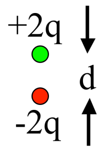
3.27

$$\vec{p} = \sum_i q_i \vec{r}_i$$

What is the magnitude of the dipole moment of this charge distribution?

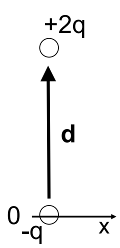


A) qd
B) 2qd
C) 3qd
D) 4qd
E) It's not determined

(To think about: How does V(**r**) behave as |r| gets large?)

MD6.1

$$\vec{p} = \sum_i q_i \vec{r}_i$$

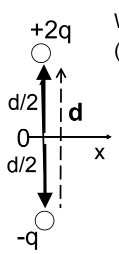


What is the dipole moment of this system?
(Note: it is NOT overall neutral!)

A) $q\vec{d}$
B) $2q\vec{d}$
C) $\frac{3}{2}q\vec{d}$
D) $3\,q\vec{d}$
E) Something else (or, not defined)!

MD6.1

$$\vec{p} = \sum_i q_i \vec{r}_i$$



What is the dipole moment of this system?
(Note: same as last question, just shifted in z!)

A) $q\vec{d}$
B) $2q\vec{d}$
C) $\frac{3}{2}q\vec{d}$
D) $3\,q\vec{d}$
E) Something else (or, not defined)!

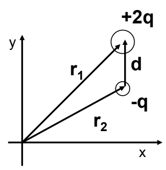
MD6 - 3

For a collection of point charges, the dipole moment is defined as

$$\vec{p} = \sum_i q_i \vec{r}_i$$

Consider the two charges, +2q and –q, shown. Which statement is true?

A) The dipole moment is independent of the origin.
B) The dipole moment depends on the position of the origin.
C) The dipole moment is zero.
D) The dipole moment is undefined.



3.22 c

You have a physical dipole, +q and -q a finite distance d apart.
When can you use the expression:

$$V(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\frac{\vec{p}\cdot\hat{r}}{r^2}$$

A) This is an exact expression everywhere.

B) It's valid for large r

C) It's valid for small r

D) ?

3.22 d

You have a physical dipole, +q and -q, a finite distance d apart.
When can you use the expression

$$V(r) = \frac{1}{4\pi\varepsilon_0}\sum \frac{q_i}{\mathfrak{R}_i}$$

A) This is an exact expression everywhere.

B) It's valid for large r

C) It's valid for small r

D) ?

3.22
b

$$\vec{\mathbf{E}}(\vec{r}) = \frac{p}{4\pi\varepsilon_0 r^3}\left(2\cos\theta\,\hat{\mathbf{r}} \;+\; \sin\theta\,\vec{\theta}\right)$$

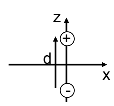
Sketch this E field…

MD6 - 2

For a dipole at the origin pointing in the z-direction, we have derived

$$\vec{\mathbf{E}}_{dip}(\vec{r}) = \frac{p}{4\pi\varepsilon_0 r^3}\left(2\cos\theta\,\hat{\mathbf{r}} \;+\; \sin\theta\,\hat{\theta}\right)$$

For the dipole **p** = q **d** shown, what does the formula predict for the direction of **E**(**r**=0)?



A) Down B) Up C) some other direction

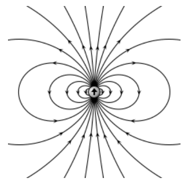
D) The formula doesn't apply.

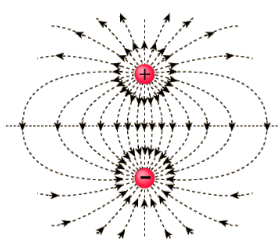
3.22
b

An ideal dipole (tiny dipole moment p=qd) points in the z direction.

We have derived $\vec{\mathbf{E}}(\vec{r}) = \frac{p}{4\pi\varepsilon_0 r^3}\left(2\cos\theta\,\hat{\mathbf{r}} \;+\; \sin\theta\,\vec{\theta}\right)$

(What would change if the dipole separation d was not so tiny?)





3.23

Griffiths argues that the force *on* a dipole in an E field is: $\vec{\mathbf{F}} = (\vec{\mathbf{p}} \bullet \vec{\nabla})\vec{\mathbf{E}}$

If the dipole **p** points in the z direction, what direction is the force?

A) Also in the z direction
B) perpendicular to z
C) it could point in any direction

3.24

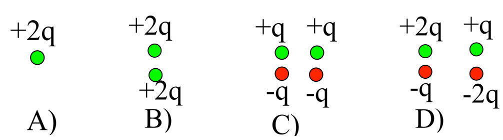
Griffiths argues that the force *on* a dipole in an E field is: $\vec{\mathbf{F}} = (\vec{\mathbf{p}} \bullet \vec{\nabla})\vec{\mathbf{E}}$

If the dipole **p** points in the z direction, what can you say about **E** if I tell you the force is in the x direction?

A) **E** simply points in the x direction
B) Ez must depend on x
C) Ez must depend on z
D) Ex must depend on x
E) Ex must depend on z

3.25

Which charge distributions below produce a potential which looks like C/r² when you are far away?

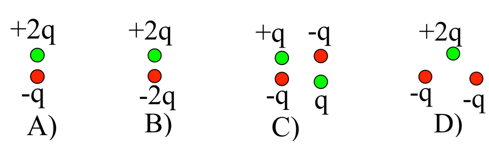


E) None of these, or *more* than one of these!

(Note: for any which you did not select, how DO they behave at large r?)

3.26

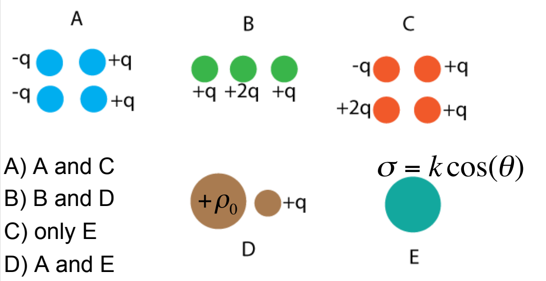
Which charge distributions below produce a potential which looks like C/r² when you are far away?



E) None of these, or *more* than one of these!

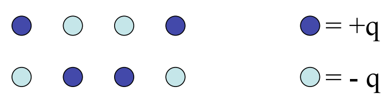
(Note: for any which you did not select, how DO they behave at large r?)

3.28 In which situation is the dipole term the leading non-zero contribution to the potential?



A) A and C
B) B and D
C) only E
D) A and E
E) Some other combo

3.29 In terms of the multipole expansion V(r) = V(mono) + V(dip) + V(quad) + … the following charge distribution has the form:



A) V(r) = V(mono) + V(dip) + higher order terms
B) V(r) = V(dip) + higher order terms
C) V(r) = V(dip)
D) V(r)=only higher order terms than dipole
E) No higher terms, V(r)=0 for this one.

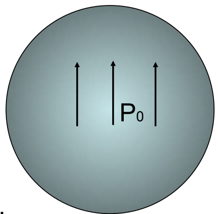
Let me know how far along you are:

A) DONE with page 1
B) DONE with page 2
C) DONE with page 3!

4.1 alt

The sphere below (radius a) has uniform polarization $\mathbf{P}_0$ (which points in the z direction.)

What is the total dipole moment of this sphere?

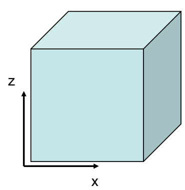


A) zero
B) $P_0 a^3$
C) $4\pi a^3 P_0/3$
D) P_0
E) None of these/must be more complicated

4.1

The cube below (side a) has uniform polarization $\mathbf{P}_0$
(which points in the z direction.)

What is the total dipole moment of this cube?



A) zero
B) $a^3 \mathbf{P}_0$
C) $\mathbf{P}_0$
D) $\mathbf{P}_0 /a^3$
E) $2 \mathbf{P}_0 a^2$