AP® Physics B
2002 Sample Student Responses
Form B

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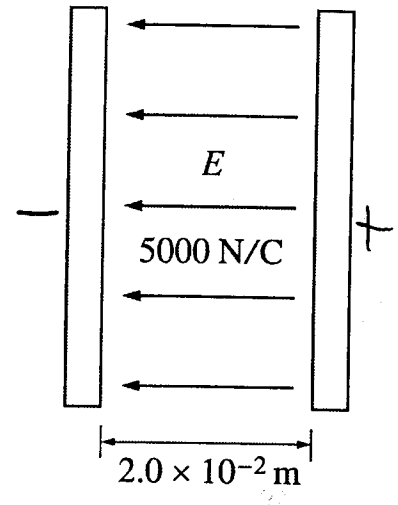

Note: Figure not drawn to scale.

5. (10 points)

Two parallel conducting plates, each of area 0.30 m^2, are separated by a distance of 2.0×10^{-2} m of air. One plate has charge $+Q$; the other has charge $-Q$. An electric field of 5000 N/C is directed to the left in the space between the plates, as shown in the diagram above.

(a) Indicate on the diagram which plate is positive (+) and which is negative (-).

(b) Determine the potential difference between the plates.

$V = Ed$

$V = 5000 \frac{N}{C} (2 \cdot 10^{-2} m)$

$\boxed{V = 100 V}$

(c) Determine the capacitance of this arrangement of plates.

$C = \frac{\varepsilon_0 A}{d}$

$C = \frac{8.85 \cdot 10^{-12} (.3)}{2 \cdot 10^{-2}}$

$C = 1.3275 \cdot 10^{-10}$

$\boxed{C = 133 pF}$

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An electron is initially located at a point midway between the plates.

(d) Determine the magnitude of the electrostatic force on the electron at this location and state its direction.

$F = qE$

$F = 1.6 \cdot 10^{-19}(5000)$

$F = 8 \cdot 10^{-16} N$ to the right (positive plate)

(e) If the electron is released from rest at this location midway between the plates, determine its speed just before striking one of the plates. Assume that gravitational effects are negligible.

$PE = qV$

$PE = 1.6 \cdot 10^{-19}(50)$

$PE = 8 \cdot 10^{-18} J$

$PE = KE$

$8 \cdot 10^{-18} = \frac{1}{2} m v^2$

$8 \cdot 10^{-18} = \frac{1}{2}(9.11 \cdot 10^{-31}) v^2$

$\sqrt{1.76 \cdot 10^{13}} = \sqrt{v^2}$

$4.2 \cdot 10^6 \, m/s = v$

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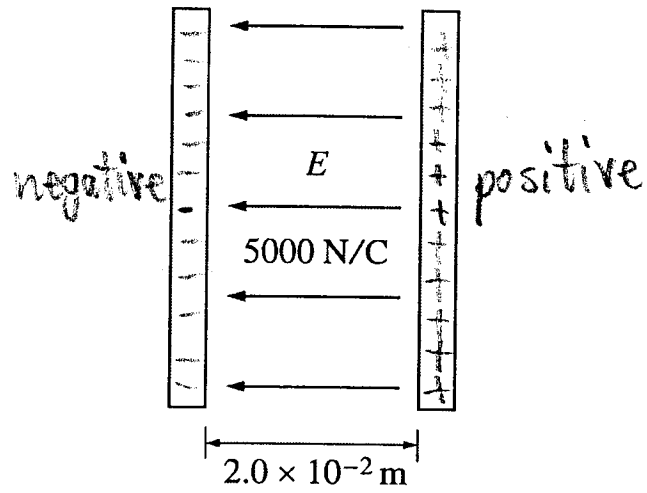

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5. (10 points)

Two parallel conducting plates, each of area 0.30 m^2, are separated by a distance of 2.0×10^{-2} m of air. One plate has charge $+Q$; the other has charge $-Q$. An electric field of 5000 N/C is directed to the left in the space between the plates, as shown in the diagram above.

(a) Indicate on the diagram which plate is positive (+) and which is negative (-).

(b) Determine the potential difference between the plates.

$V = -\int E\,dQ$

$V = -E\,d = -5000\ N/C\ (2.0 \cdot 10^{-2}\ m)$

$V = 100\ V$

(c) Determine the capacitance of this arrangement of plates.

$C = \frac{\varepsilon A}{d} = \frac{(8.85 \cdot 10^{-12}\ C^2/Nm^2)\ 0.30\ m^2}{(2.0 \cdot 10^{-2}\ m)} = 1.3275 \cdot 10^{-10}\ C^2/Nm$

$C = 1.3 \cdot 10^{-10}\ C^2/Nm$

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An electron is initially located at a point midway between the plates.

(d) Determine the magnitude of the electrostatic force on the electron at this location and state its direction.

$q_{e^-} = 1.60 \cdot 10^{-19} C$

$E = \frac{F}{q_{e^-}} \qquad F = E_q = (5000 N/C)(1.60 \cdot 10^{-19} C)$

$\boxed{F = 8.0 \cdot 10^{-16} N \text{ right}}$

(e) If the electron is released from rest at this location midway between the plates, determine its speed just before striking one of the plates. Assume that gravitational effects are negligible.

$a = \frac{F}{m_{e^-}} = \frac{8.0 \cdot 10^{-16} N}{9.11 \cdot 10^{-31} kg} = 8.8 \cdot 10^{15} m/s^2$

$V^2 = 2(8.8 \cdot 10^{15} m/s^2)(1.0 \cdot 10^{-2} m) = 17.6 \cdot 10^{13} m^2/s^2$

$\boxed{V = 4.2 \cdot 10^7 m/s}$

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