Jan 7

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Tangible: Building intuition for *E* field Tangible - WebAssign Electric Force & Field Activities

what?

$$V = \frac{5}{\sqrt{x^2+y^2}}$$

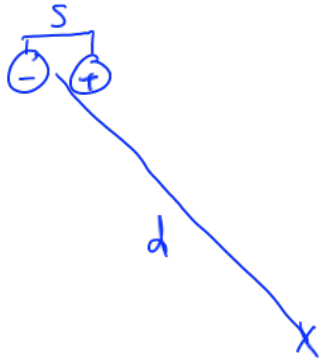
$$\vec{E} = -\vec{\nabla} V$$

$$= -\left(\hat{x}\frac{\partial}{\partial x} + \hat{y}\frac{\partial}{\partial y} + \hat{z}\frac{\partial}{\partial z}\right) V$$

Tangible: Superposition principle

Net electric field at a location in space is the vector sum of the individual fields by all charges located elsewhere.

Discussion: Dipole



$d >> s$

$$\vec{E}_1 = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r^2}\hat{r}$$

↑ for single particle

On dipole axis exact:

$$\vec{E}_1 = \left\langle \frac{1}{4\pi\varepsilon_0} \frac{2qsr}{\left(r-\frac{s}{2}\right)^2\left(r+\frac{s}{2}\right)^2}, 0, 0 \right\rangle$$

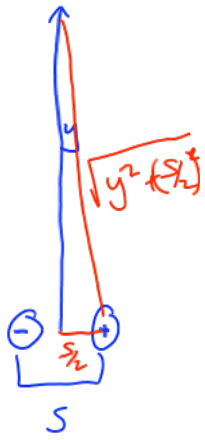
On axis approximation

$$\vec{E}_1 = \left\langle \frac{1}{4\pi\varepsilon_0} \frac{2qs}{r^3}, 0, 0 \right\rangle \qquad r >> s$$

↳ drops like $\frac{1}{r^3}$

On dipole bisector exact:

$$\vec{E}_2 = \frac{1}{4\pi\varepsilon_0}\frac{qs}{\left[\left(\frac{s}{2}\right)^2 + y^2\right]^{3/2}}\langle -1,0,0\rangle$$



On bisector approximation:

$$\vec{E}_2 = \left\langle \frac{-1}{4\pi\varepsilon_0}\frac{qs}{r^3},0,0 \right\rangle \text{ at } \langle 0,r,0\rangle$$

$y \gg s$

↳ drops like $\frac{1}{r^3}$

Discussion: Electric Dipole Moment

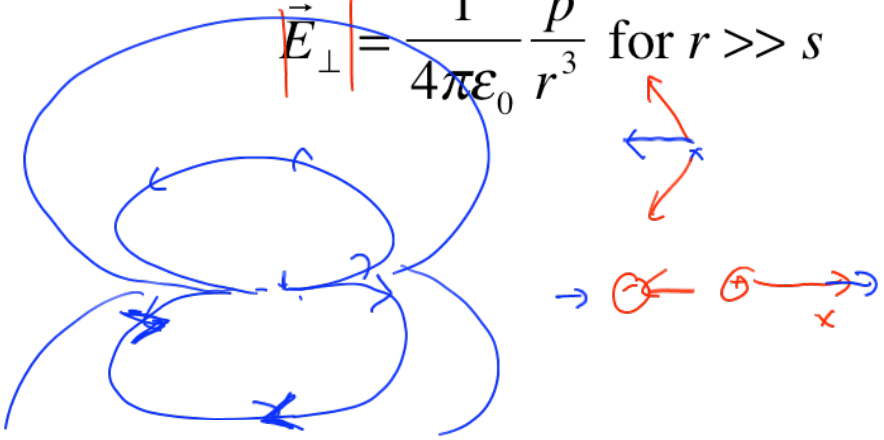
$p = qs$ |charge| x displacement vector from negative to positive charge

On axis approximation

$$\left|\vec{E}_{\text{axis}}\right| = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3} \text{ if } r >> s$$

On bisector approximation

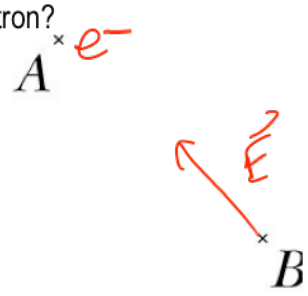
$$\left|\vec{E}_{\perp}\right| = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^3} \text{ for } r >> s$$

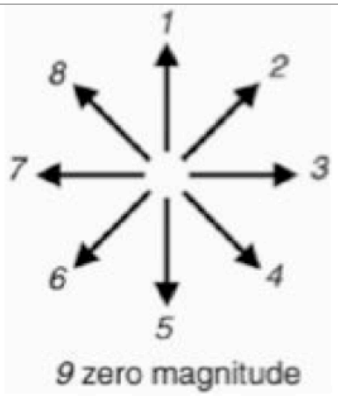


Clicker questions:

Q1

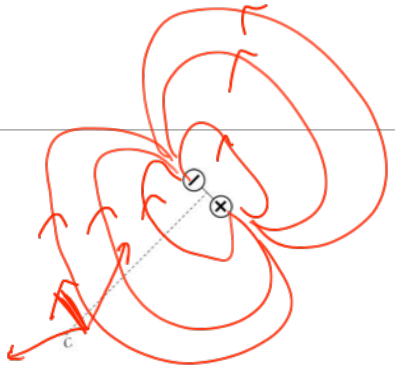
An electron is placed at location *A*. What is the direction of the electric field at location B, due to the electron?



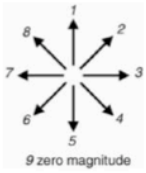


A. 2
B. 4
C. 6
D. 8
E. 9

Q2

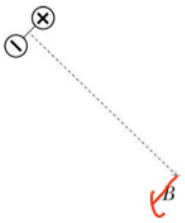


What is the direction of the electric field at location C, due to the dipole?

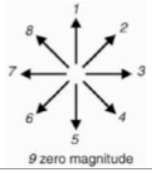


A. 2
B. 4
C. 6
D. 8
E. 9

Q3

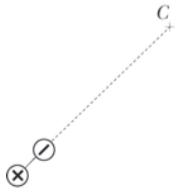


An alpha particle (He^{+2}) is placed at location *B*. What is the direction of the force on the alpha particle?

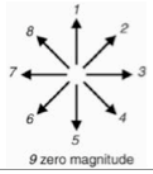


A. 2
B. 4
C. 6
D. 8
E. 9

Q4



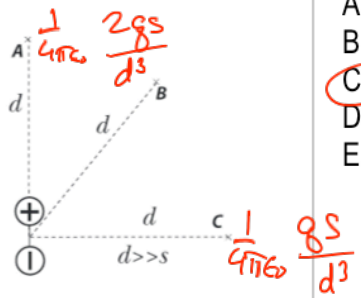
An chloride ion (Cl^-) is placed at location *C*. What is the direction of the force on the chloride ion?



A. 2
B. 4
C. 6
D. 8
E. 9

Q5

In the following image,
$s = 2 \times 10^{-10}$ m and
$d = 3 \times 10^{-6}$ m.

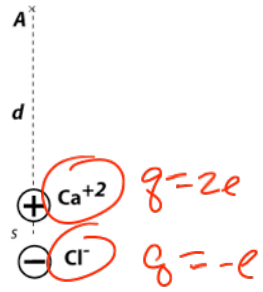


At which locations is the magnitude of the electric field approximately $\frac{1}{4\pi\varepsilon_0}\frac{qs}{d^3}$?

A) A
B) B
C) C
D) A and C
E) A and B and C

Q6

In the following image,
$s = 2 \times 10^{-10}$ m and $d = 3 \times 10^{-6}$ m.



$q = 2e$

$q = -e$

Not a dipole

What is the magnitude of the electric field at location *A*?

A) $\frac{1}{4\pi\varepsilon_0}\frac{es}{d^3}$

B) $\frac{1}{4\pi\varepsilon_0}\frac{2es}{d^3}$

C) None of the above

Tangible: Dipole field in the classroom