CollegeBoard
Advanced Placement Program

AP® Physics C: Electricity and Magnetism 2005 Scoring Commentary

Question 1

Overview

This question explored students' understanding of electric fields, the motion of charged particles in electric fields, and the relation between electric field and electric potential. In part (a) students were asked to interpret a map of electric field lines in order to determine at which of three points the electric field was greatest and at which of three points the electric potential was greatest. In part (b) they were to discuss the motion of an electron after it is released in a nonuniform electric field. In part (c) students were asked to estimate the magnitude of an electric field between two points (the two points had a 20-volt potential difference between them). The final part of the question required that students draw an equipotential line on the field-line map. The equipotential had to pass through a given point and intercept at least three electric field lines.

Sample: 1A
Score: 15

In part (b) the statement about moving to the left with increasing speed is an example of implying acceleration to the left. This response makes a correct statement about potential in part (c) that does imply a uniform field.

Sample: 1B
Score: 11

Part (a) lost 1 point for the justification in (ii). Part (b)(i) earned only the point for increasing speed, and (ii) earned full credit, as did (c) and (d).

Sample: 1C
Score: 7

In part (a), (i) earned 2 points, and (ii) earned none. In part (b), (i) earned full credit, and (ii) received nothing. Part (c) earned 1 point for assumption 2, which is correct, and (d) earned nothing.

Question 2

Overview

This question tested the students' understanding of LR circuits at long and short time scales. Students needed to understand that at short time scales, inductors resist changes in the current flowing through them. In the dc circuit shown, when the switch *S* was closed, the current flowing through the inductor was zero, and all of the current flowing through R_1 had to flow through R_2. After a long time, the inductor acted like a short circuit, so that all of the current flowing through R_1 flowed through *L*. When the switch *S* was opened again, the current continued to flow through *L*, and the voltage drop across R_2 could be calculated by Ohm's Law. The remaining concept, which is that the voltage drop across an inductor is given by $L(dI/dt)$, was tested in part (b). Part (d) was designed to test students' ability to graph the time-dependent behavior of the current supplied by the battery.

Sample: 2A
Score: 15

The work in part (b) begins with what looks like a general statement of the voltage across an inductor, or an incorrect statement that this voltage equals the battery emf, neither of which would earn credit. However, the substitution in the last line would indicate that the equations were intended to apply to the right-hand loop.

Sample: 2B
Score: 10

This response earned full credit for the first three parts. Only 2 points were earned in (d) since the upper and lower values are not indicated on the graph. Part (e) received no credit.

Sample: 2C
Score: 4

Part (a) received full credit. Parts (b), (c), and (e) received nothing, and (d) received 1 point for the correct asymptotic rise of the curve.

Question 3

Overview

The question required that students do numerical and graphical analysis on a set of data presented in the exam booklet. In the course of this analysis they were to use the equation for the magnetic field in a long solenoid ($B = \mu_0 nI$). The data consisted of the current flowing through the solenoid, the magnetic field within the solenoid, and the length of a coil whose number of turns was fixed but whose length could be varied. Students were asked to graph the data in such a way as to be able to determine a value for μ_0 from the graph. If B were graphed on the vertical axis and n on the horizontal axis, the slope of the resulting line was equal to $\mu_0 I$. Students were also asked to calculate the percent error between the value of μ_0 that they found from their graph and the theoretical value of that constant.

Sample: 3A
Score: 15

This response earned full credit and even includes the simple calculations used to determine n in part (a).

Sample: 3B
Score: 10

This response earned full credit for parts (a), (b), and (d). Part (c) shows no indication of using a slope and has no units on the answer, so it earned only 1 point for correctly substituting the given current.

Sample: 3C
Score: 6

This response is an example of using the equation $B = \mu_0 nI$ in part (a) to determine n. It received only 3 points there because there are too many significant figures shown. Part (b) earned no credit since the points are plotted incorrectly and neither line is a good best fit. Part (c) received 1 point for the indication that a slope should be calculated. However, μ_0 is incorrectly equated directly to the slope. The number given could have come either from using two data points or from the slope of part of the straighter line drawn, but with no work or units shown, no other credit was awarded. Part (d) earned full credit.