

A scenic view of a university campus. In the foreground, there is a large, well-maintained green lawn. To the left, a white, modern, curved architectural structure is visible. In the middle ground, a large, multi-story building with a central dome and several windows is situated. The building is surrounded by trees and a paved walkway. In the background, a large, rugged mountain rises under a blue sky with scattered clouds. The text "Welcome to Class" is overlaid in the center of the image in a bold, yellow font.

# Welcome to Class



# Fun Physics Fact of the Day

1,000

Number of stars known in ancient times

2,000

Number of stars known in 1600 A.D.

3,000

Number of stars known in 1712 A.D.

The machinery of the heavens  
is... like a clock... all the variety of  
motions is from one simple  
force... as in the clock all motions  
are from a simple weight.”

Johannes Kepler

225,300

Number of stars known in 1918 A.D.

16 million

Number of stars known in 1983

What is an isotope? ion?

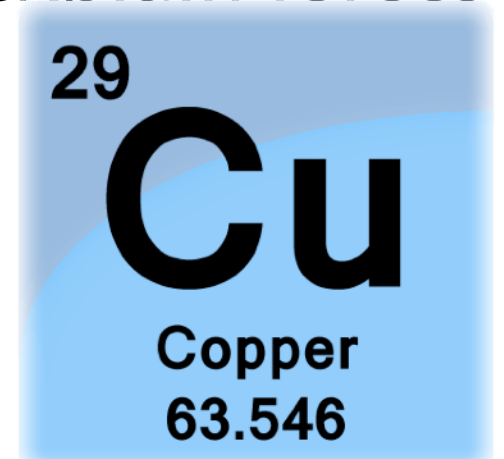
What is charge? What particles have charge?

What is the difference between an insulator and a conductor?

How do you charge an insulator, conductor?

Explain the meaning of the numbers on the periodic table.

What does polarization mean and how does it explain forces on neutral objects?



Metal

Positive  
ion cores

What is an isotope? ion?

What is charge? What particles have charge?

What is the difference between an insulator and a conductor?

Valence electrons form  
a "sea of electrons."

Insulator

Nucleus

Core electrons

Valence electrons

How do you charge an insulator, conductor?

Explain the meaning of the numbers on the periodic table.

Valence electrons  
are tightly bound.

What does polarization mean and how does it explain forces  
on neutral objects?

29

Cu

Copper

63.546

What is an isotope? ion?

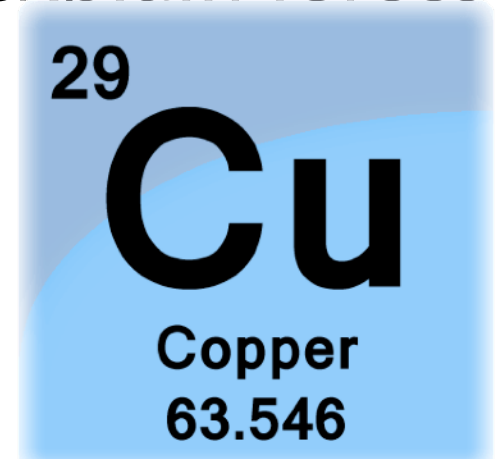
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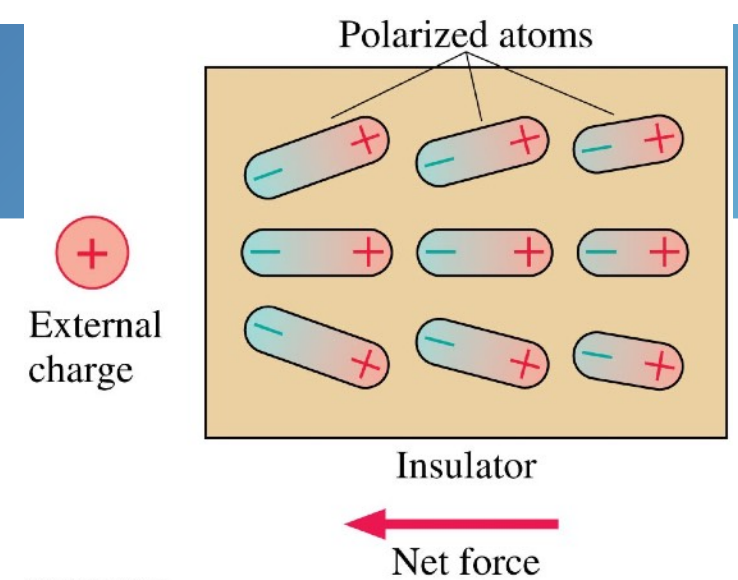
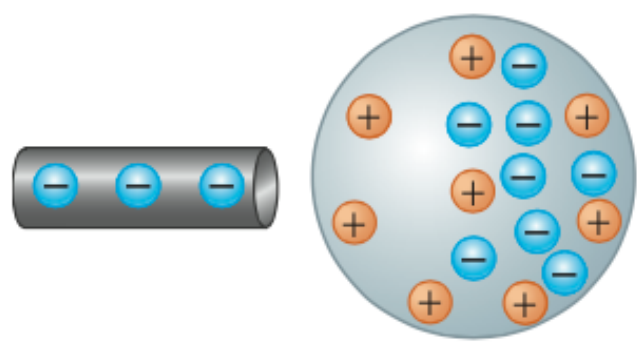
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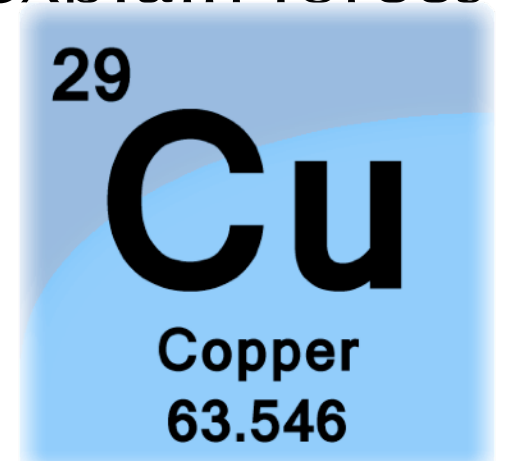
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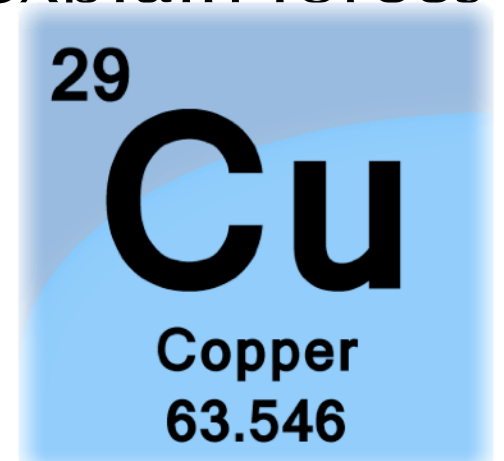
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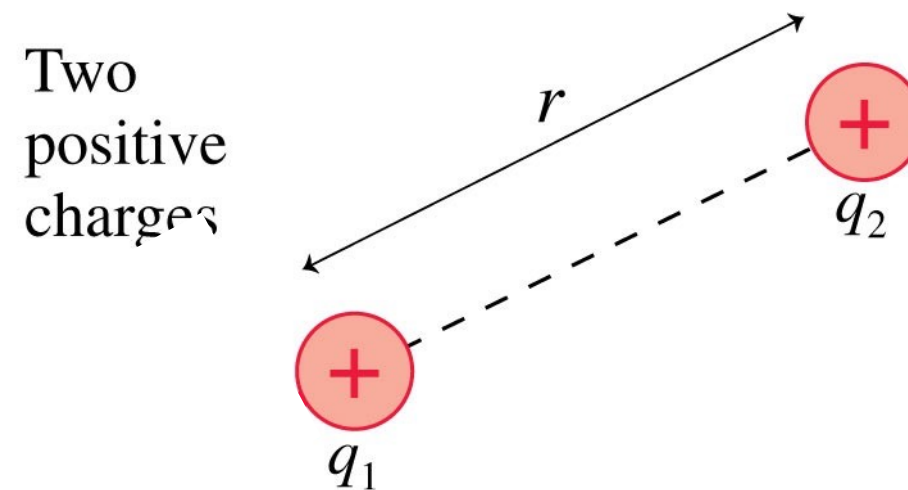
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# Coulomb's Law

Indicate to your neighbor the direction of the force vectors on both charges.

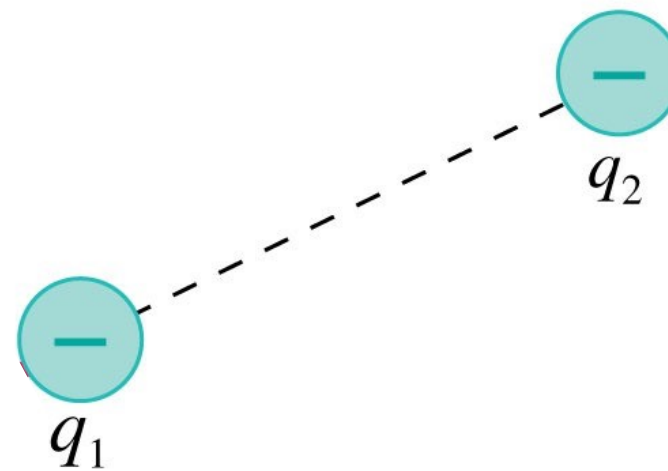




# Coulomb's Law

Indicate to your neighbor the direction of the force vectors on both charges.

Two  
negative  
charges



# Coulomb's Law

Indicate to your neighbor  
the direction of the force  
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Opposite  
charges



# Coulomb's Law

$$F = \frac{k|q_1||q_2|}{r^2}$$

Indicate to your neighbor  
the direction of the force  
vectors on both charges.

$$k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ N m}^2/\text{C}^2$$

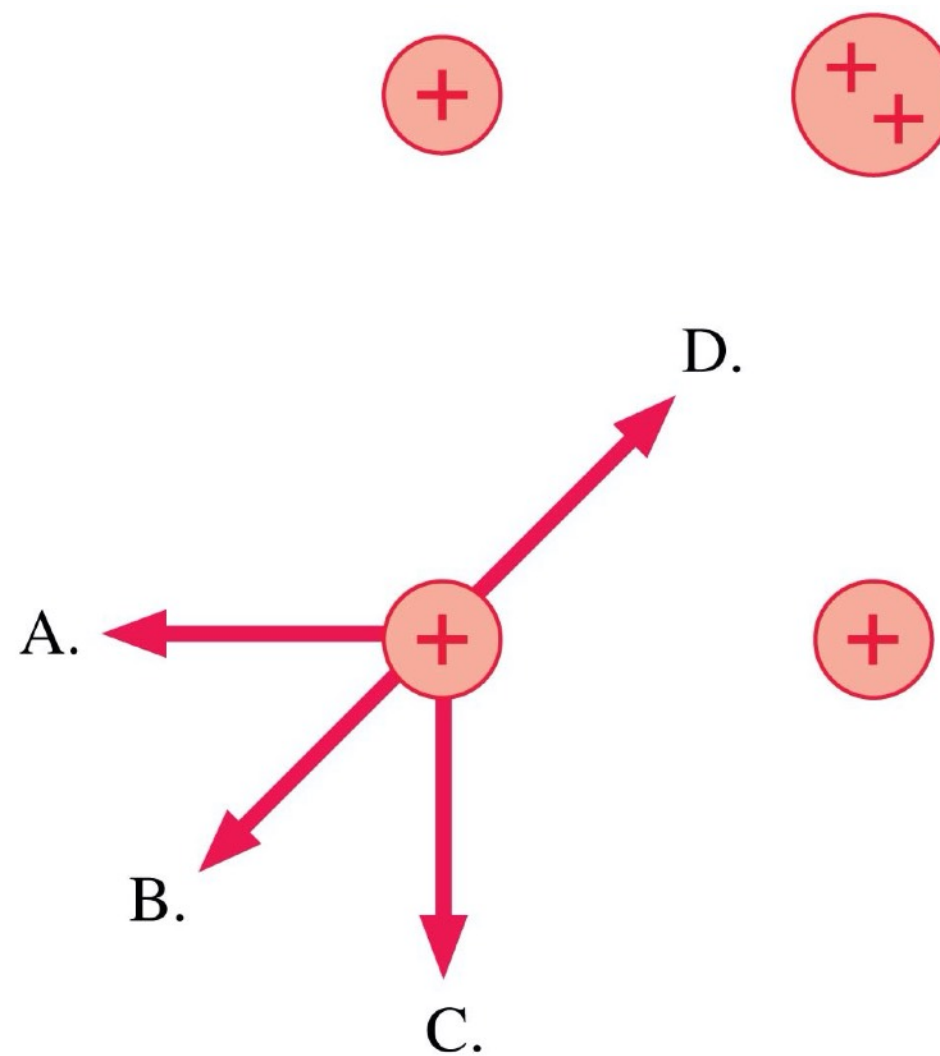
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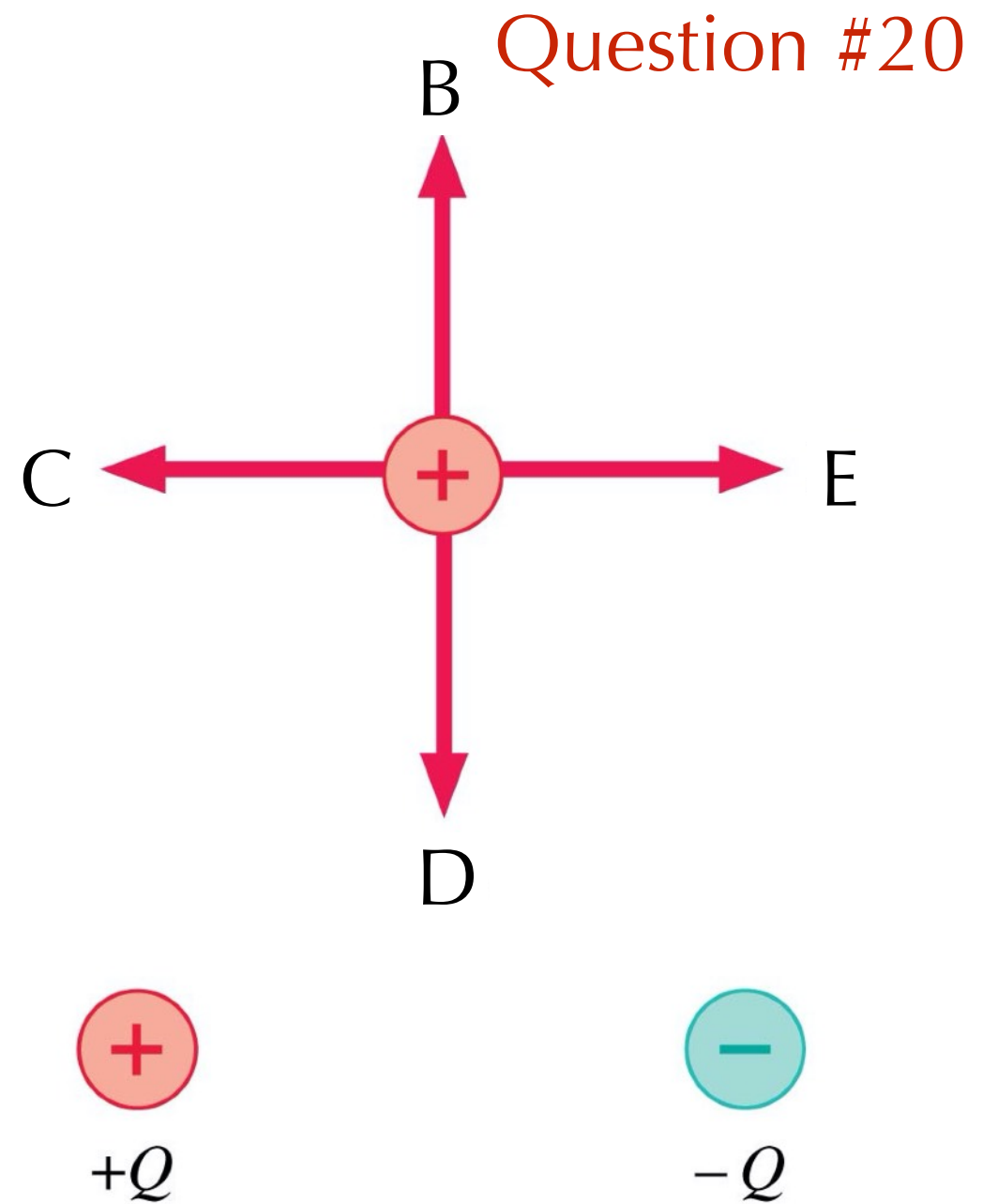


## Question #19

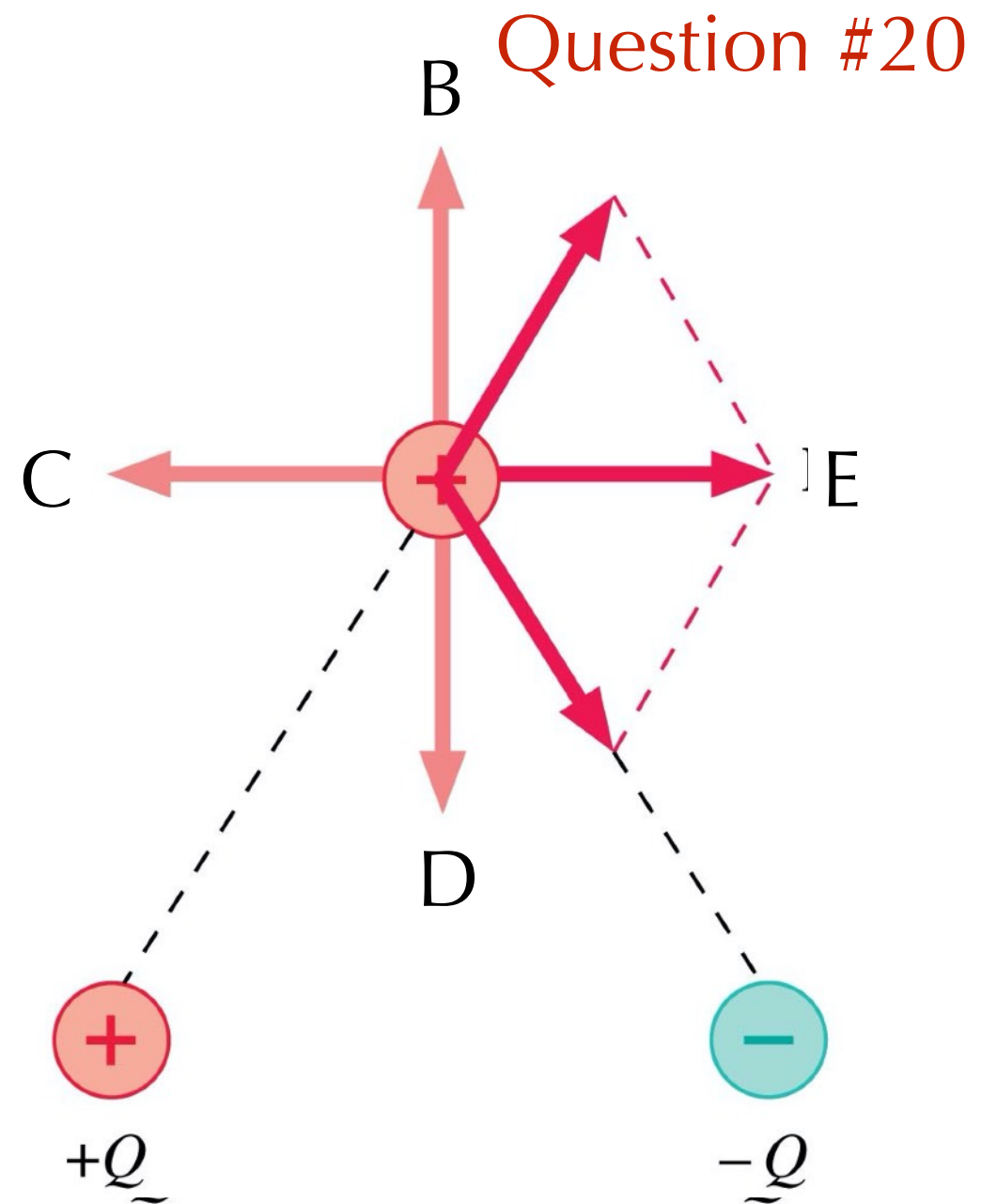
Which is the direction of the net force on the charge at the lower left?



Which is the direction of the net force on the charge at the top?



Which is the direction of the net force on the charge at the top?





## Question #21

The direction of the force on charge  $-q$  is

- a) right
- b) left
- c) up
- d) down
- e) zero



$+Q$



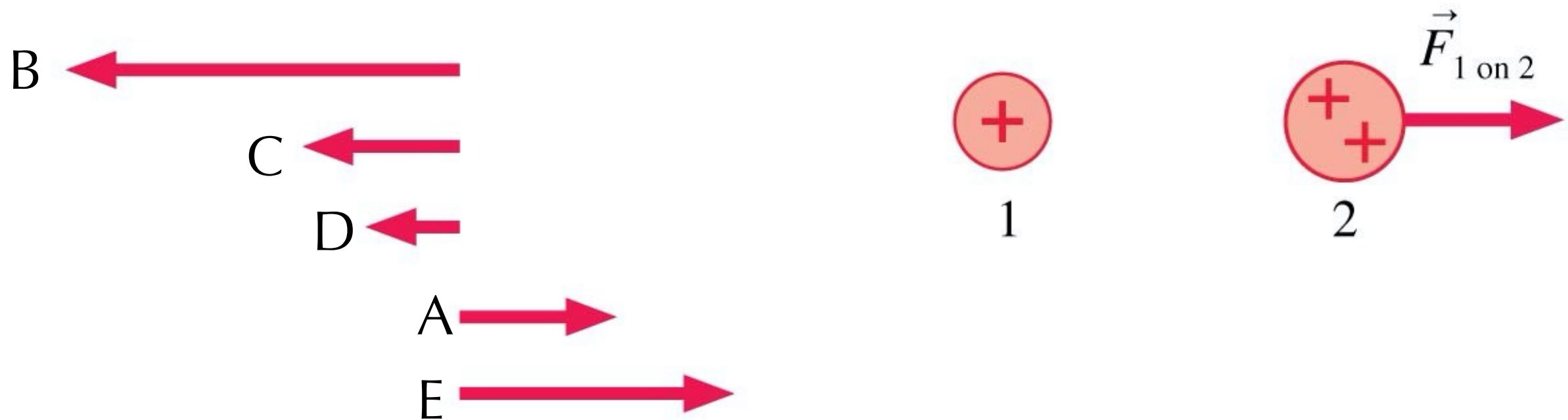
$-Q$



$-q$

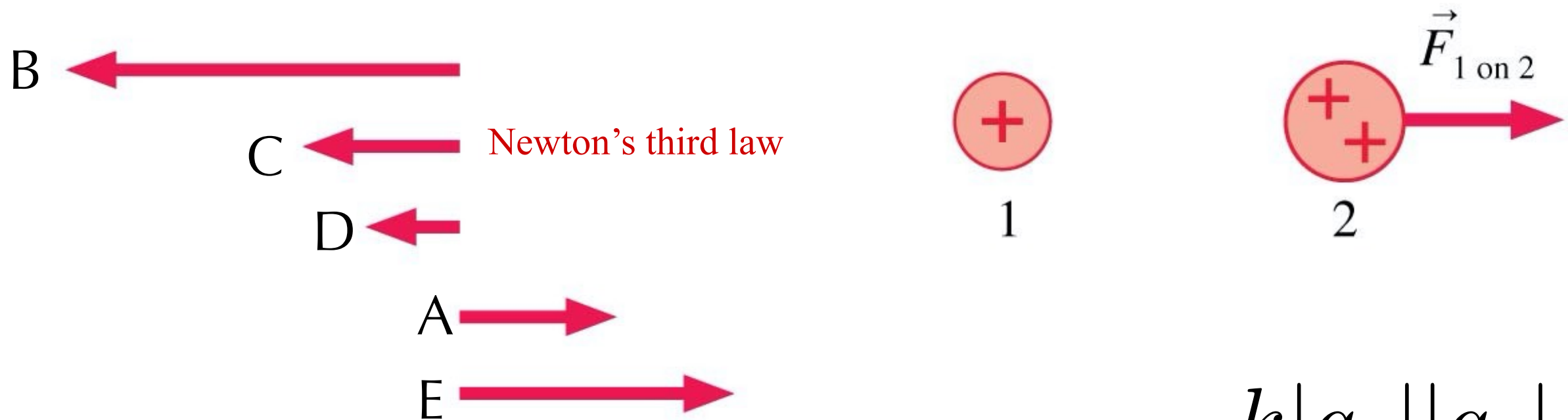
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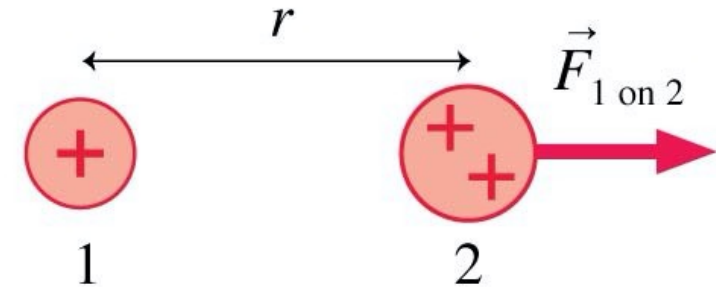
$$F = \frac{k|q_1||q_2|}{r^2}$$



## Question #23




The charge of sphere 2 is twice that of sphere 1.  
Which vector below shows the force of 1 on 2  
if the distance between the spheres is reduced to  $r/2$ ?

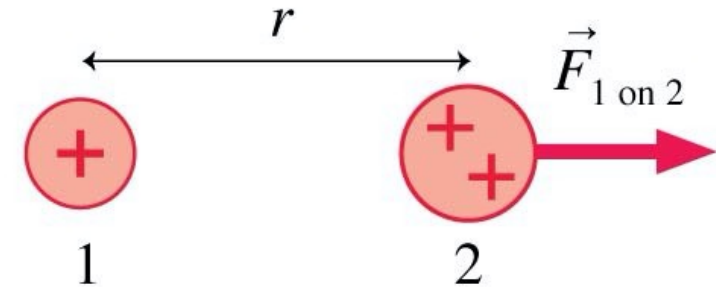
- B   $1/2$
- C  same
- D  double
- E - None of the above



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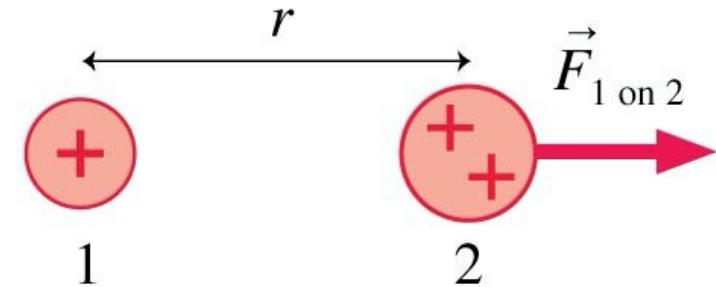


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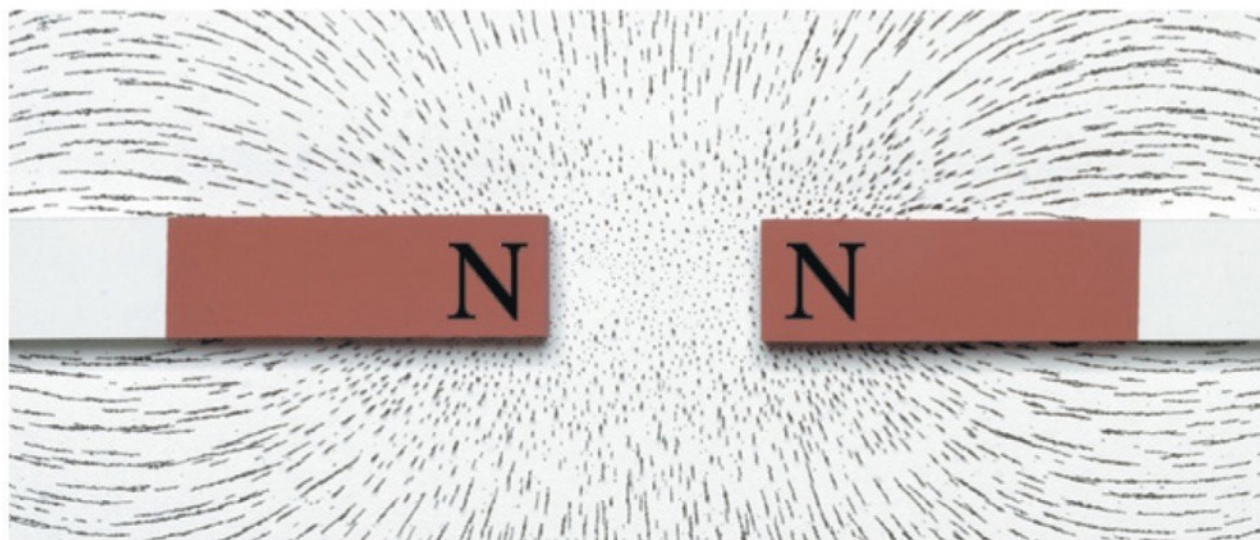


At half the distance, the force is four  
times as large: 

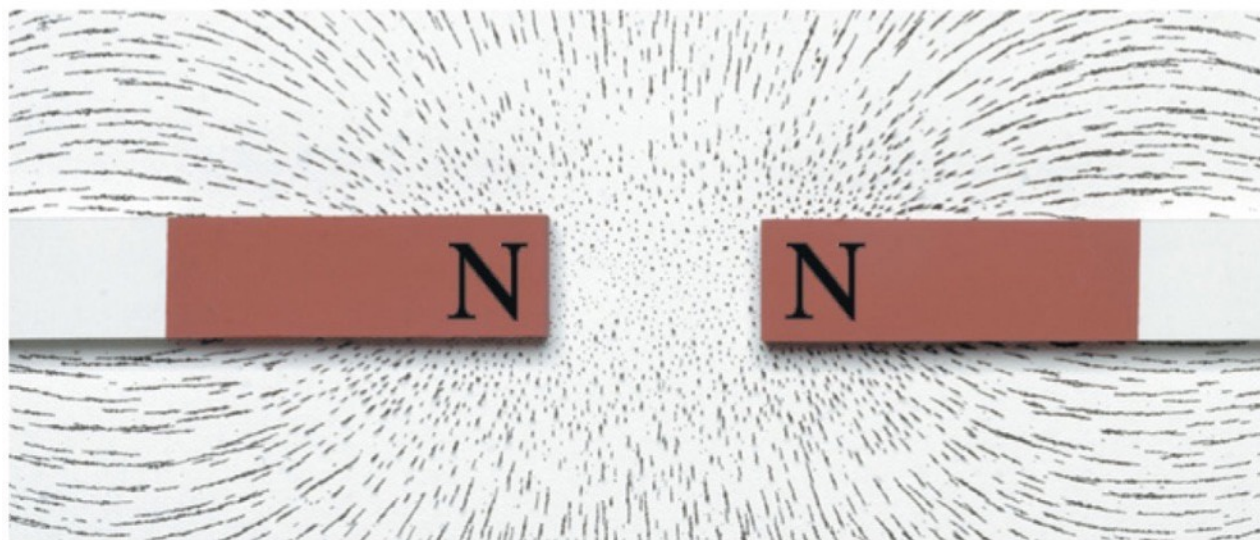
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# The Electric Field



# The Electric Field



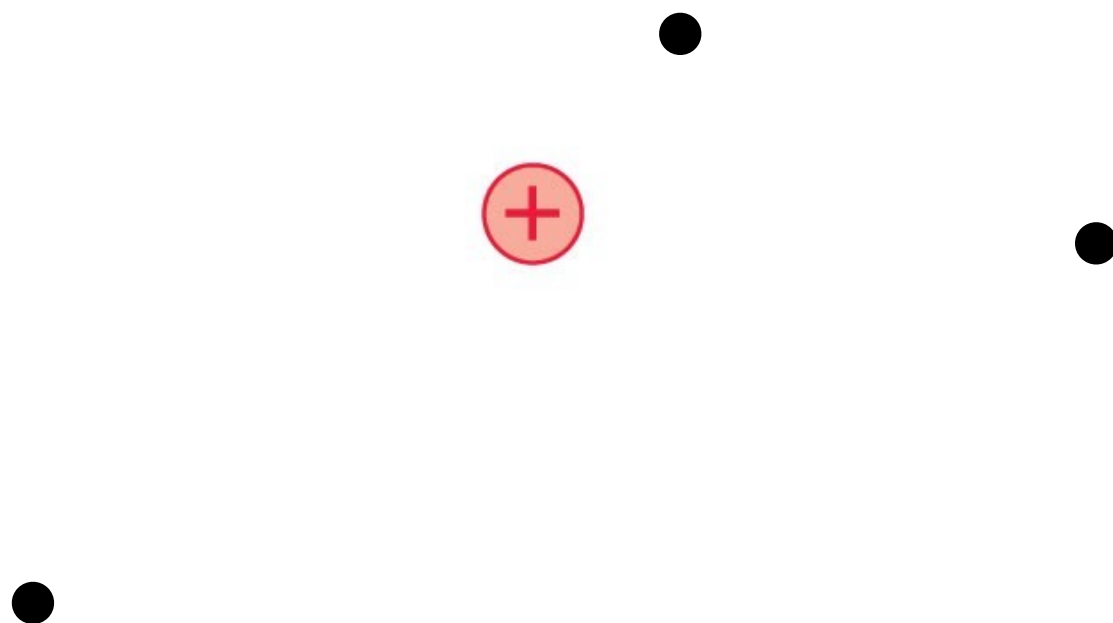
Key question: If you took the iron filings away, would there still be something different about the region of space that they used to occupy?



## From Math class

Field: A function which assigns a vector to every point in space.

But what does the vector represent?



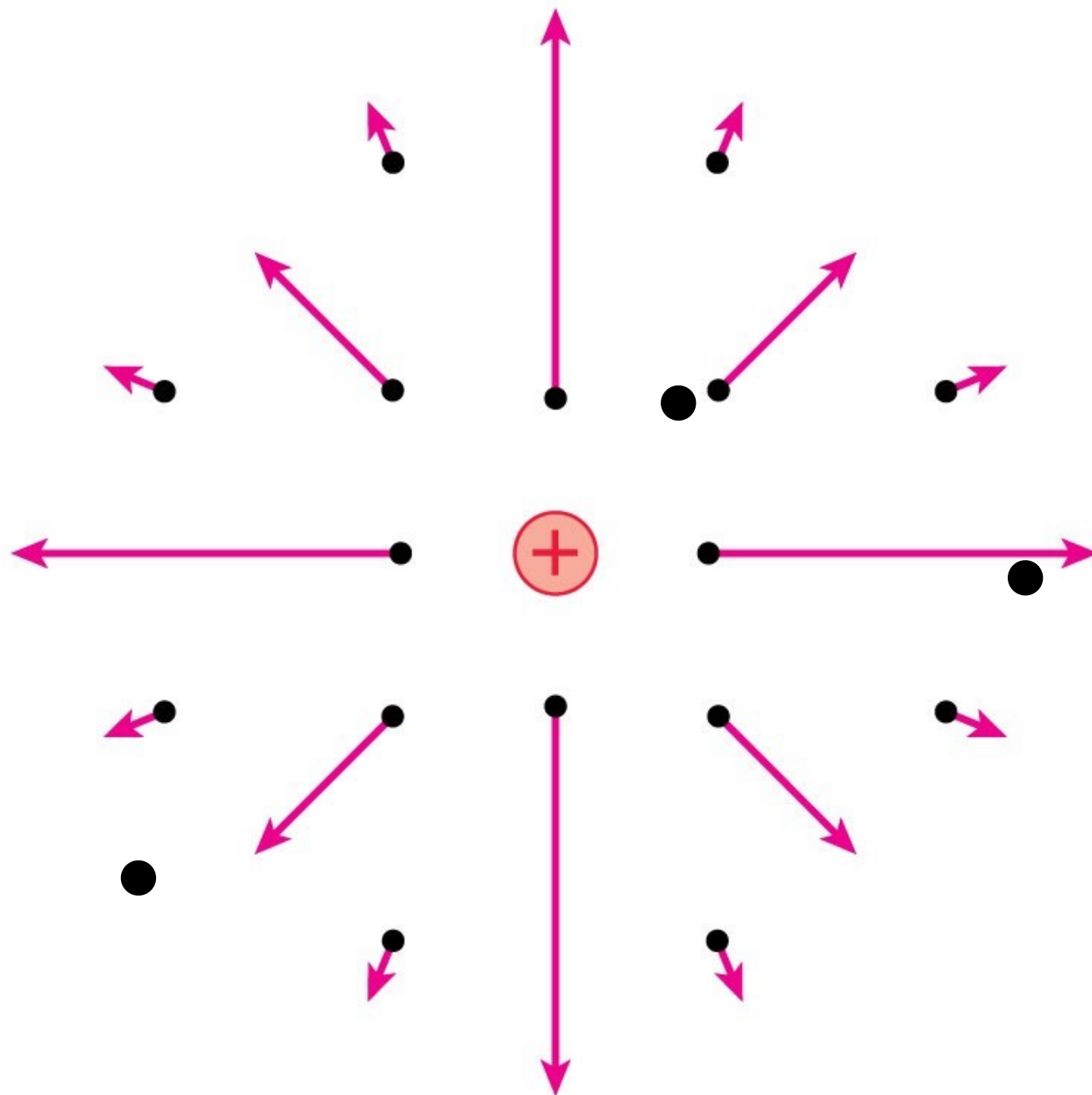
Draw the force vector that a proton would experience if it were there.

$$\vec{E} = \frac{\vec{F}}{q_1} \hat{r}$$

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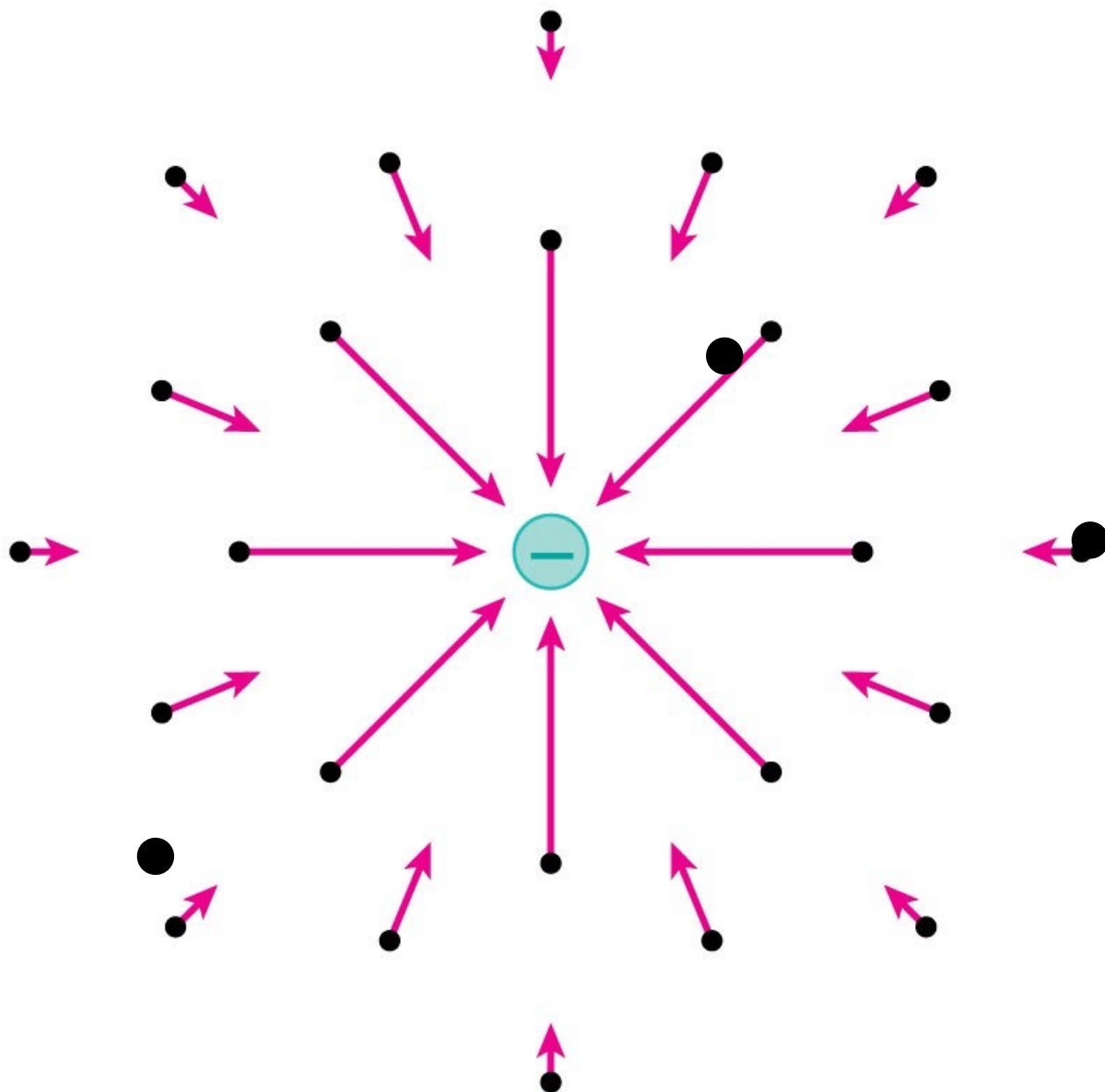
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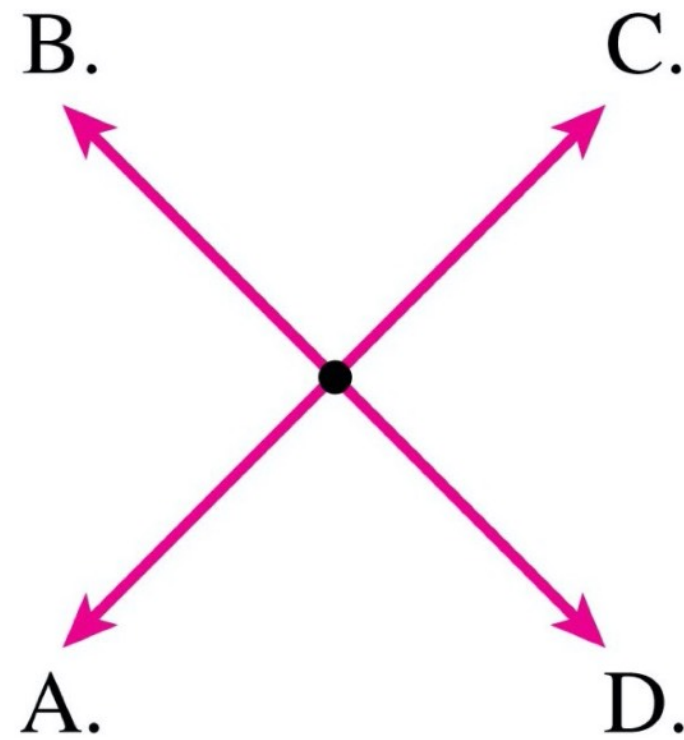


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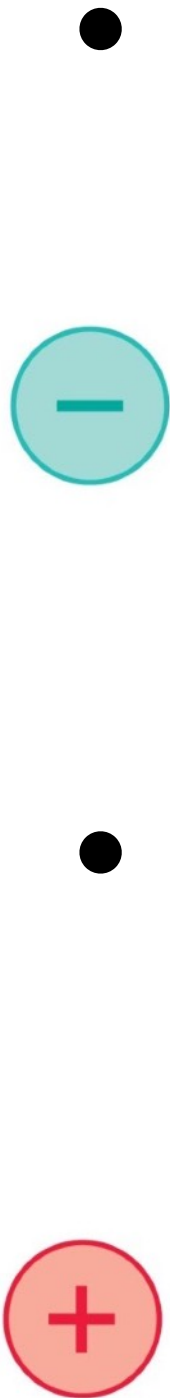
## Question #24

Which is the electric field at the dot?



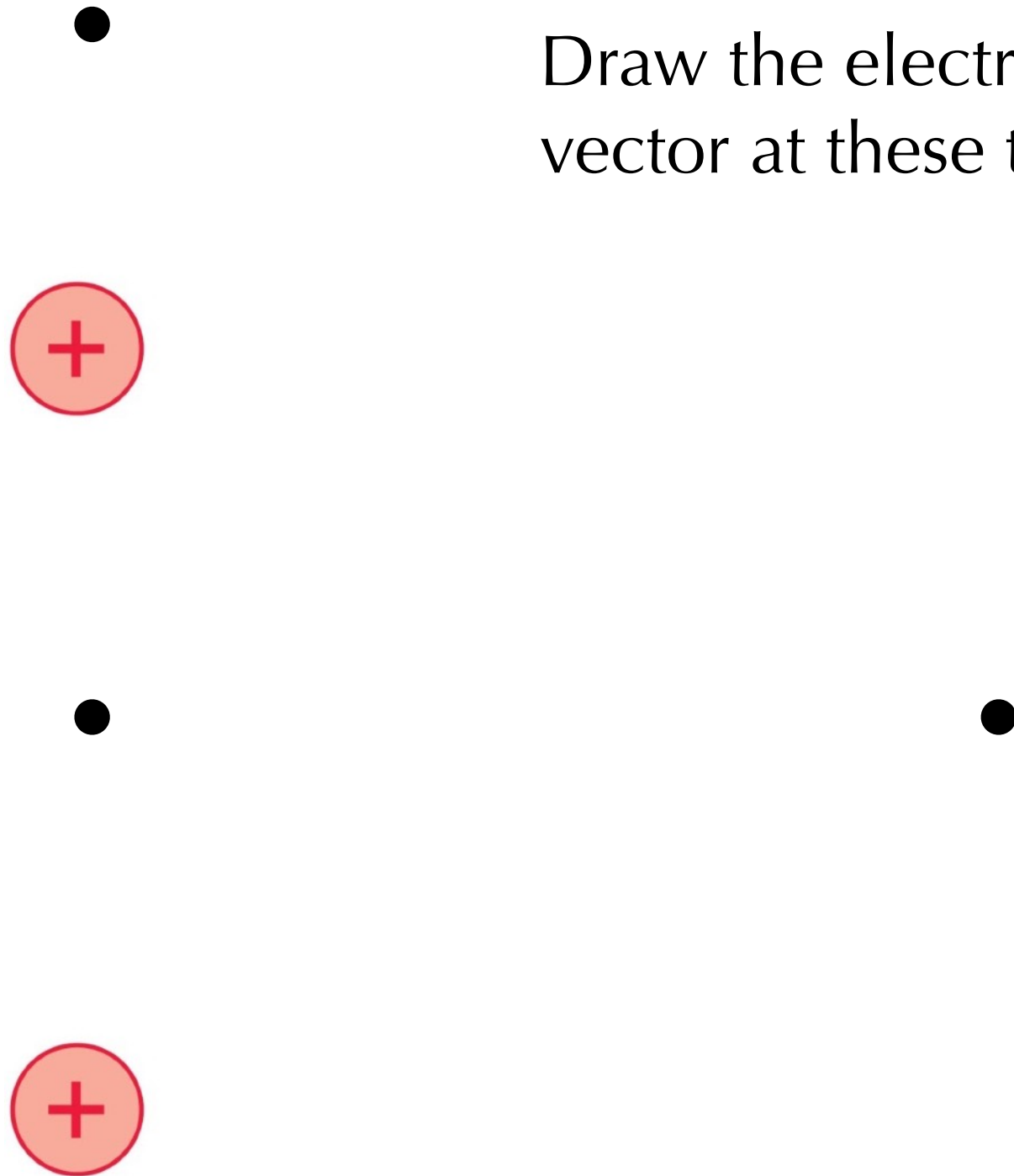
$$\vec{E} = \frac{kQ}{r^2} \hat{r}$$

Draw the electric field vector at these three points.



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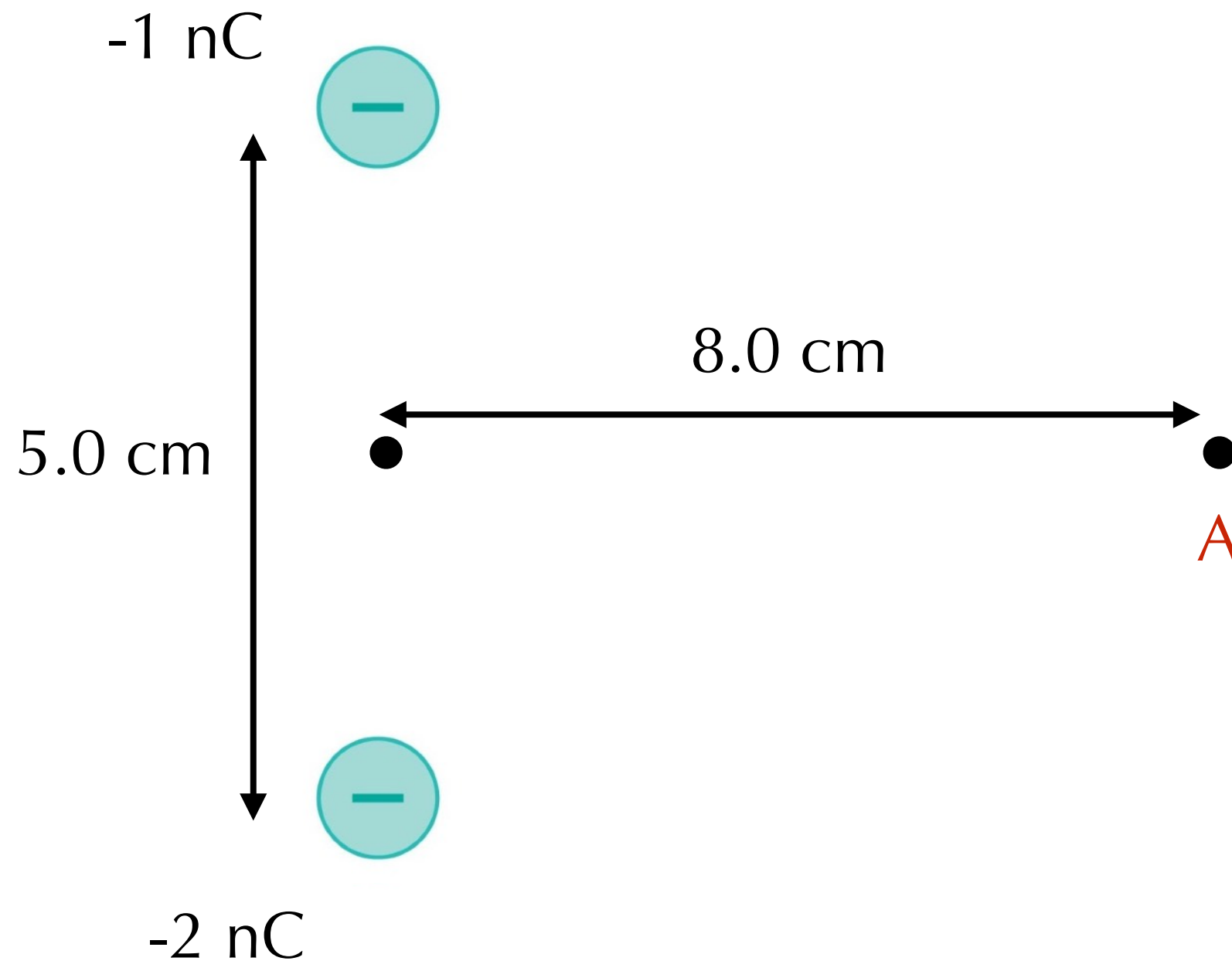
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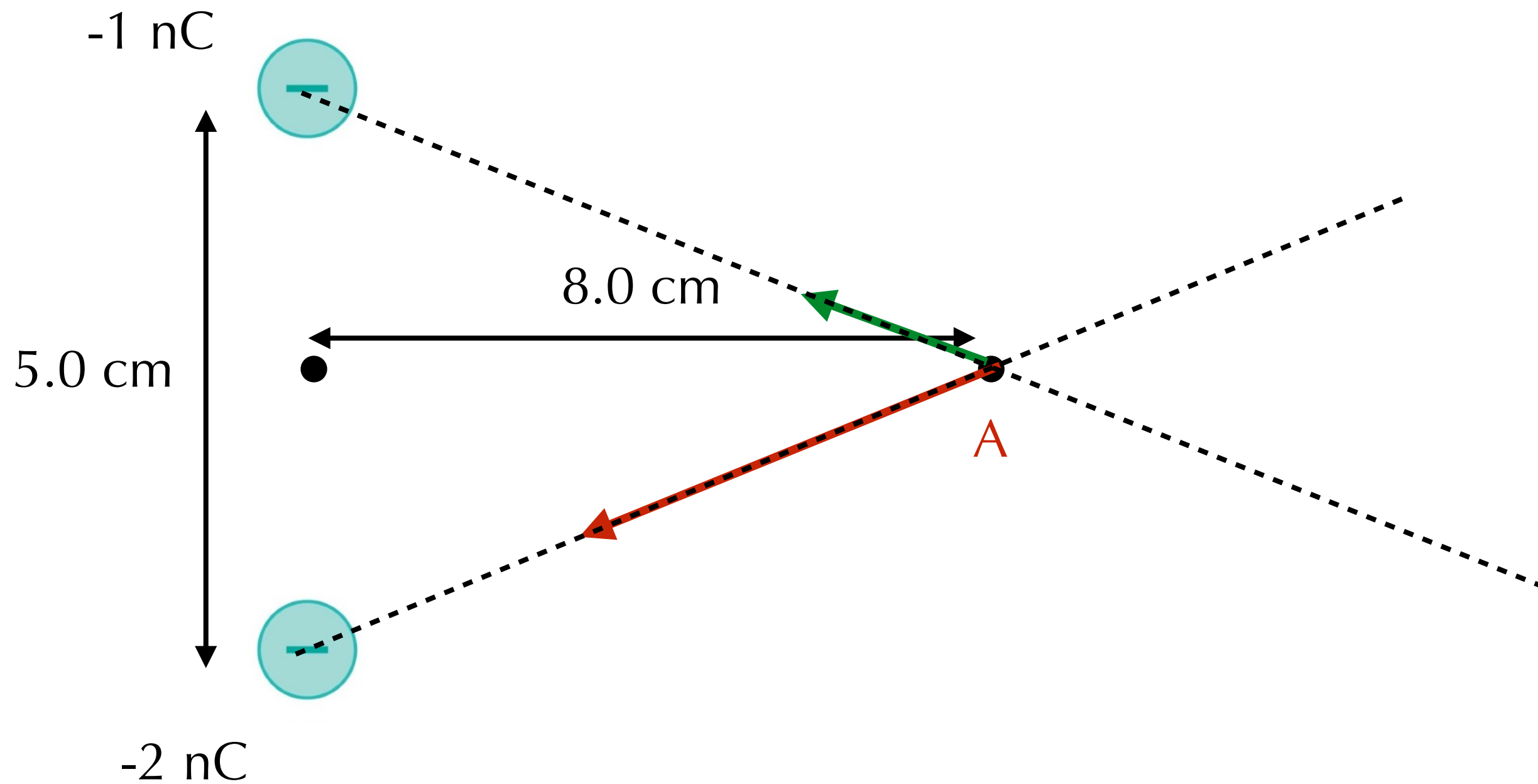


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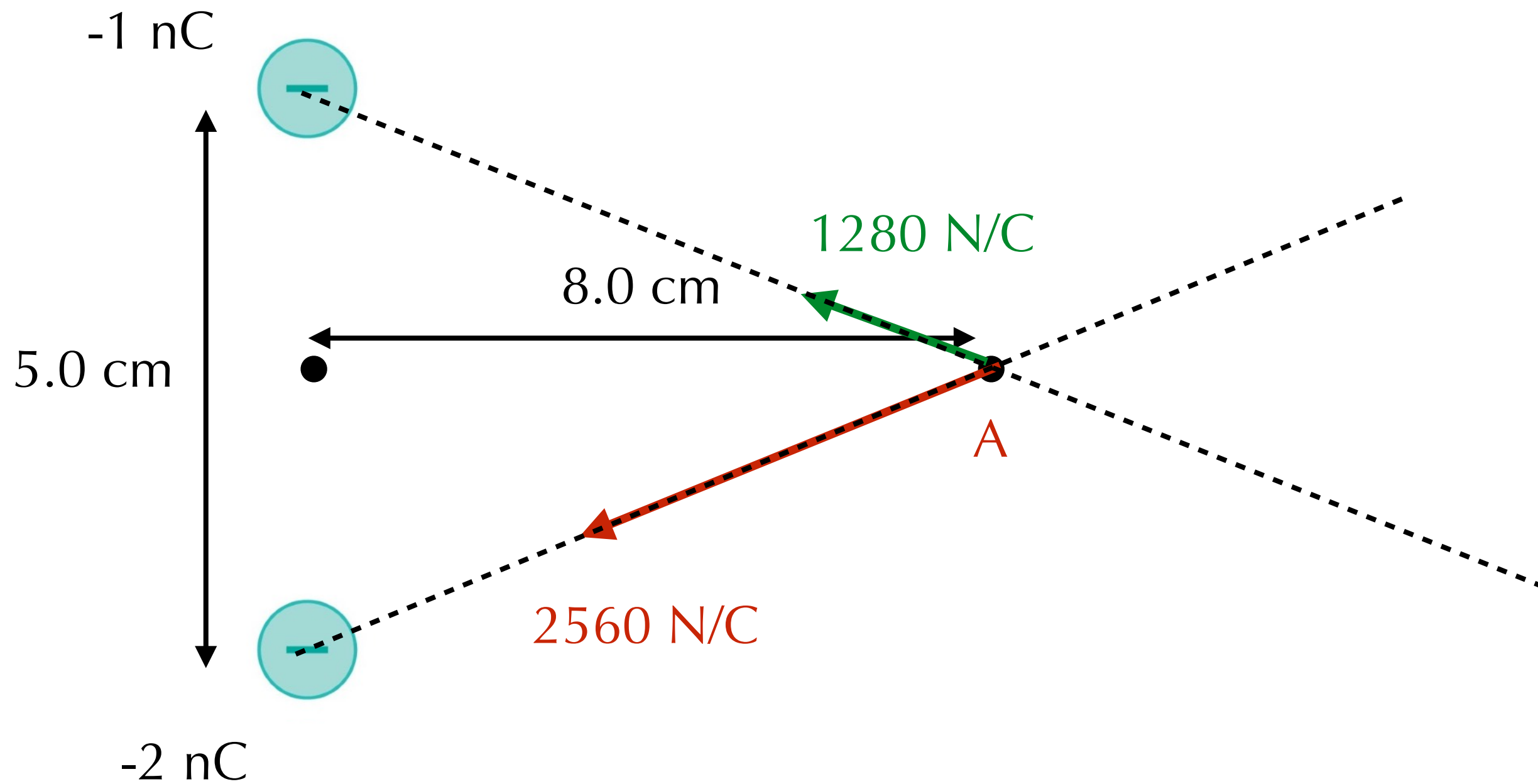
Find the magnitude and direction of the electric field at point A.

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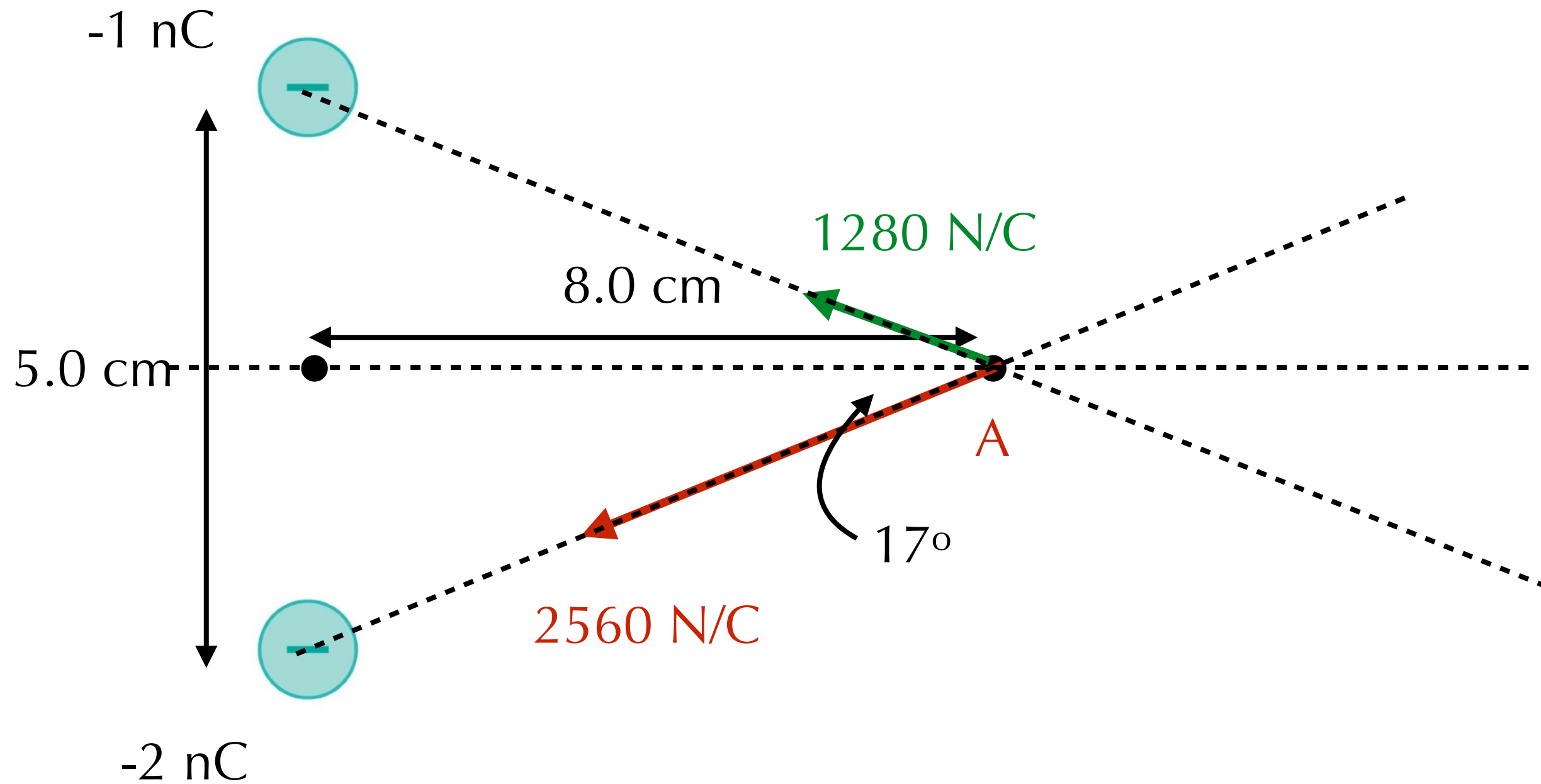
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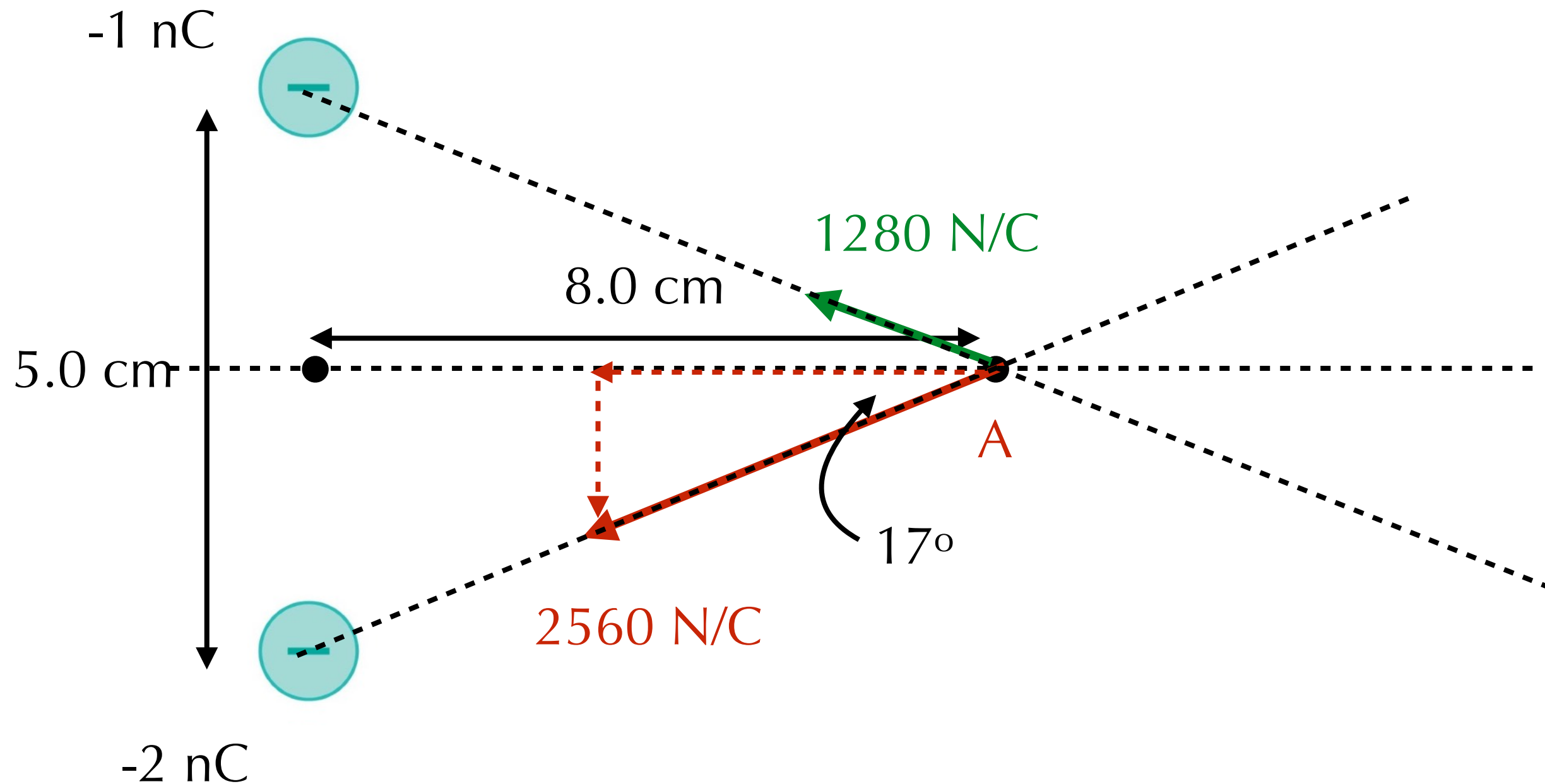
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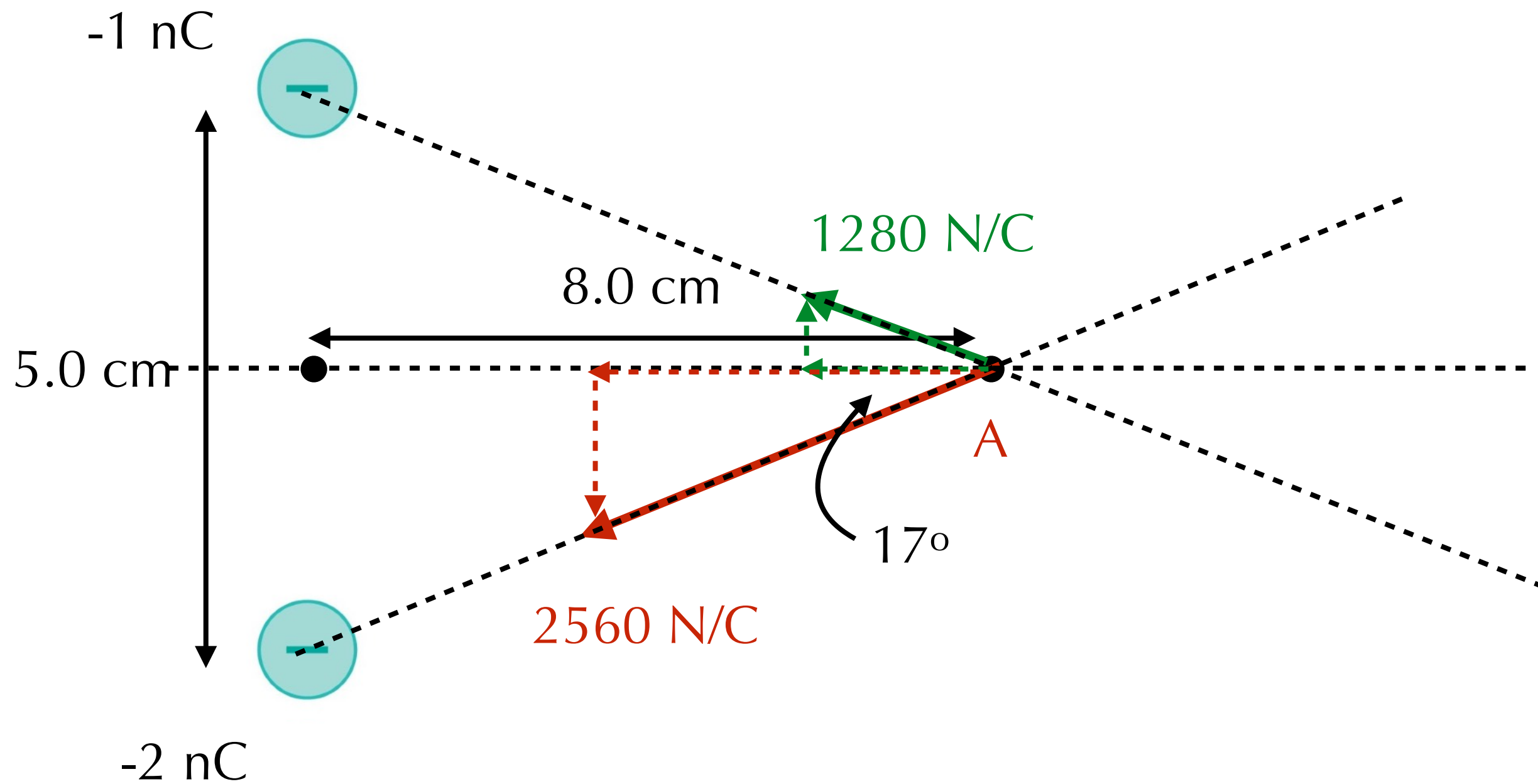
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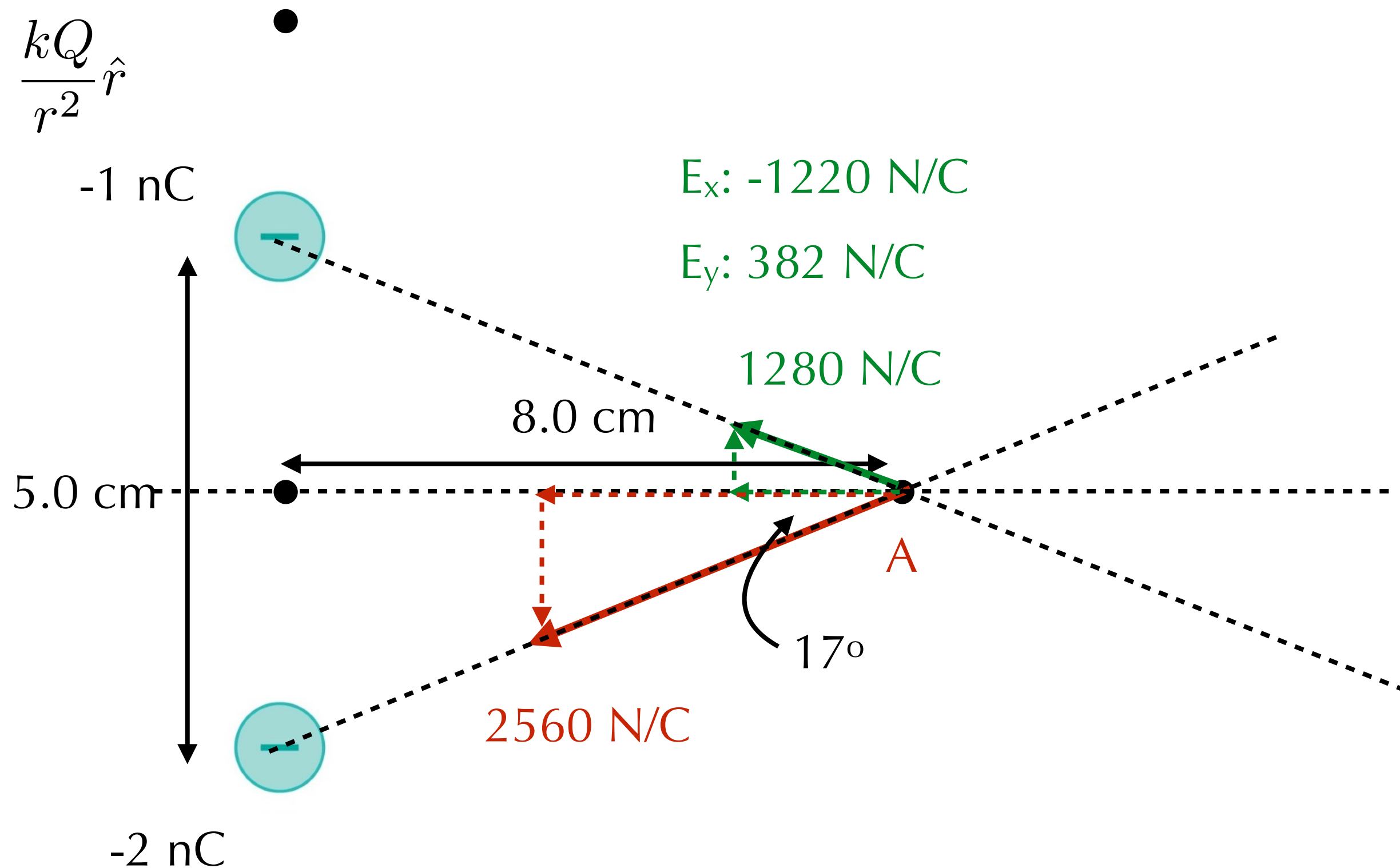
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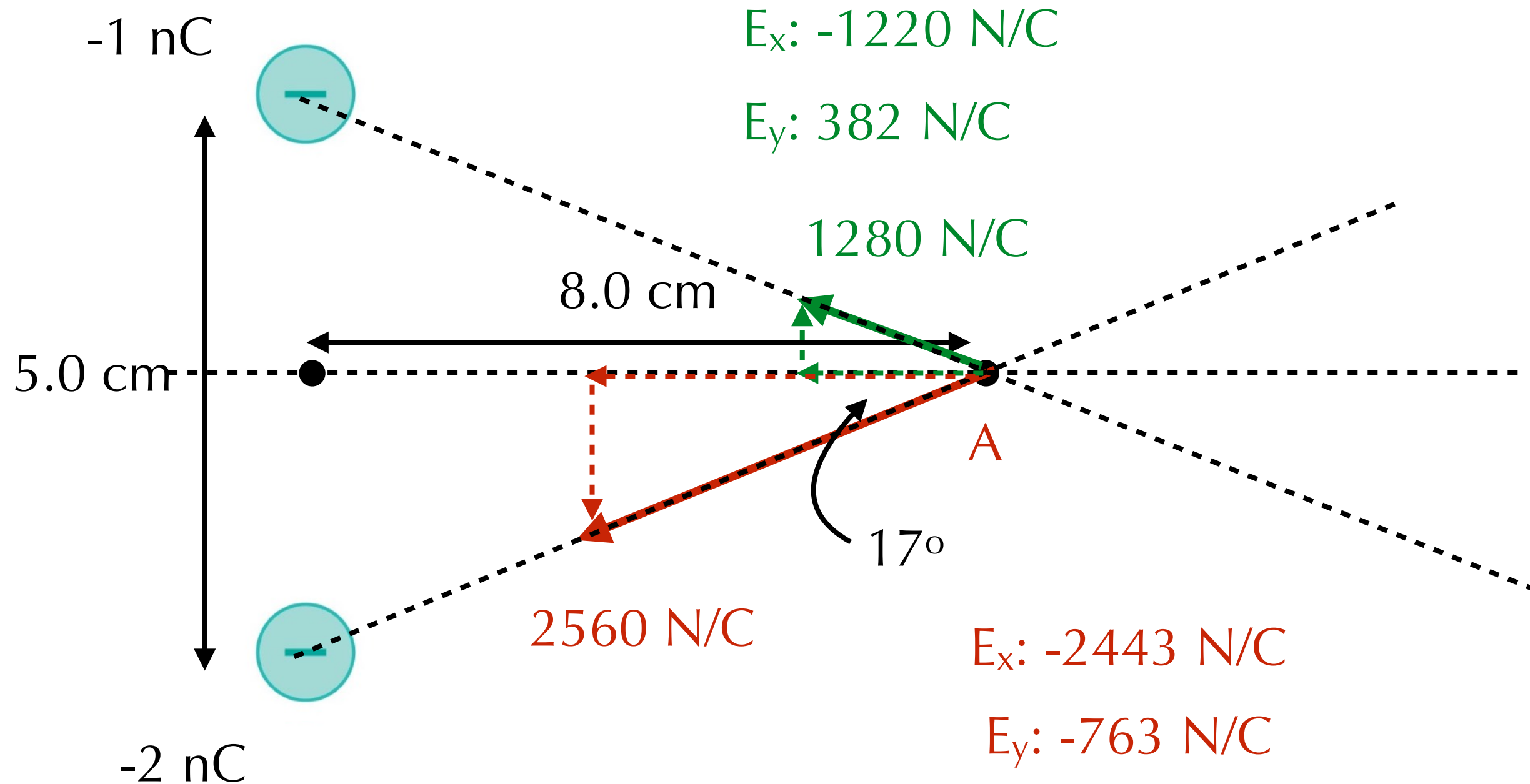


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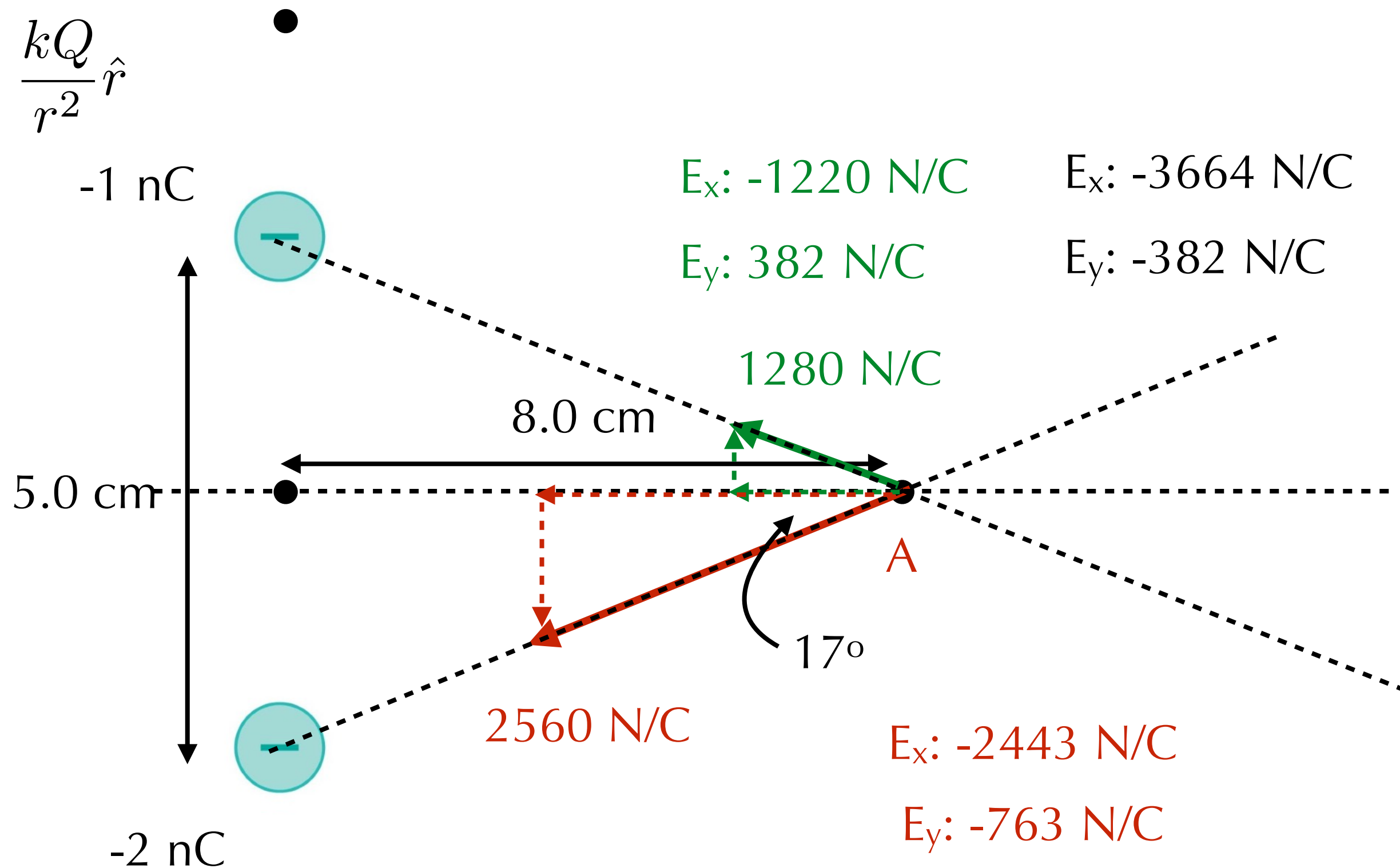
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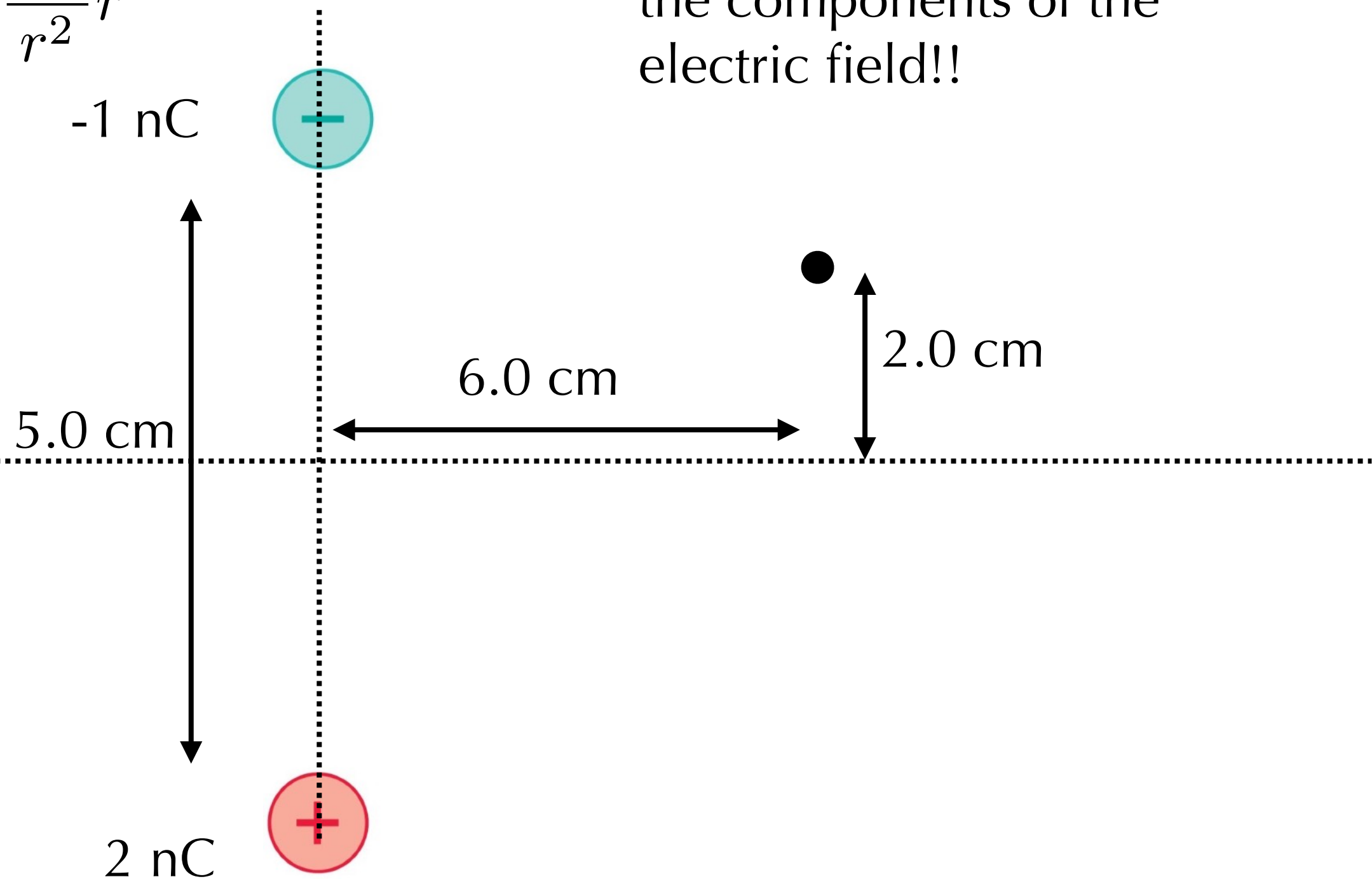
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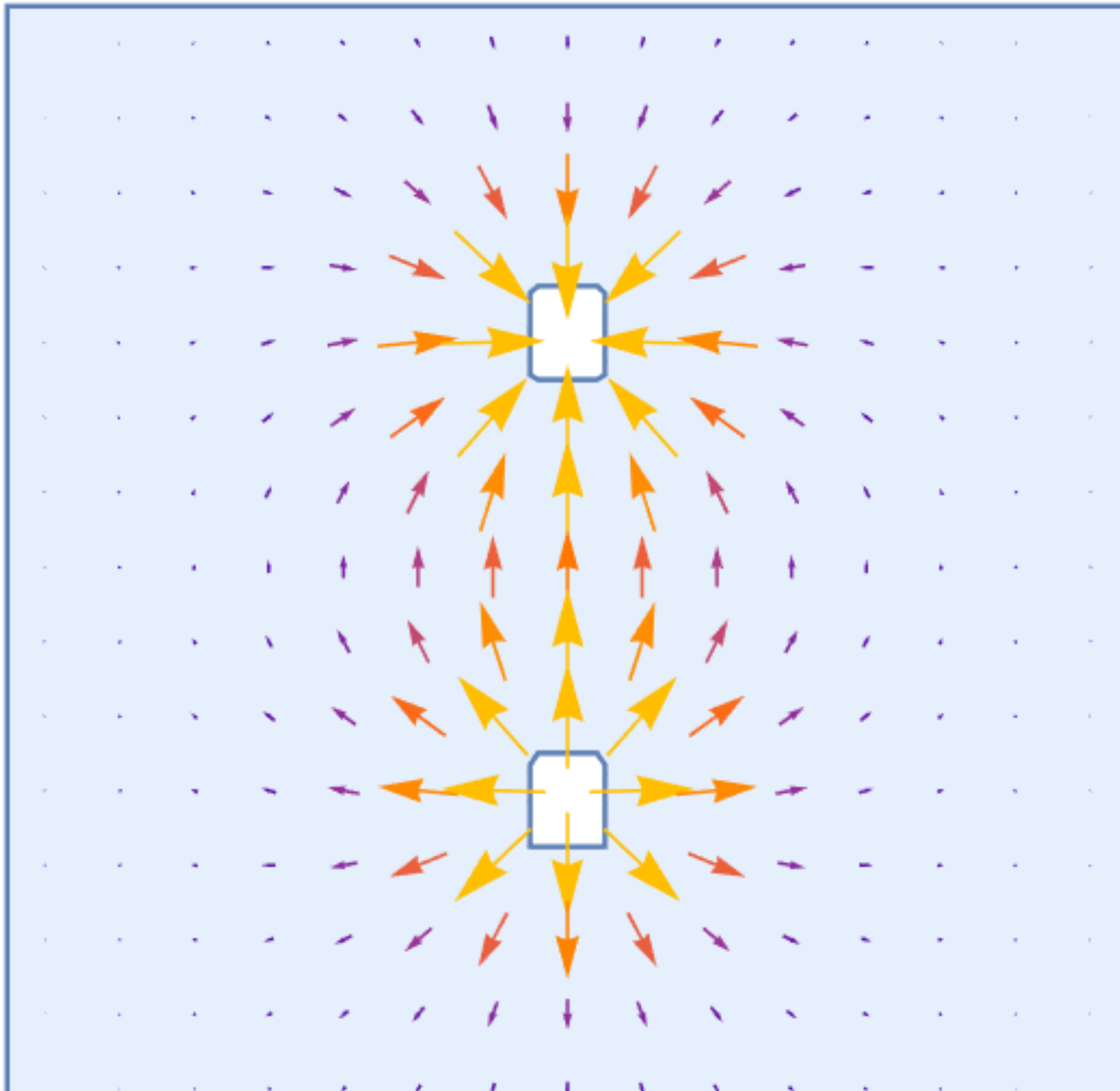


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Modify your code to find  
the components of the  
electric field!!





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e

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