



Electromagnetics:
Electromagnetic Field Theory

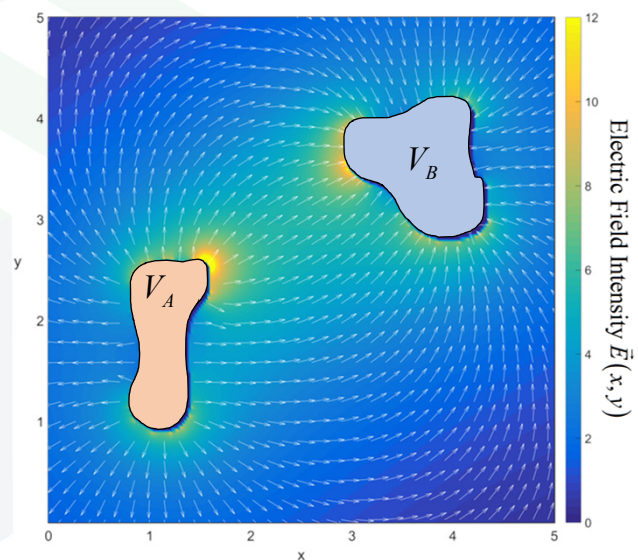
Electric Potential Example

1

Example Setup

What is the potential difference V_{AB}
between these two objects?

$$V_{AB} = V_B - V_A$$

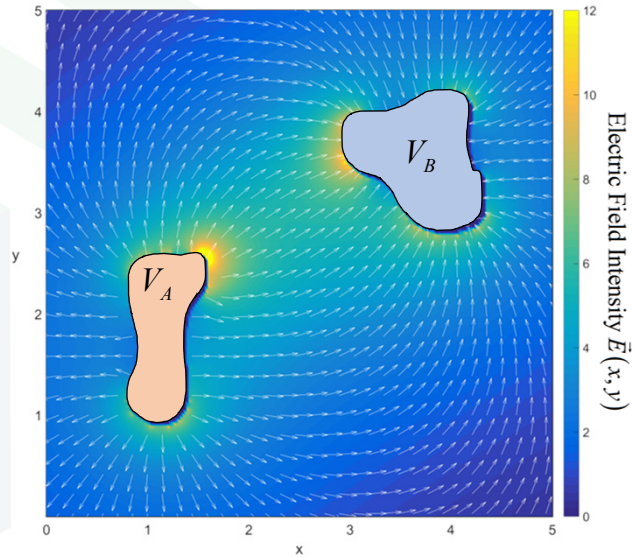


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Solution (1 of 8)

Calculate V_{AB} from \vec{E} using a line integration.

$$V_{AB} = V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{\ell}$$



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Solution (2 of 8)

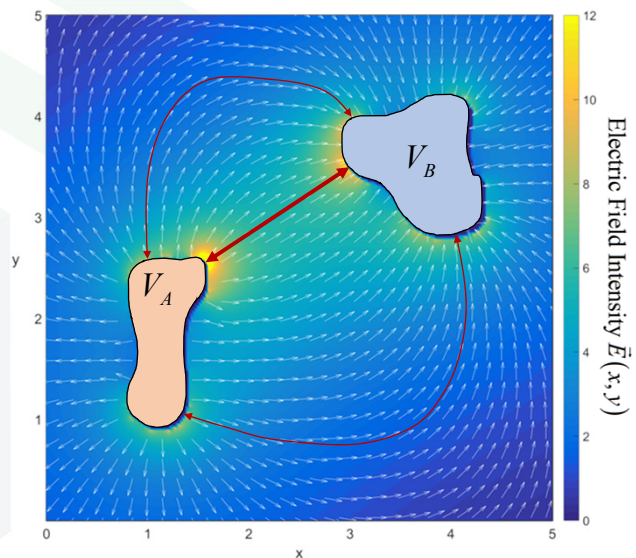
Calculate V from \vec{E} using a line integration.

$$V_{AB} = V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{\ell}$$

For easiest integration, try to choose a path where the electric field is always parallel to that path.

This will simplify the dot product to

$$\vec{E} \cdot d\vec{\ell} \approx |\vec{E}| dl$$



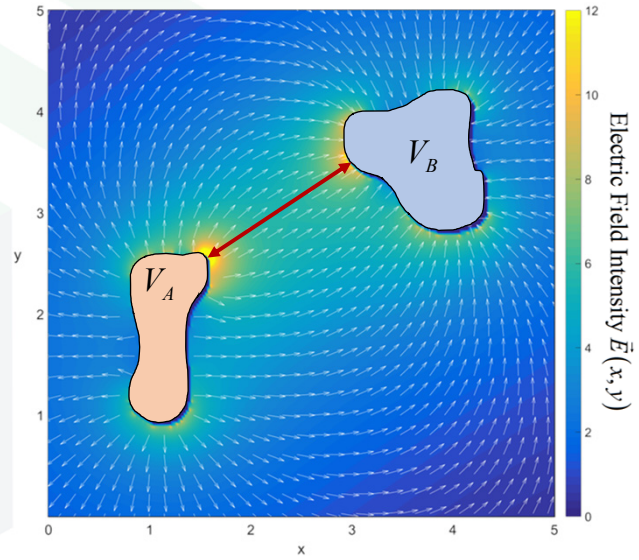
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Solution (3 of 8)

Is this a good path?



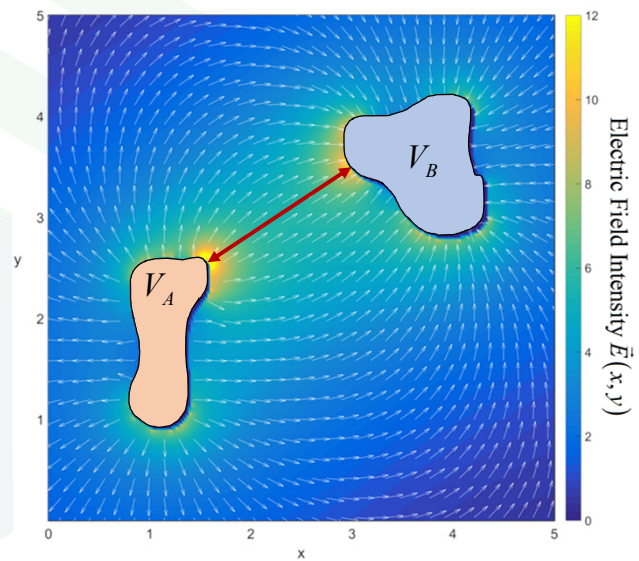
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Solution (4 of 8)

From the figure, the electric field is almost constant along this path.



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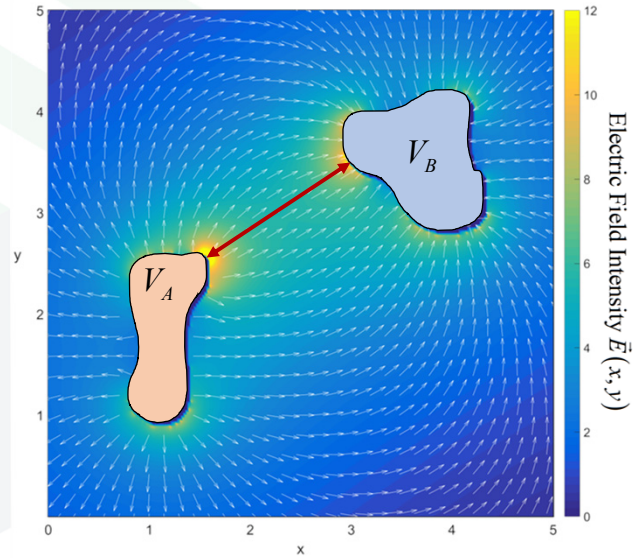
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Solution (5 of 8)

From the figure, the electric field is almost constant along this path.

This let's the integral be approximated as

$$\begin{aligned} V_{AB} &= -\int_A^B \vec{E} \cdot d\vec{\ell} \\ &\approx -\int_A^B |\vec{E}| d\ell \\ &\approx -|\vec{E}| L \end{aligned}$$



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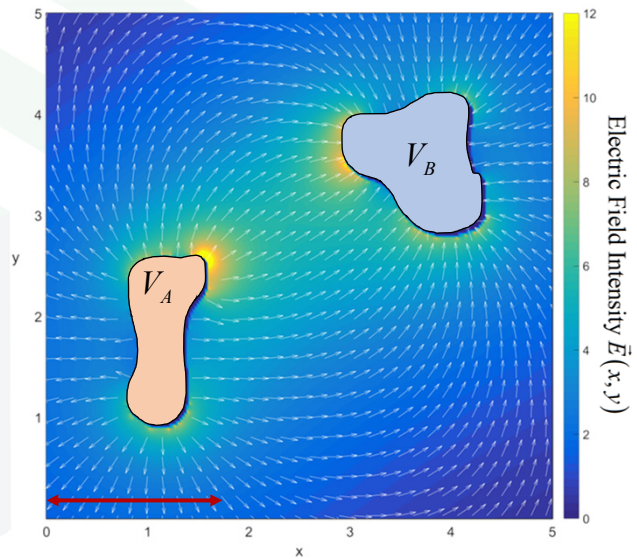
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Solution (6 of 8)

To estimate L , the line is moved down to the x -axis.

$$L \approx 1.7$$



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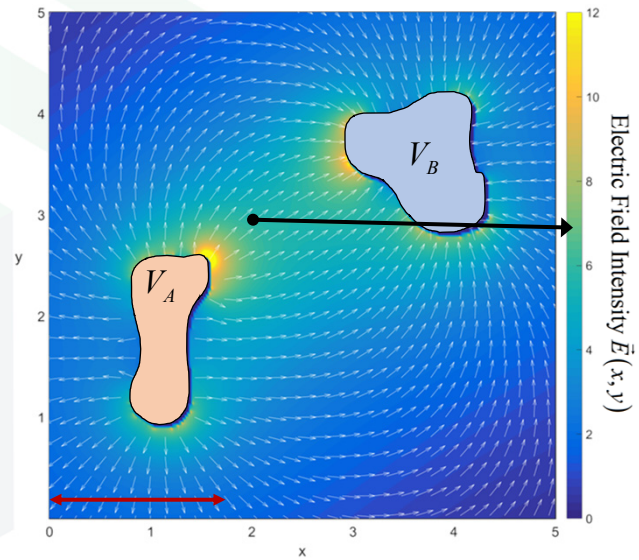
Solution (7 of 8)

To estimate L , the line is moved down to the x -axis.

$$L \approx 1.7$$

To estimate $|\vec{E}|$, the color is read from the colorbar.

$$|\vec{E}| \approx 7.0$$



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Solution (8 of 8)

To estimate L , the line is moved down to the x -axis.

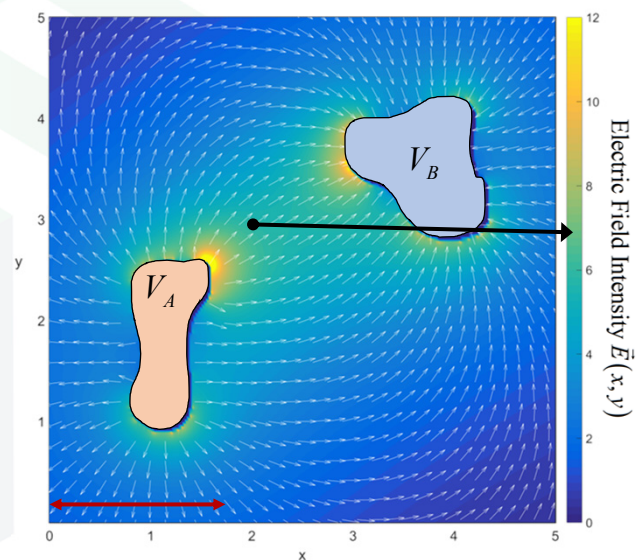
$$L \approx 1.7$$

To estimate $|\vec{E}|$, the color is read from the colorbar.

$$|\vec{E}| \approx 7.0$$

Finally, the potential difference V is approximately

$$V_{AB} = -|\vec{E}|L = -(7.0)(1.7) = \boxed{-11.9 \text{ V}}$$

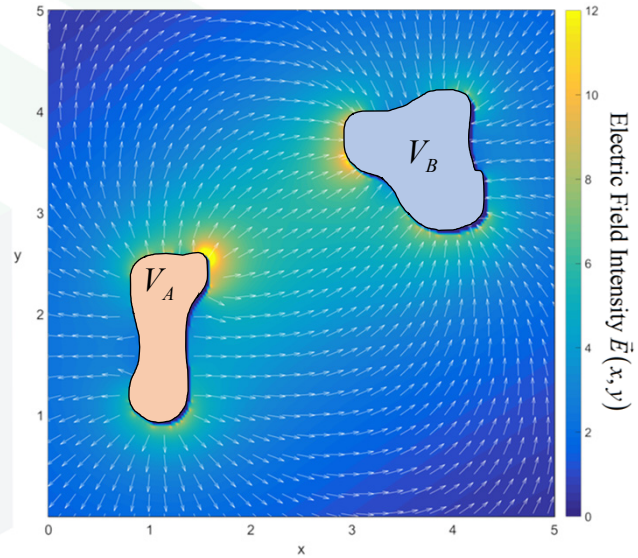


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Interpreting the Sign (1 of 2)

Why is the voltage negative?

$$V_{AB} = -11.9 \text{ V}$$



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Interpreting the Sign (2 of 2)

Why is the voltage negative?

$$V_{AB} = -11.9 \text{ V}$$

Recall the definition of V_{AB} .

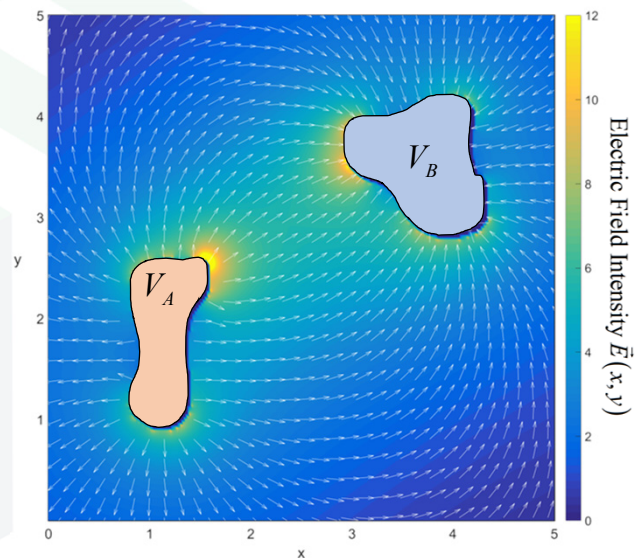
$$V_{AB} = V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{\ell}$$

From the figure, it is concluded that

$$V_A > V_B$$

Therefore

$$V_{AB} = V_B - V_A \text{ is negative.}$$



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