AP Physics B
2000 Student Samples

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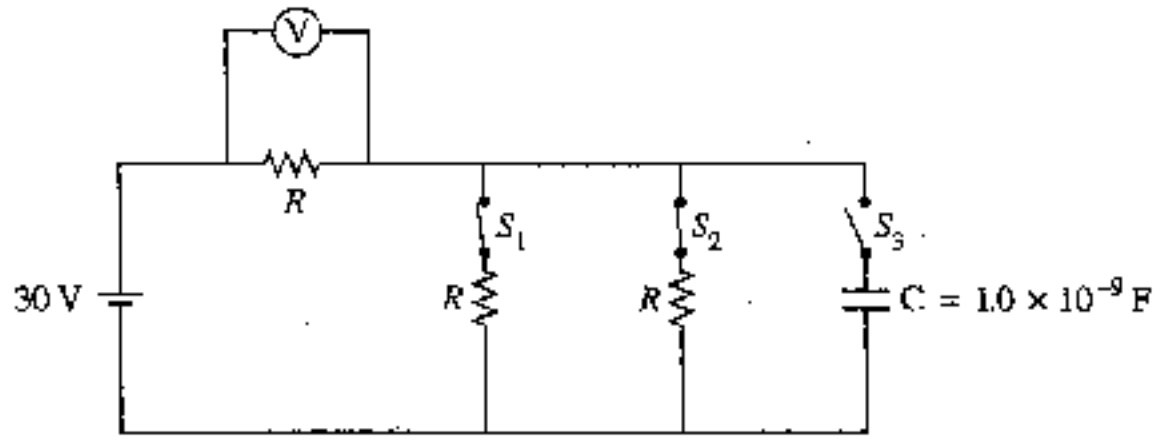
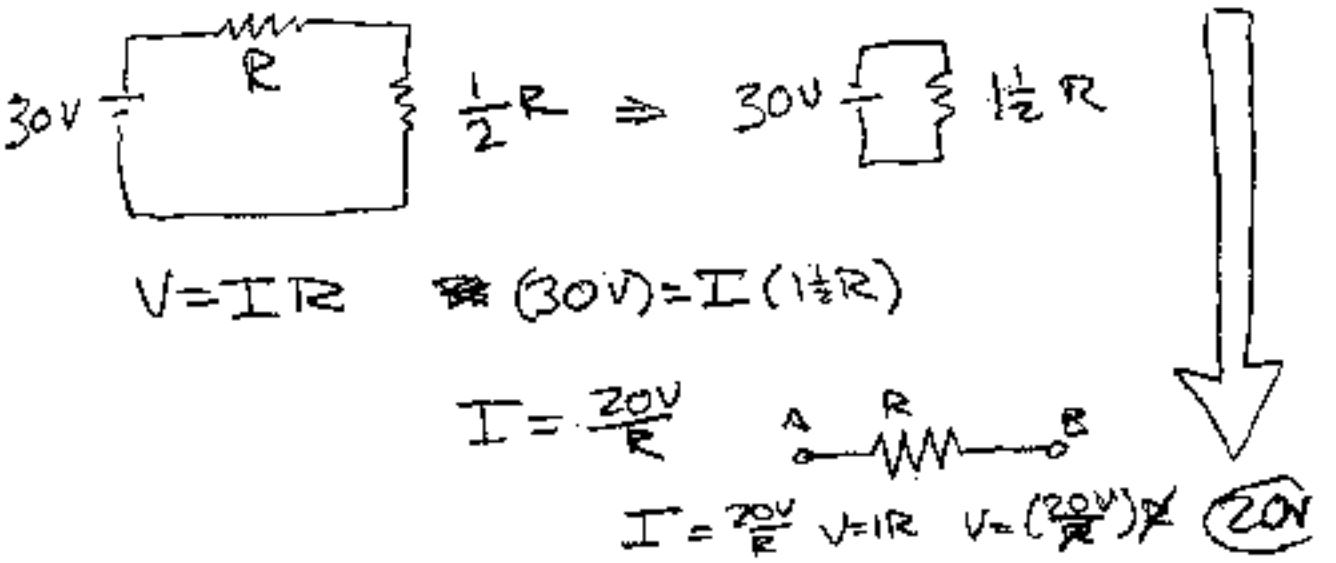
K1



3. (15 points)

Three identical resistors, each with resistance R, and a capacitor of 1.0×10^{-9} F are connected to a 30 V battery with negligible internal resistance, as shown in the circuit diagram above. Switches S_1 and S_2 are initially closed, and switch S_3 is initially open. A voltmeter is connected as shown.

(a) Determine the reading on the voltmeter.



(b) Switches S_1 and S_2 are now opened, and then switch S_3 is closed. Determine the charge Q on the capacitor after S_3 has been closed for a very long time.

$C = \frac{Q}{V}$ $\quad Q = VC \quad V = 30V \quad C = 1 \times 10^{-9}$

$3 \times 10^{-8} C$

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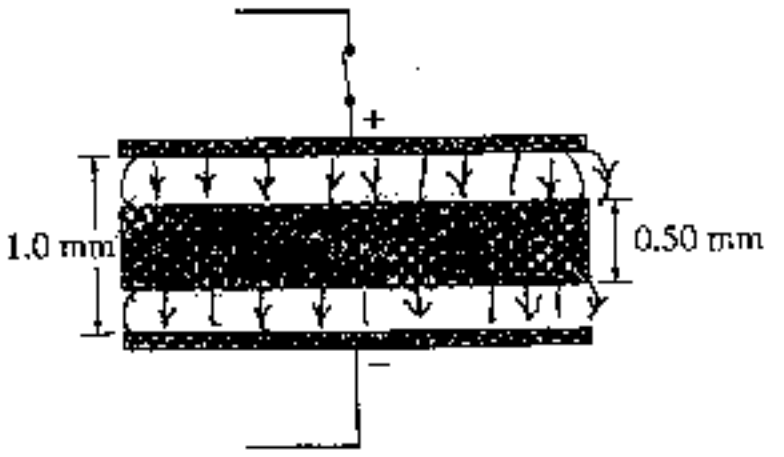
K2

After the capacitor is fully charged, switches S_1 and S_2 remain open, switch S_3 remains closed, the plates are held fixed, and a conducting copper block is inserted midway between the plates, as shown below. The plates of the capacitor are separated by a distance of 1.0 mm, and the copper block has a thickness of 0.5 mm.



(c) i. What is the potential difference between the plates?

30 V

ii. What is the electric field inside the copper block?

0

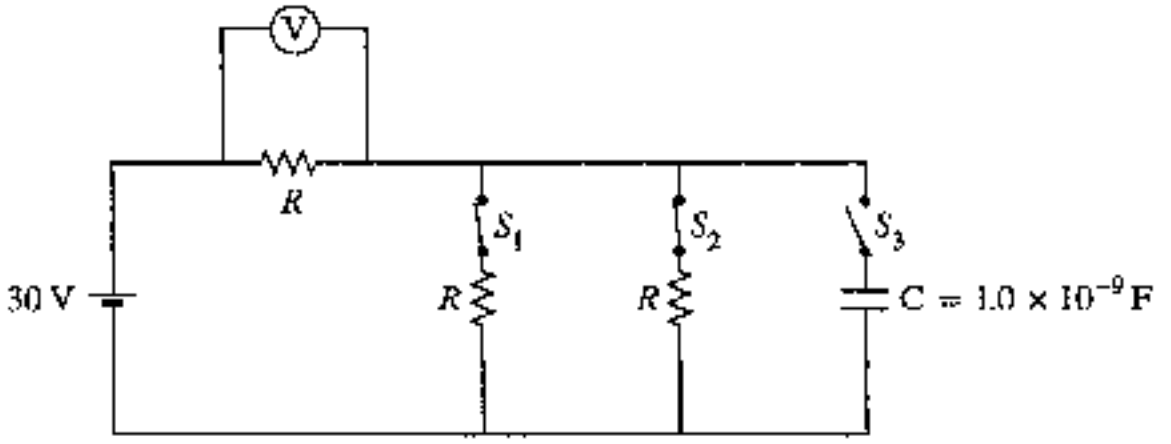
iii. On the diagram above, draw arrows to clearly indicate the direction of the electric field between the plates.

iv. Determine the magnitude of the electric field in each of the spaces between the plates and the copper block.

$$\vec{E} = \frac{V}{d} = \frac{30V}{0.5mm} = \frac{30V}{.0005m} = 60000\ \frac{V}{m}$$

GO ON TO THE NEXT PAGE.

M1



3. (15 points)

Three identical resistors, each with resistance R, and a capacitor of 1.0×10^{-9} F are connected to a 30 V battery with negligible internal resistance, as shown in the circuit diagram above. Switches S_1 and S_2 are initially closed, and switch S_3 is initially open. A voltmeter is connected as shown.

(a) Determine the reading on the voltmeter.

$\frac{1}{R_T} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R} = \frac{1}{R_T}$

$R_T = \frac{R}{2} + R$

$= \frac{3R}{2}$

$V = IR$

$30 = I \frac{3R}{2}$

$I = \frac{20}{R}$

$V = IR$

$= \frac{20}{R} R$

$= 20\,V$ //

(b) Switches S_1 and S_2 are now opened, and then switch S_3 is closed. Determine the charge Q on the capacitor after S_3 has been closed for a very long time.

$Q = CV$

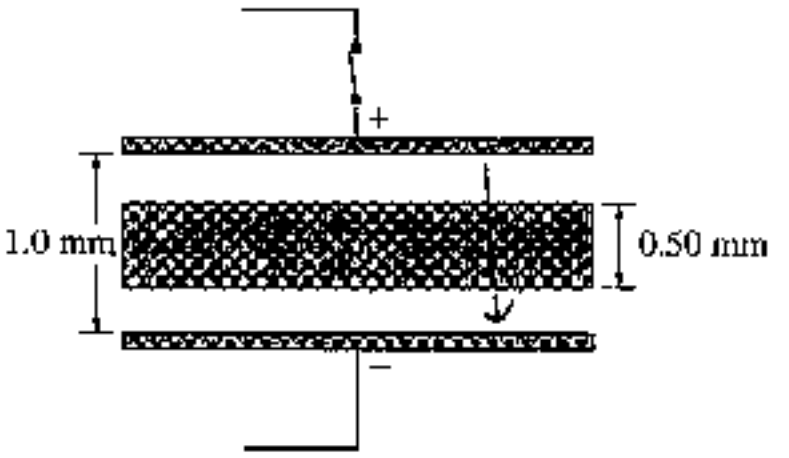
$= 1.0 \times 10^{-9} \cdot 30$

$= 3.0 \times 10^{-8}\,C$ //

GO ON TO THE NEXT PAGE.

M2

After the capacitor is fully charged, switches S_1 and S_2 remain open, switch S_3 remains closed, the plates are held fixed, and a conducting copper block is inserted midway between the plates, as shown below. The plates of the capacitor are separated by a distance of 1.0 mm, and the copper block has a thickness of 0.5 mm.



(c) i. What is the potential difference between the plates?

$V = 30\ V$ //

ii. What is the electric field inside the copper block?

$E = \frac{V}{d} = \frac{30}{1.0\times10^{-3}} = 3.0\times10^{4}\ \frac{N}{C}$ //

iii. On the diagram above, draw arrows to clearly indicate the direction of the electric field between the plates.

iv. Determine the magnitude of the electric field in each of the spaces between the plates and the copper block.

$E = \frac{V}{d} = \frac{30}{0.25} = 120\ N/C$ //

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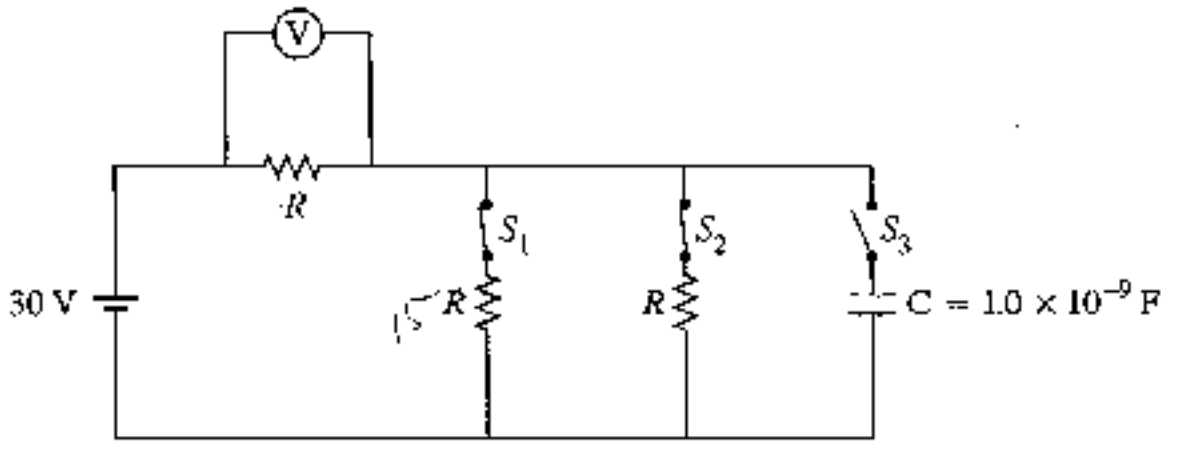
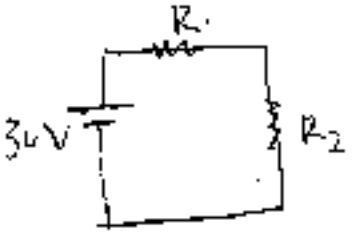
N1



3. (15 points)

Three identical resistors, each with resistance R, and a capacitor of 1.0×10^{-9} F are connected to a 30 V battery with negligible internal resistance, as shown in the circuit diagram above. Switches S_1 and S_2 are initially closed, and switch S_3 is initially open. A voltmeter is connected as shown.

(a) Determine the reading on the voltmeter.



Since $R_1 = R_2$

and in series, voltage is added up from each resistor

Thus, the reading on the voltmeter will be $\frac{30}{2} = 15V$

(b) Switches S_1 and S_2 are now opened, and then switch S_3 is closed. Determine the charge Q on the capacitor after S_3 has been closed for a very long time.

$$C = \frac{Q}{V}$$

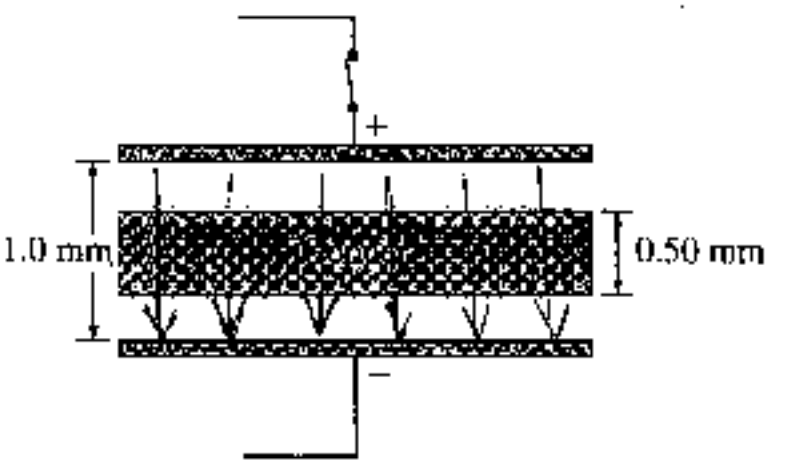
$$1.0 \times 10^{-9} = \frac{Q}{30}$$

$$Q = 3.0 \times 10^{-8}\ C$$

GO ON TO THE NEXT PAGE.

N2

After the capacitor is fully charged, switches S_1 and S_2 remain open, switch S_3 remains closed, the plates are held fixed, and a conducting copper block is inserted midway between the plates, as shown below. The plates of the capacitor are separated by a distance of 1.0 mm, and the copper block has a thickness of 0.5 mm.



(c) i. What is the potential difference between the plates?

potential difference = voltage = 30 V

ii. What is the electric field inside the copper block?

zero

iii. On the diagram above, draw arrows to clearly indicate the direction of the electric field between the plates.

iv. Determine the magnitude of the electric field in each of the spaces between the plates and the copper block.

$$E = \frac{V}{d}$$

$$E = \frac{30}{0.5} = 60 \ \frac{V}{m}$$

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