



AP[®] Physics B 2003 Sample Student Responses

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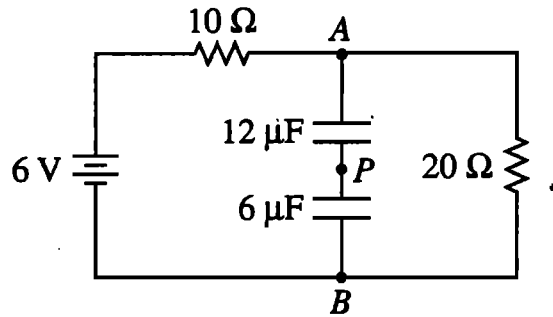
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2. (15 points)

A circuit contains two resistors ($10\ \Omega$ and $20\ \Omega$) and two capacitors ($12\ \mu\text{F}$ and $6\ \mu\text{F}$) connected to a $6\ \text{V}$ battery, as shown in the diagram above. The circuit has been connected for a long time.

(a) Calculate the total capacitance of the circuit.

$$C_1 = 12\ \mu\text{F} \quad C_2 = 6\ \mu\text{F}$$

$$\begin{aligned} C_T &= \left(\frac{1}{C_1} + \frac{1}{C_2} \right)^{-1} \\ &= \left(\frac{1}{12\ \mu\text{F}} + \frac{1}{6\ \mu\text{F}} \right)^{-1} \\ &= \left(\frac{3}{12\ \mu\text{F}} \right)^{-1} \\ &= 4\ \mu\text{F} \end{aligned}$$

(b) Calculate the current in the $10\ \Omega$ resistor.

$$R_1 = 10\ \Omega \quad R_2 = 20\ \Omega$$

$$\begin{aligned} R_T &= R_1 + R_2 \\ &= 30\ \Omega \end{aligned}$$

$$\begin{aligned} I &= \frac{V_T}{R_T} \\ &= \frac{6\ \text{V}}{30\ \Omega} = 0.20\ \text{A} \end{aligned}$$

(c) Calculate the potential difference between points A and B.

$$\begin{aligned} V_1 &= R_1 I & V_{\text{point A}} \\ &= 10\ \Omega \cdot 0.20\ \text{A} &= V_T - V_1 \\ &= 2\ \text{V} &= 6\ \text{V} - 2\ \text{V} \\ & &= 4\ \text{V} \end{aligned}$$

$$\begin{aligned} \Delta V_{BA} &= V_B - V_A \\ &= 0\ \text{V} - 4\ \text{V} \\ &= -4\ \text{V} \end{aligned}$$

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- (d) Calculate the charge stored on one plate of the $6 \mu\text{F}$ capacitor.

$$\begin{aligned} V_2 &= IR_2 \\ &= 0.20\text{A} \cdot 20\Omega \\ &= 4\text{V} \end{aligned}$$

Q is the same in series

$$\begin{aligned} Q &= C_1 V & C_1 &= 4 \mu\text{F} \\ &= 4 \times 10^{-6} \frac{\text{C}}{\text{V}} \cdot 4\text{V} \\ &= 1.6 \times 10^{-5} \text{C} \end{aligned}$$

- (e) The wire is cut at point P . Will the potential difference between points A and B increase, decrease, or remain the same?

increase

decrease

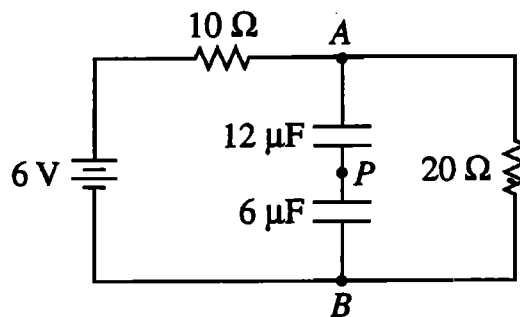
remain the same

Justify your answer.

Since the wire with the two capacitors and the wire with a 20Ω resistor are in parallel with each other, the voltage across each wire would have the same value, which is 4V . At point A , there is a voltage drop of 2V after the 10Ω resistor. At point B , the circuit would need to experience the total of 6V voltage drop since that is the total voltage of the battery. Thus even if the wire is cut at point P , the potential difference between point A and B would remain the same.

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2. (15 points)

A circuit contains two resistors ($10\ \Omega$ and $20\ \Omega$) and two capacitors ($12\ \mu\text{F}$ and $6\ \mu\text{F}$) connected to a $6\ \text{V}$ battery, as shown in the diagram above. The circuit has been connected for a long time.

(a) Calculate the total capacitance of the circuit.

Capacitors in series $\frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C_{\text{tot}}}$

$$\frac{1}{12 \times 10^{-6}} + \frac{1}{6 \times 10^{-6}} = \frac{1}{C_{\text{tot}}}$$

$$4 \times 10^{-6}$$

4 μF

(b) Calculate the current in the $10\ \Omega$ resistor.

$$V = IR \quad R = 10 + 20\ \Omega$$

$$6 = I(30)$$

$I = 0.2\ \text{A}$

(c) Calculate the potential difference between points A and B.

$$V = IR$$

$$V = \left(\frac{1}{5}\right)(20)$$

$$V = 4$$

voltage in parallel paths is equal

4V

GO ON TO THE NEXT PAGE.

(d) Calculate the charge stored on one plate of the $6 \mu\text{F}$ capacitor.

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

$$6 \frac{\mu\text{F}}{6\text{V}} = 1 \mu\text{C}$$

(e) The wire is cut at point P . Will the potential difference between points A and B increase, decrease, or remain the same?

increase

decrease

remain the same

Justify your answer.

The was no current running through the capacitors after they were charged, so after the wire is cut there will still be no current, so the voltage from A to B will not change

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