D* and intersects at least three electric field lines.

GO ON TO THE NEXT PAGE.



E&M. 2.

In the circuit shown above, resistors 1 and 2 of resistance R_1 and R_2, respectively, and an inductor of inductance L are connected to a battery of emf $\mathcal{E}$ and a switch S. The switch is closed at time $t = 0$. Express all algebraic answers in terms of the given quantities and fundamental constants.

(a) Determine the current through resistor 1 immediately after the switch is closed.

(b) Determine the magnitude of the initial rate of change of current, dI/dt, in the inductor.

(c) Determine the current through the battery a long time after the switch has been closed.

(d) On the axes below, sketch a graph of the current through the battery as a function of time.

Some time after steady state has been reached, the switch is opened.

(e) Determine the voltage across resistor 2 just after the switch has been opened.

Question 1 (continued)

Distribution of points

(c) 2 points

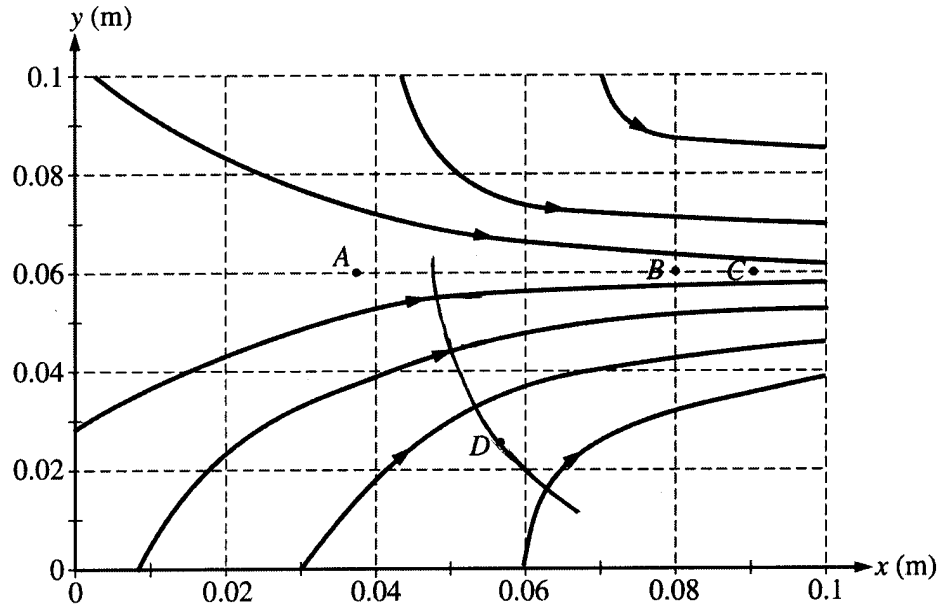
$$E = -\frac{\Delta V}{r}$$

$$E = \frac{20\ \text{V}}{0.01\ \text{m}}$$

For the correct answer with correct units 1 point
$E = 2000\ \text{V/m}$ or $2000\ \text{N/C}$

For the correct assumption that the field is close enough to uniform in this region to do a calculation as if it were 1 point

(d) 2 points



For drawing a curved line concave up or concave right that passes through point *D* and at least three electric field lines 1 point

For drawing the curved line perpendicular to at least three field lines 1 point