








Which charge distributions below produce a "dipole like" potential when you are far away?

+2q  






A)

+2q  
  
  
+2q

B)

+q   +q  
   
   
-q   -q

C)

+2q   +q  
   
   
-q   -2q

D)

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


(For any which you did not select, how DO they behave at large  $r$ ?)

# **PHY 905 SEC 005 UPDATE**

## **SURVEY OF PHYSICS EDUCATION RESEARCH (3 CREDITS)**

- Will count as capstone for Physics and Astronomy majors
- Will count as Tier-2 Writing Requirement
- Need override to be enrolled
- See Jenn Roberts to get enrolled in class
- Make appointment with Stuart Tessmer for class to count as capstone



Which charge distributions below produce a potential that looks like  $\frac{C}{r^2}$  when you are far away?

+2q  




A)

+2q  
  
+2q

B)

+q +q  
  
  
-q -q

C)

+2q +q  
  
  
-q

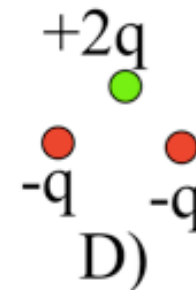
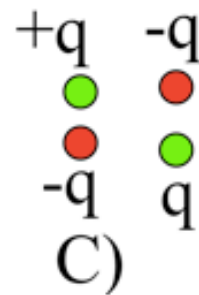
D)

+q  
  
  
-2q

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

(For any which you did not select, how DO they behave at large  $r$ ?)

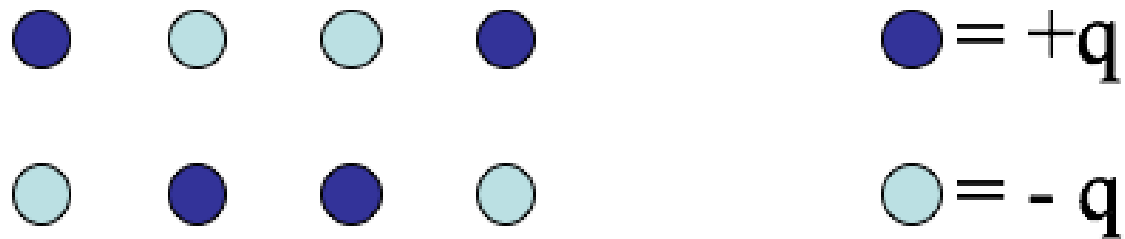
Which charge distributions below produce a potential that looks like  $\frac{C}{r^2}$  when you are far away?



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

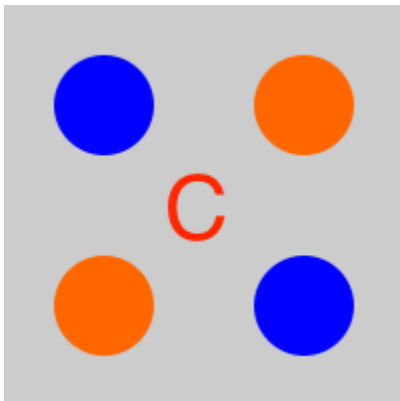
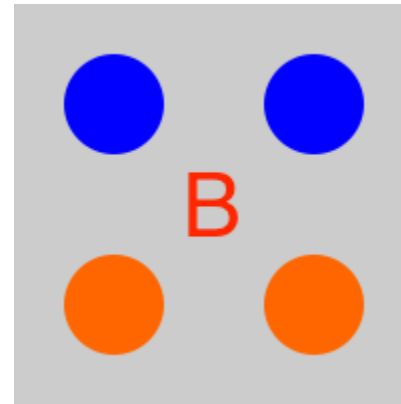
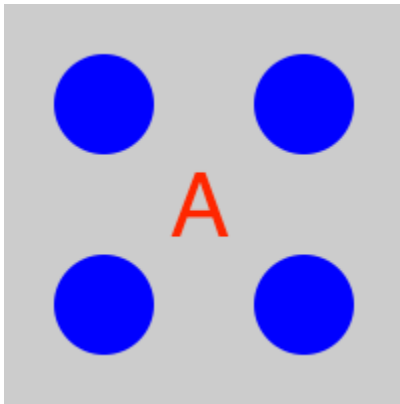
(For any which you did not select, how DO they behave at large  $r$ ?)

In terms of the multipole expansion  
 $V(r) = V(\text{mono}) + V(\text{dip}) + V(\text{quad}) + \dots$ , the  
following charge distribution has the form:



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

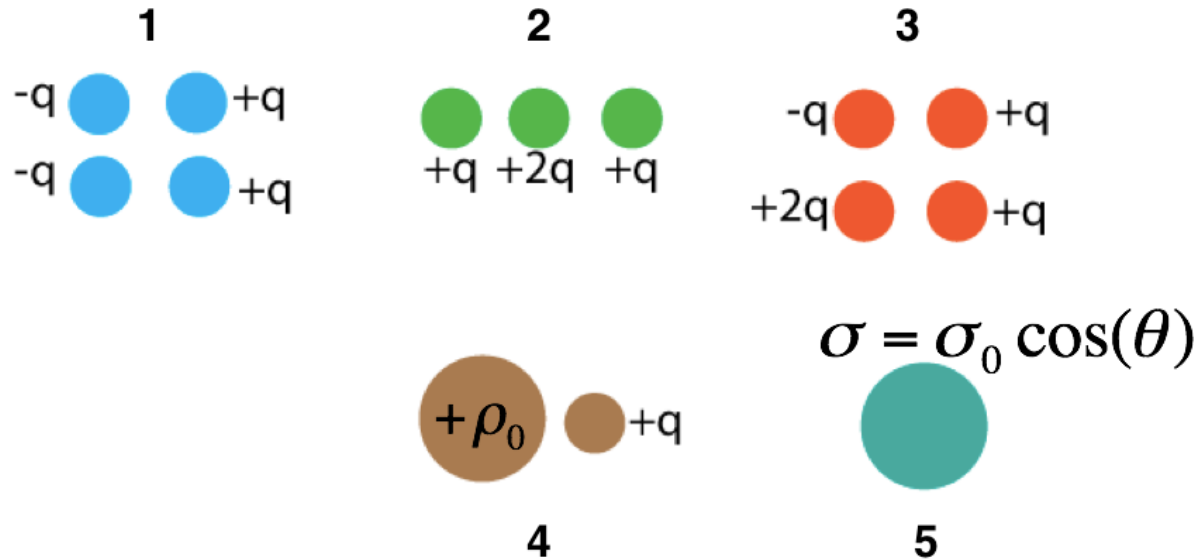
Which of the following distributions could have a dipole contribution to the potential far from the charges?



D. None

E. More than one!

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



- A. 1 and 3
- B. 2 and 4
- C. only 5
- D. 1 and 5
- E. Some other combo

Consider a single point charge at the origin. It will have ONLY a monopole contribution to the potential at a location

$$\mathbf{r} = \langle x, y, z \rangle.$$

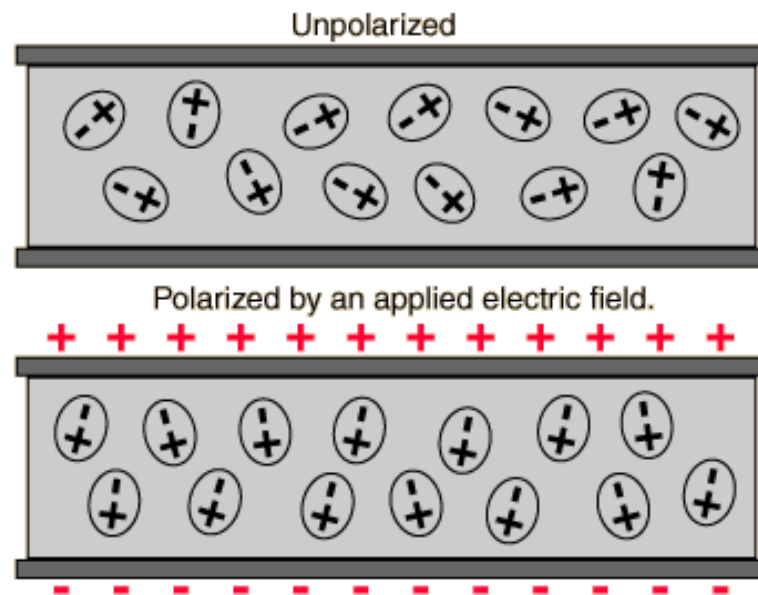
As we have seen, if we move the charge to another location (e.g.,  $\mathbf{r}' = \langle 0, 0, d \rangle$ ), the distribution now has a dipole contribution to the potential at  $\mathbf{r}$ !

What the hell is going on here?

- A. It's just how the math works out. Nothing has changed physically at  $\mathbf{r}$ .
- B. There is something different about the field at  $\mathbf{r}$  and the potential is showing us that.
- C. I'm not sure how to resolve this problem.

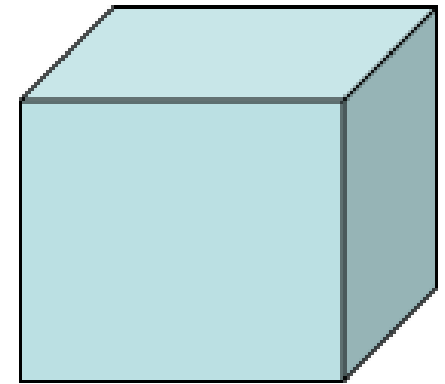


# POLARIZATION



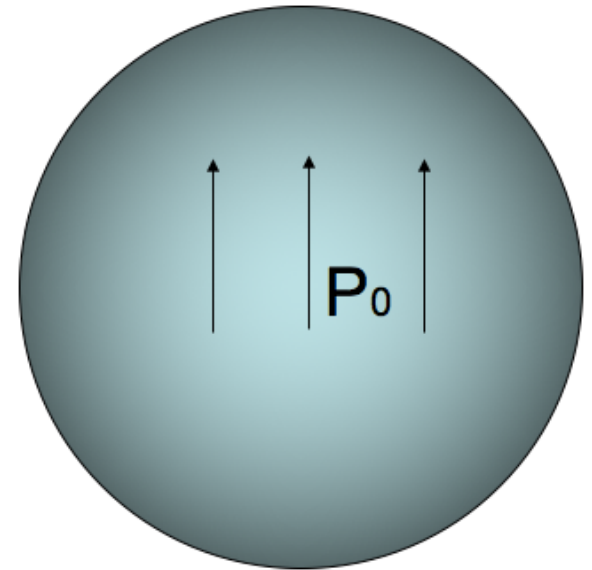
A stationary point charge  $+Q$  is near a block of polarization material (a linear dielectric). The net electrostatic force on the block due to the point charge is:

$+Q$   
 $\oplus$



- A. attractive (to the left)
- B. repulsive (to the right)
- C. zero

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.  $\mathbf{P}_0 a^3$
- C.  $4\pi a^3 \mathbf{P}_0 / 3$
- D.  $\mathbf{P}_0$
- E. None of these/must be more complicated

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.  $2\mathbf{P}_0 a^2$

