Problem 23.55

A vacuum tube diode consists of concentric cylindrical electrodes, the negative cathode and the positive anode. Because of the accumulation of charge near the cathode, the electric potential between the electrodes is not a linear function of the position, even with planar geometry, but is given by $V(x) = Cx^{4/3}$ where x is the distance from the cathode and C is a constant, characteristic of a particular diode and operating conditions. Assume that the distance between the cathode and anode is 12.0 mm and the potential difference between electrodes is 220 V .

Part A

Determine the value of C.

ANSWER:

$C =$ $8.01{\times}10^4$ $\mathrm{V/m}^{4/3}$

Correct

Part B

Obtain a formula for the electric field between the electrodes as a function of x.

Express your answer in terms of the variables C and x.

ANSWER:

$E_x =$ $-\frac{4}{3}\sqrt[3]{Cx}$

Correct

Part C

Determine the magnitude of the force on an electron when the electron is halfway between the electrodes.

ANSWER:

$F_x =$ $3.11{\times}10^{-15}$ N

Correct

Part D

Determine the direction of the force on an electron when the electron is halfway between the electrodes.

ANSWER:

⚪ Toward the negative cathode

🔘 Toward the positive anode

Correct