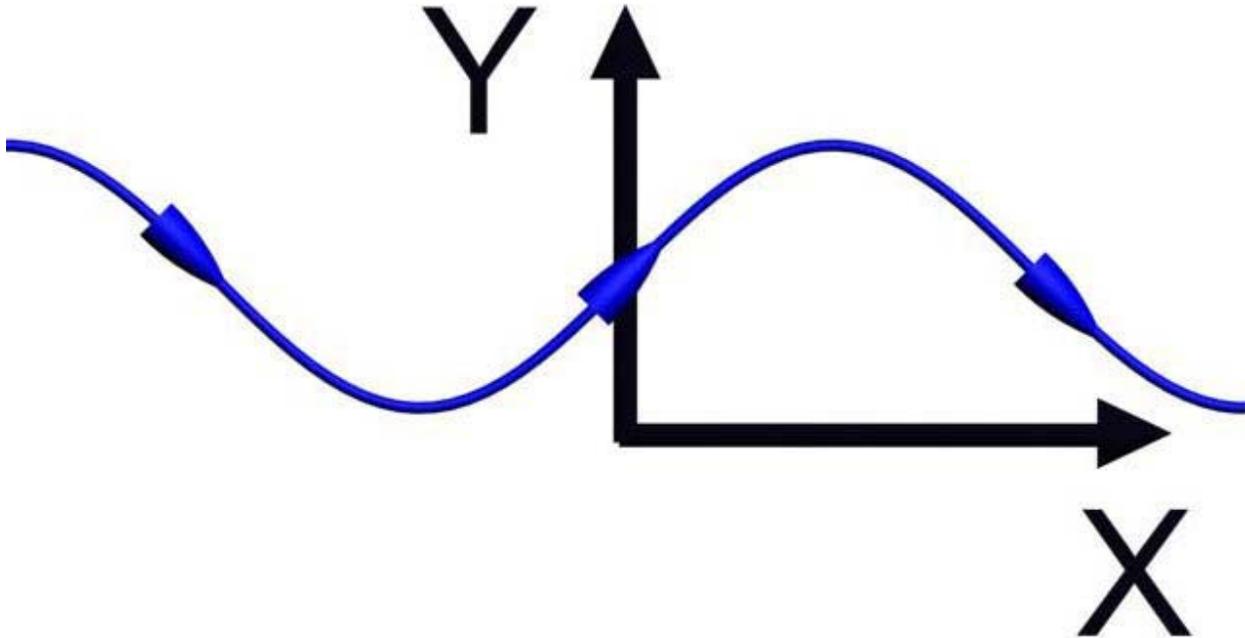


## Weird Fields Contest

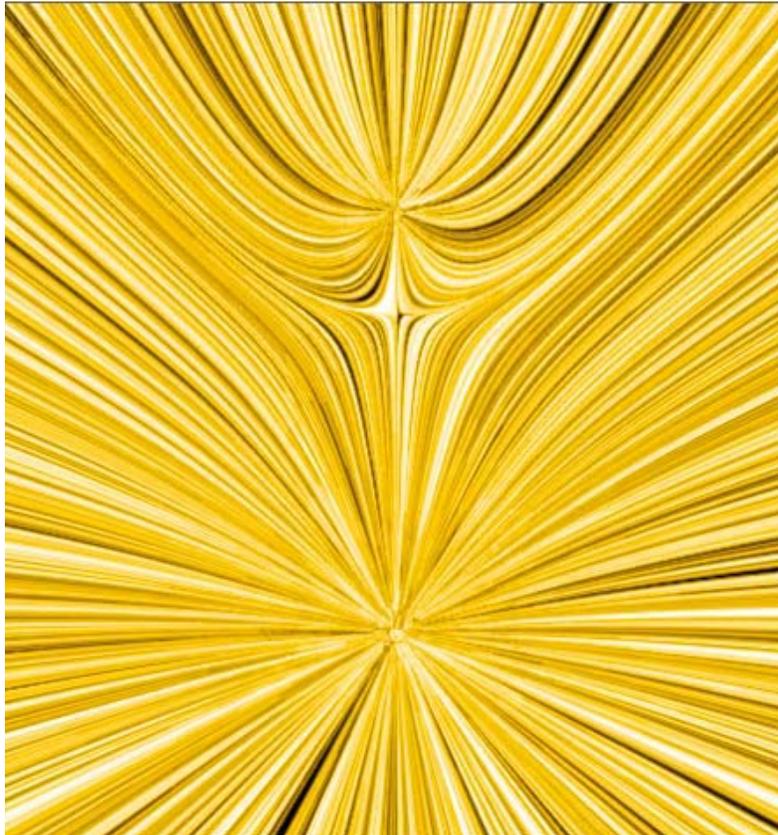
Look at the 2 top vote getters (tied for first place!) on the handout sheet and vote for the one you find most appealing or striking.

- 1.
- 2.



**The field line above corresponds to the vector field:**

1.  $\vec{F}(x, y) = \sin(x)\hat{i} + \hat{j}$
2.  $\vec{F}(x, y) = \hat{i} + \sin(x)\hat{j}$
3.  $\vec{F}(x, y) = \cos(x)\hat{i} + \hat{j}$
4.  $\vec{F}(x, y) = \hat{i} + \cos(x)\hat{j}$
5. **I don't know**



**The above vector field is created by:**

- 1. Two sources (equal strength)**
- 2. Two sources (top stronger)**
- 3. Two sources (bottom stronger)**
- 4. Source & Sink (equal strength)**
- 5. Source & Sink (top stronger)**
- 6. Source & Sink (bottom stronger)**
- 7. I don't know**



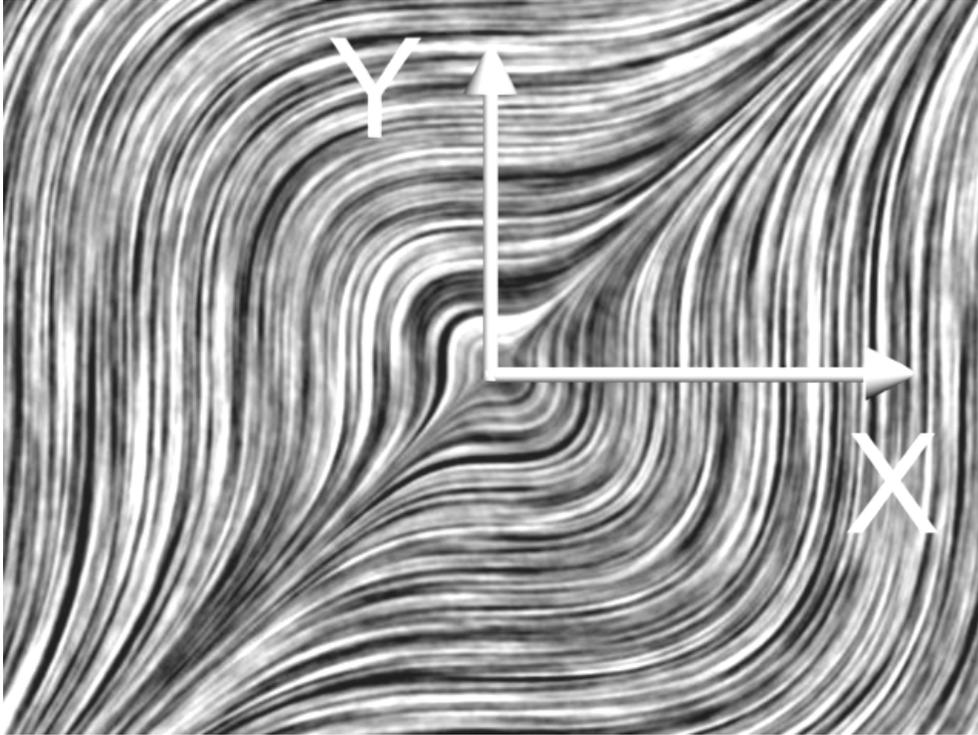
**Here there is an initial downward flow.**

- 1. The point is a source**
- 2. The point is a sink**
- 3. I don't know**



**These two circulations are in:**

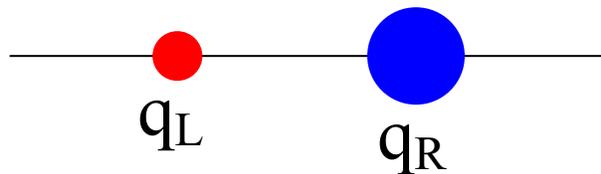
- 1. The same direction  
(e.g. both clockwise)**
- 2. Opposite directions  
(e.g. one clockwise, one ccw)**
- 3. I don't know**



**The “grass seeds” field plot above is a representation of the vector field:**

1.  $\vec{F}(x, y) = x^2\hat{\mathbf{i}} + y^2\hat{\mathbf{j}}$
2.  $\vec{F}(x, y) = y^2\hat{\mathbf{i}} + x^2\hat{\mathbf{j}}$
3.  $\vec{F}(x, y) = \sin(x)\hat{\mathbf{i}} + \cos(y)\hat{\mathbf{j}}$
4.  $\vec{F}(x, y) = \cos(x)\hat{\mathbf{i}} + \sin(y)\hat{\mathbf{j}}$
5. NOT SURE

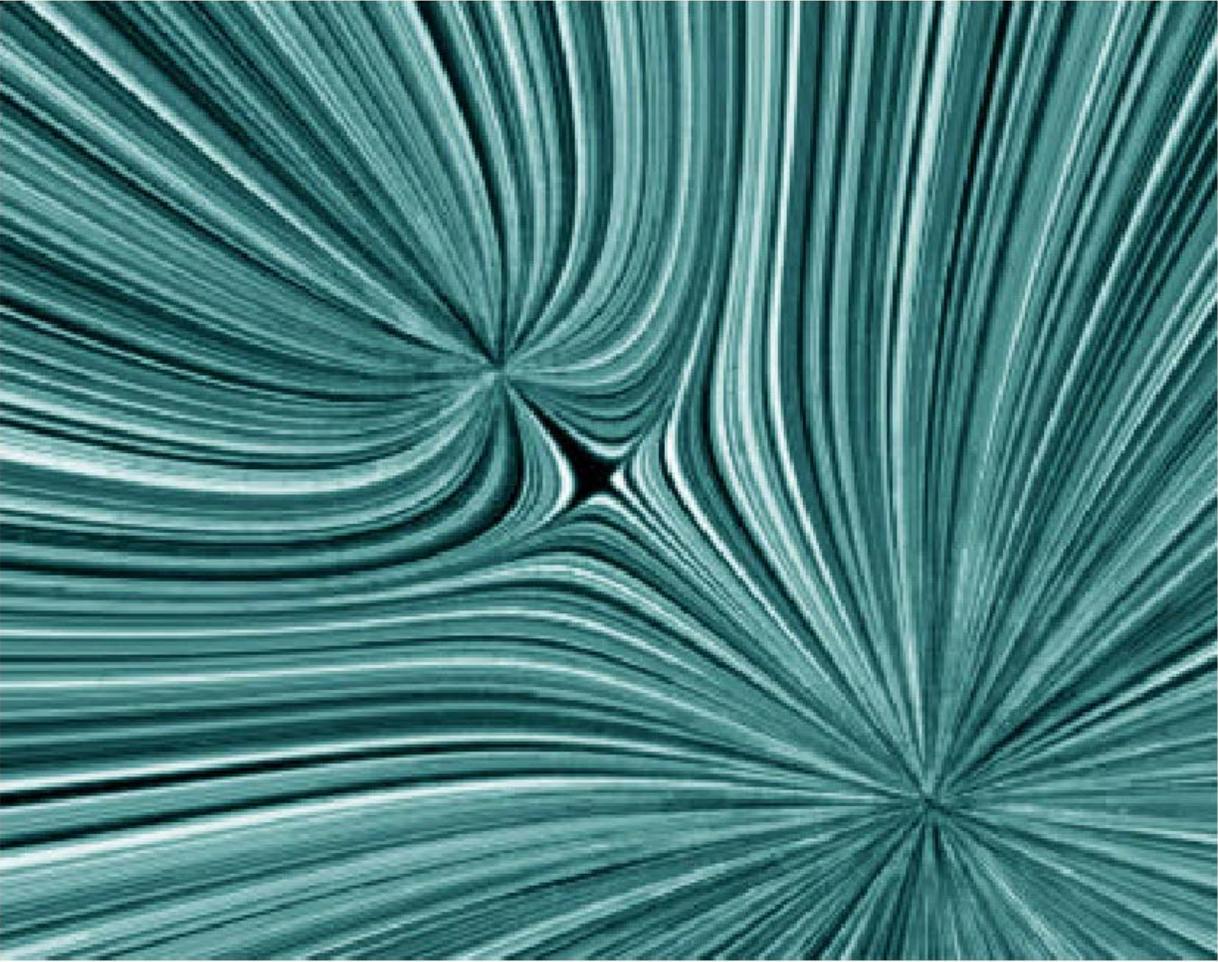
Two opposite charges are placed on a line as shown below. The charge on the right is three times larger than the charge on the left. Other than at infinity, where is the electric field zero?



1. Between the two charges
2. To the right of the charge on the right
3. To the left of the charge on the left
4. The electric field is nowhere zero
5. Not enough information – need to know which charge is positive

Electric field lines in the space surrounding a charge distribution show:

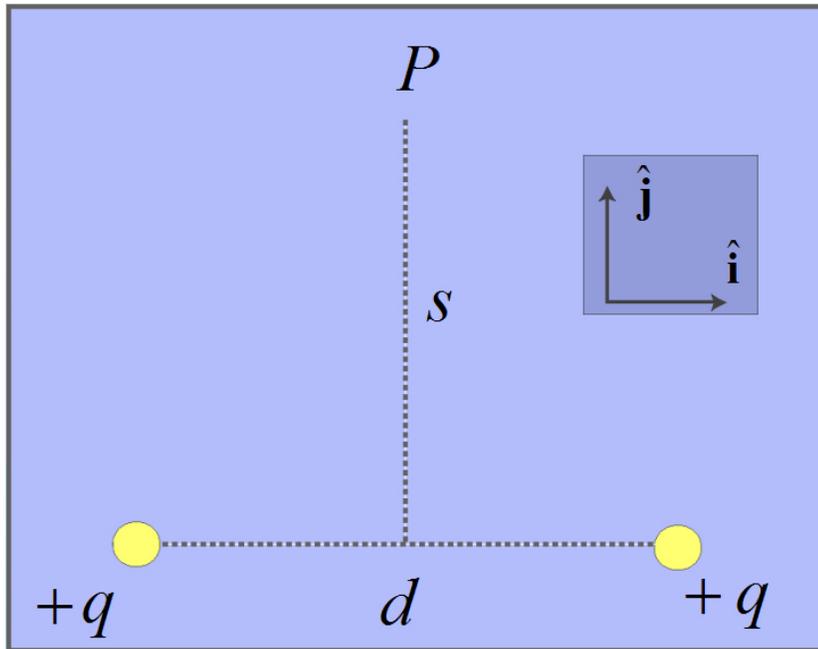
1. Directions of the forces that exist in space at all times.
2. Only directions in which static charges would accelerate when at points on those lines
3. Only directions in which moving charges would accelerate when at points on those lines.
4. Directions in which either static or moving charges would accelerate when passing through points on those lines.
5. Paths static or moving charges would take.



The force between the two charges is:

- 1) Attractive
- 2) Repulsive
- 3) Can't tell without more information

# E-Field of Two Equal Charges



Electric field at point P is:

$$1. \vec{E} = \frac{2k_e q s}{\left[ s^2 + \frac{d^2}{4} \right]^{3/2}} \hat{j}$$

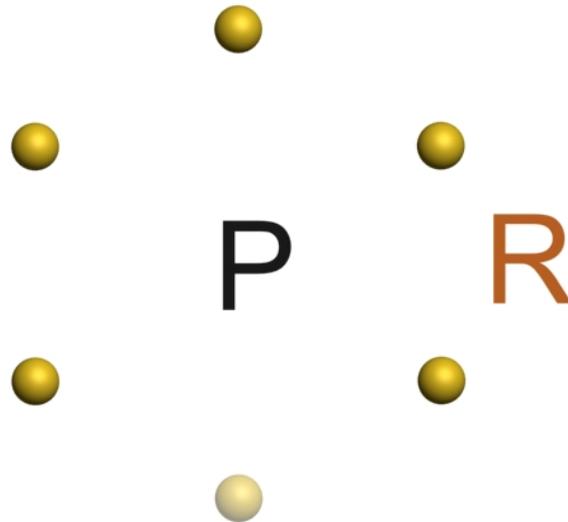
$$2. \vec{E} = -\frac{2k_e q d}{\left[ s^2 + \frac{d^2}{4} \right]^{3/2}} \hat{i}$$

$$3. \vec{E} = \frac{2k_e q d}{\left[ s^2 + \frac{d^2}{4} \right]^{3/2}} \hat{j}$$

$$4. \vec{E} = -\frac{2k_e q s}{\left[ s^2 + \frac{d^2}{4} \right]^{3/2}} \hat{i}$$

5. Don't Know

# E-Field of Five Equal Charges



Six equal positive charges  $q$  sit at the vertices of a regular hexagon with sides of length  $R$ . We remove the bottom charge. The electric field at the center of the hexagon (point P) is:

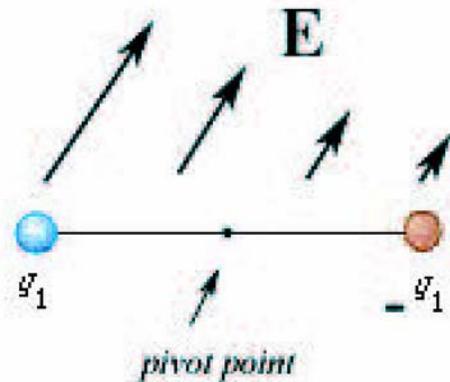
- |  |   |
|--|---|
| 1. $\vec{\mathbf{E}} = \frac{2kq}{R^2} \hat{\mathbf{j}}$ | 2. $\vec{\mathbf{E}} = -\frac{2kq}{R^2} \hat{\mathbf{j}}$ |
| 3. $\vec{\mathbf{E}} = \frac{kq}{R^2} \hat{\mathbf{j}}$  | 4. $\vec{\mathbf{E}} = -\frac{kq}{R^2} \hat{\mathbf{j}}$  |
| 5. $\vec{\mathbf{E}} = \vec{\mathbf{0}}$                 | 6. Don't know   |

## E-Field of a Dipole

As you move to large distances  $r$  away from a dipole, the electric field will fall-off as:

- 1)  $1/r^2$ , just like a point charge
- 2) More rapidly than  $1/r^2$
- 3) More slowly than  $1/r^2$
- 4) Who knows?

An electric dipole, consisting of two equal and opposite point charges at the ends of an insulating rod, is free to rotate about a pivot point in the center. The rod is placed in a non-uniform electric field.



The dipole will experience

1. a noticeable electric force and no noticeable electric torque
2. no noticeable electric force and a noticeable electric torque
3. a noticeable electric force and a noticeable electric torque
4. no noticeable electric force and no noticeable electric torque

## Masses in Potentials

Consider 3 equal masses sitting in different gravitational potentials:

- A) Constant, zero potential
- B) Constant, non-zero potential
- C) Linear potential ( $V \propto x$ ) but sitting at  $V = 0$

Which statement is true?

1. None of the masses will accelerate
2. Only B will accelerate
3. Only C will accelerate
4. All masses will accelerate, but B will have the largest acceleration
5. All masses will accelerate, but C will have the largest acceleration

# Positive Charge

Place a positive charge in an electric field. It will move from

1. higher to lower *electric potential*;  
lower to higher *potential energy*
2. higher to lower *electric potential*;  
higher to lower *potential energy*
3. lower to higher *electric potential*;  
lower to higher *potential energy*
4. lower to higher *electric potential*;  
higher to lower *potential energy*

## Negative Charge

Place a negative charge in an electric field. It will move from

1. higher to lower *electric potential*;  
lower to higher *potential energy*
2. higher to lower *electric potential*;  
higher to lower *potential energy*
3. lower to higher *electric potential*;  
lower to higher *potential energy*
4. lower to higher *electric potential*;  
higher to lower *potential energy*

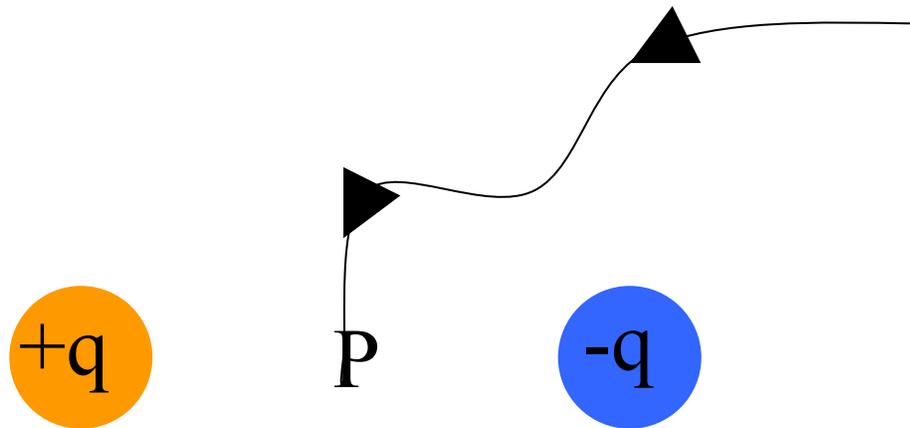
# Potential and Energy

Which is true?

- I. It takes positive work to bring like charges together.
  - II. Electric field lines always point in the direction of decreasing electric potential.
  - III. If a negative charge moves in the direction of the electric field, its potential energy decreases.
1. II only.
  2. II and III only.
  3. I, II and III.
  4. I and II only.
  5. I only.

## Two Point Charges

The work done in moving a positive test charge from infinity to the point P midway between two charges of magnitude  $+q$  and  $-q$ :



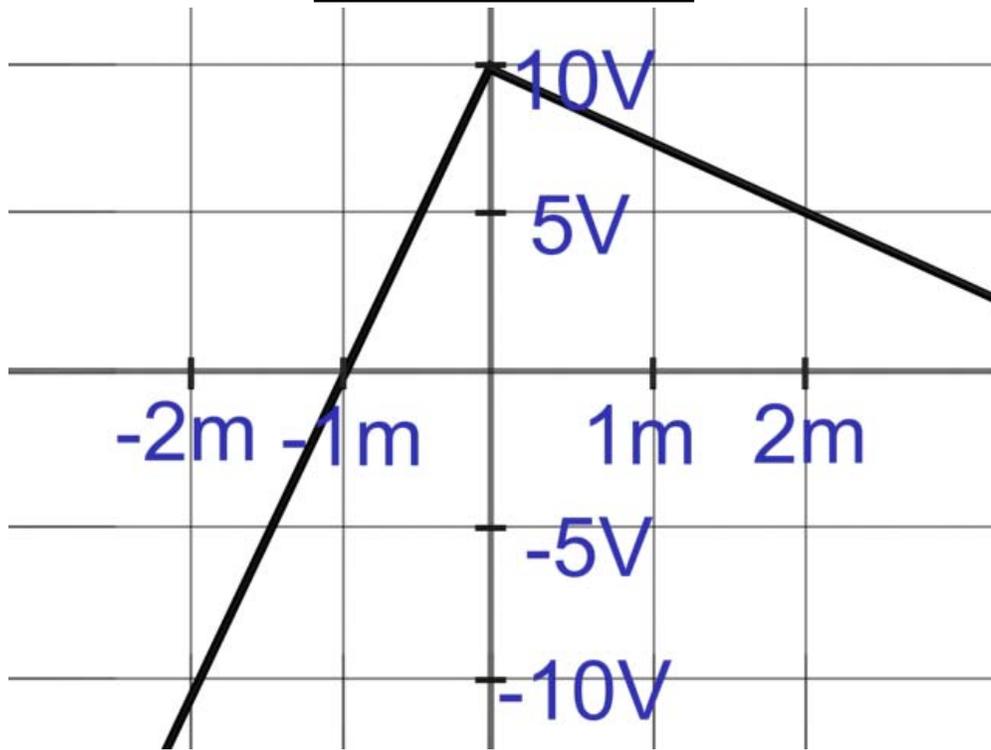
1. is positive.
2. is negative.
3. is zero.
4. can not be determined since not enough information is given.
5. I don't know

# Potential Landscape

If I think of the electric potential as a mountain range, then the electric field points:

- 1) Up the mountain sides
- 2) Down the mountain sides
- 3) Around the mountain sides
- 4) I don't know

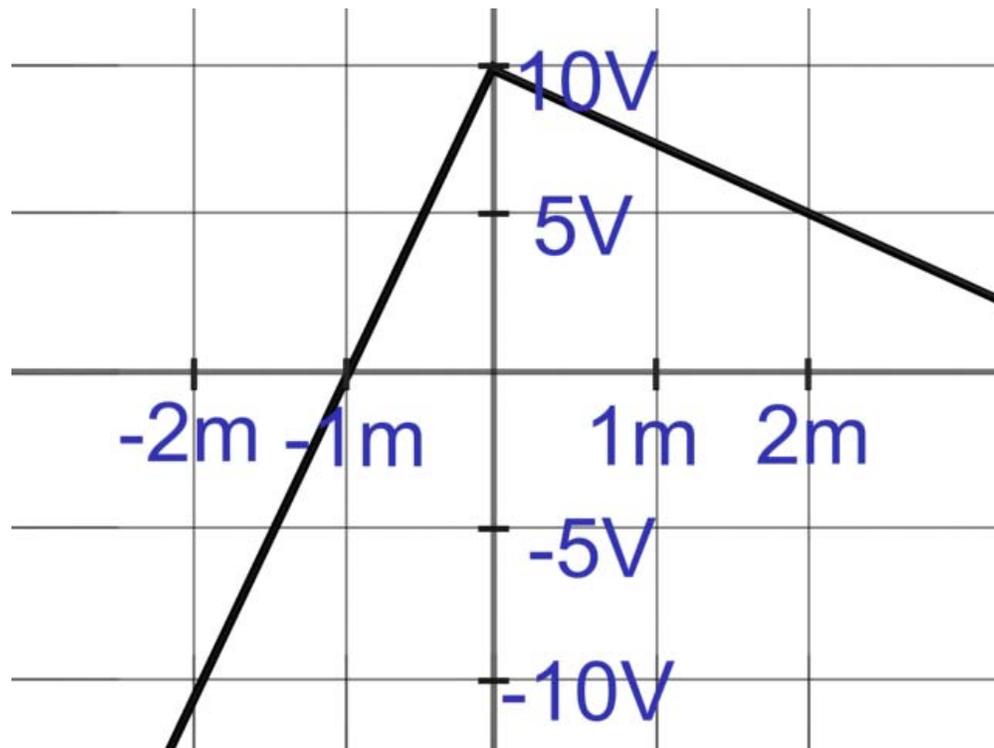
## E from V



The graph above shows a potential  $V$  as a function of  $x$ . The *magnitude* of the electric field for  $x > 0$  is

1. larger than that for  $x < 0$
2. smaller than that for  $x < 0$
3. equal to that for  $x < 0$
4. I don't know

E from V

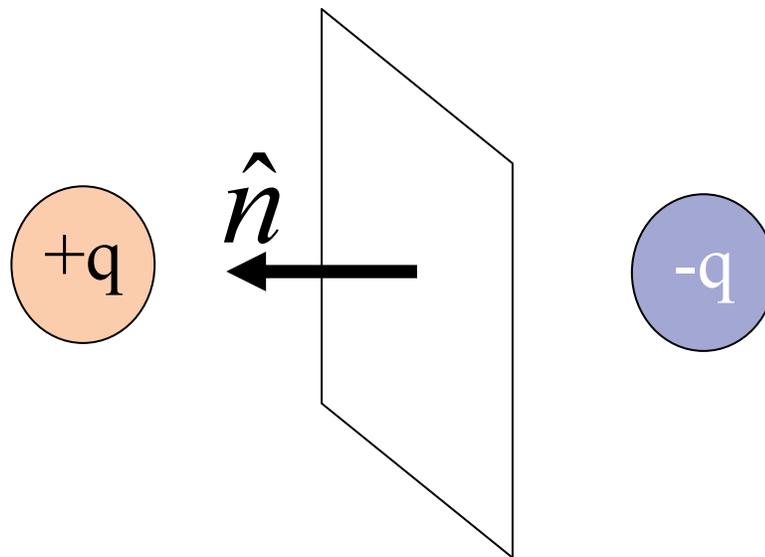


The graph above shows a potential  $V$  as a function of  $x$ . Which is true?

1.  $E_{x > 0}$  is  $> 0$  and  $E_{x < 0}$  is  $> 0$
2.  $E_{x > 0}$  is  $> 0$  and  $E_{x < 0}$  is  $< 0$
3.  $E_{x > 0}$  is  $< 0$  and  $E_{x < 0}$  is  $< 0$
4.  $E_{x > 0}$  is  $< 0$  and  $E_{x < 0}$  is  $> 0$
5. I don't know

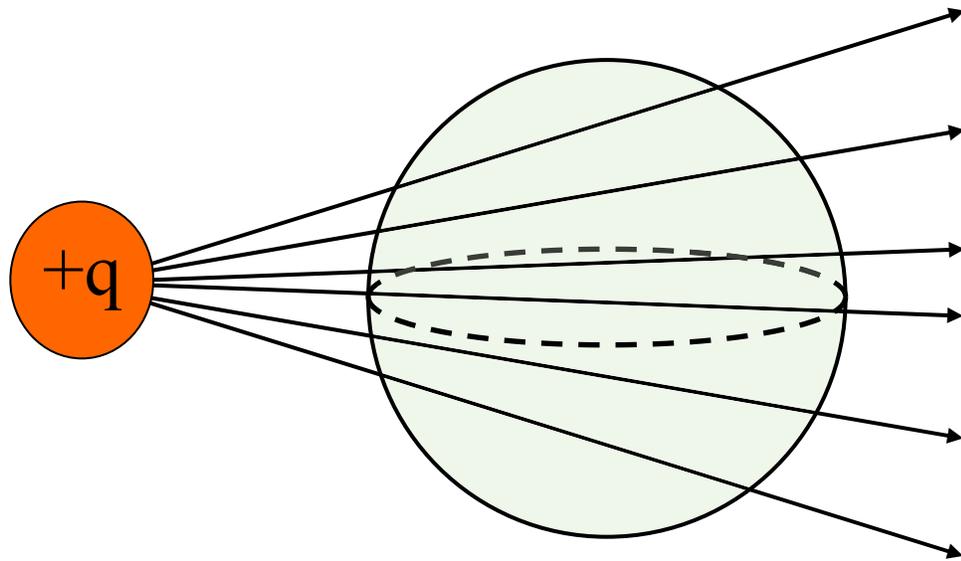
# Flux Direction

The flux through the planar surface below (positive unit normal to left)



1. is positive.
2. is negative.
3. is zero.
4. I don't know

# Flux Through Sphere



The total flux through the above spherical surface is

1. positive.
2. negative.
3. zero.
4. I don't know

# Should We Use Gauss' Law?

For which of the following uniform charge distributions can we use Gauss' Law to determine the electric field?

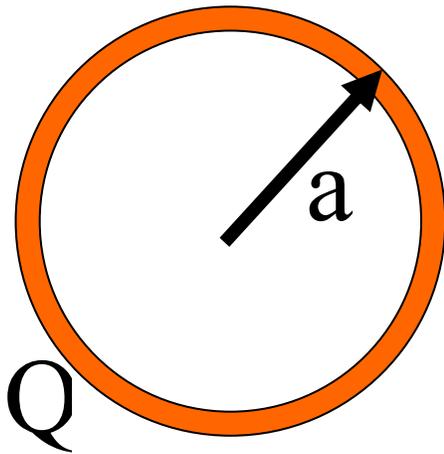
- A. Concentric nested spherical shells
- B. Non-concentric nested spherical shells
- C. Finite line of charge
- D. Infinite line of charge
- E. Thin, infinite, sheet of charge
- F. Thick, infinite, slab of charge

- |                    |                    |
|--------------------|--------------------|
| 1. None of them    | 2. All of them     |
| 3. A, B, C only    | 4. D, E, F only    |
| 5. A, D, E, F only | 6. C, D only       |
| 7. A, D, E only    | 8. C, D, E, F only |

# Spherical Shell

We just saw that in a solid sphere of charge the electric field grows

linearly with distance.



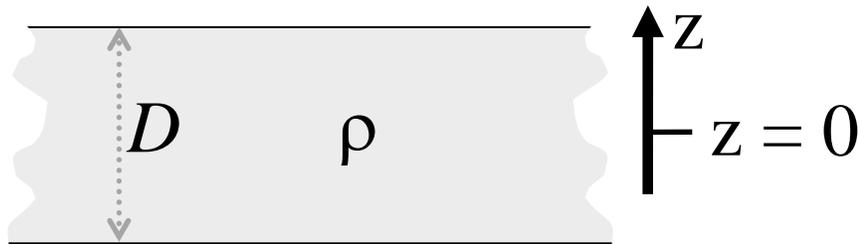
Inside the charged spherical shell at left ( $r < a$ ) what does the electric field do?

1. Constant and Zero
2. Constant but Non-Zero
3. Still grows linearly
4. Some other functional form  
(use Gauss' Law to determine)
5. Can't determine with Gauss Law

## E Field from Slab

A positively charged, semi-infinite flat slab has thickness  $D$ .

The  $z$ -axis is perpendicular to the sheet, with center at  $z = 0$ .



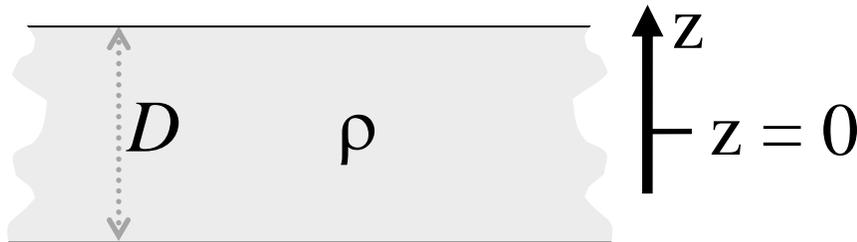
At the plane's center ( $z = 0$ ),  $\mathbf{E}$

1. points in the positive  $z$ -direction
2. points in the negative  $z$ -direction
3. is zero
4. I don't know

## E Field from Slab

A positively charged, semi-infinite flat slab has thickness  $D$ .

The  $z$ -axis is perpendicular to the sheet, with at  $z = 0$ .



A distance  $z$  from its central plane,

1.  $E$  is constant

2.  $E \propto \frac{1}{z^2}$

3.  $E \propto \frac{1}{z}$

4.  $E \propto z$

5. I don't know

# Walking Down a Mountain



Consider the topo. map at left.

Starting at the center of the dot, which direction starts you downhill the fastest?

- |      |       |
|------|-------|
| 1. N | 2. NE |
| 3. E | 4. SE |
| 5. S | 6. SW |
| 7. W | 8. NW |

## Changing C Dimensions

A parallel-plate capacitor has plates with equal and opposite charges  $\pm Q$ , separated by a distance  $d$ , and **is not** connected to a battery. The plates are pulled apart to a distance  $D > d$ .

What happens to the potential difference  $V$  and the charge  $Q$ ?

1.  $V$  increases,  $Q$  increases
2.  $V$  decreases,  $Q$  increases
3.  $V$  is the same,  $Q$  increases
4.  $V$  increases,  $Q$  is the same
5.  $V$  decreases,  $Q$  is the same
6.  $V$  is the same,  $Q$  is the same
7.  $V$  increases,  $Q$  decreases
8.  $V$  decreases,  $Q$  decreases
9.  $V$  is the same,  $Q$  decreases

## Changing C Dimensions

A parallel-plate capacitor has plates with equal and opposite charges  $\pm Q$ , separated by a distance  $d$ , and is connected to a battery. The plates are pulled apart to a distance  $D > d$ .

What happens to the potential difference  $V$  and the charge  $Q$ ?

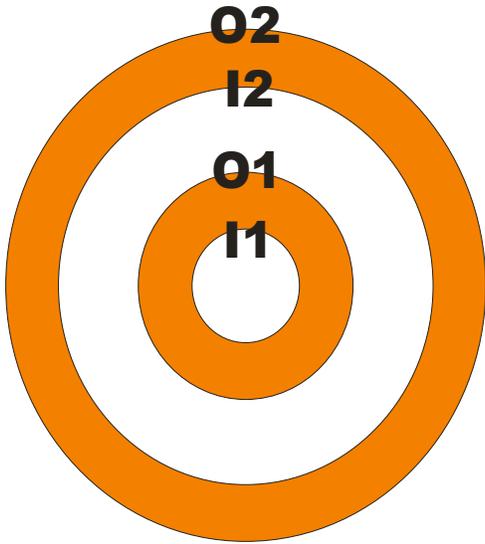
1.  $V$  increases,  $Q$  increases
2.  $V$  decreases,  $Q$  increases
3.  $V$  is the same,  $Q$  increases
4.  $V$  increases,  $Q$  is the same
5.  $V$  decreases,  $Q$  is the same
6.  $V$  is the same,  $Q$  is the same
7.  $V$  increases,  $Q$  decreases
8.  $V$  decreases,  $Q$  decreases
9.  $V$  is the same,  $Q$  decreases

## Changing C Dimensions

A parallel-plate capacitor, disconnected from a battery, has plates with equal and opposite charges, separated by a distance  $d$ . Suppose the plates are pulled apart until separated by a distance  $D > d$ . How does the final electrostatic energy stored in the capacitor compare to the initial energy?

1. The final stored energy is smaller
2. The final stored energy is larger
3. Stored energy does not change.

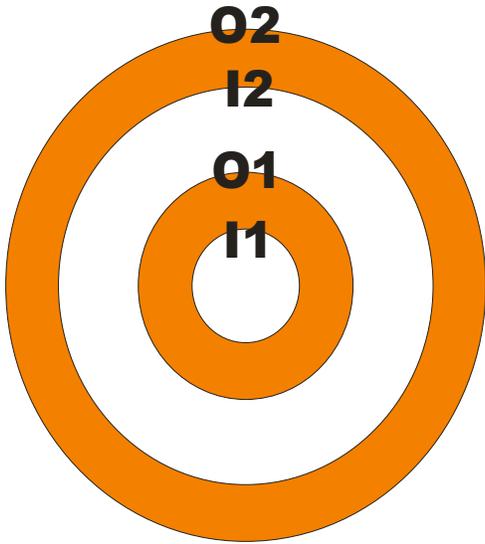
# Hollow Conductors



A point charge  $+Q$  is placed at the center of the conductors. The induced charges are:

1.  $Q(I1) = Q(I2) = -Q;$   
 $Q(O1) = Q(O2) = +Q$
2.  $Q(I1) = Q(I2) = +Q;$   
 $Q(O1) = Q(O2) = -Q$
3.  $Q(I1) = -Q; Q(O1) = +Q$   
 $Q(I2) = Q(O2) = 0$
4.  $Q(I1) = -Q; Q(O2) = +Q$   
 $Q(O1) = Q(I2) = 0$

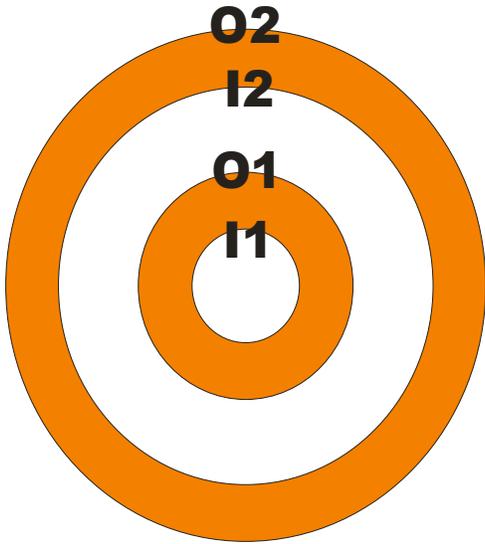
# Hollow Conductors



A point charge  $+Q$  is placed at the center of the conductors. The potential at  $O1$  is:

1. Higher than at  $I1$
2. Lower than at  $I1$
3. The same as at  $I1$

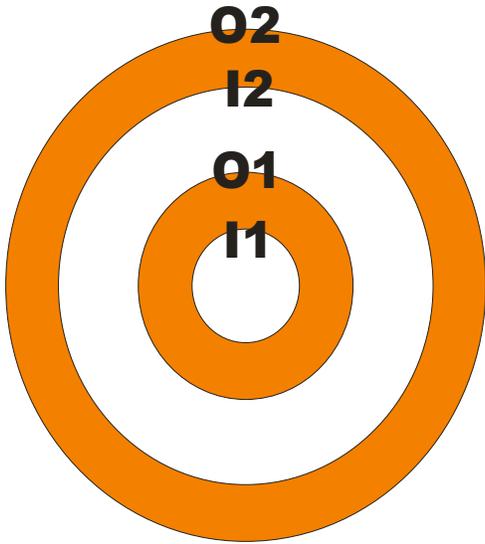
# Hollow Conductors



A point charge  $+Q$  is placed at the center of the conductors. The potential at O2 is:

1. Higher than at I1
2. Lower than at I1
3. The same as at I1

# Hollow Conductors

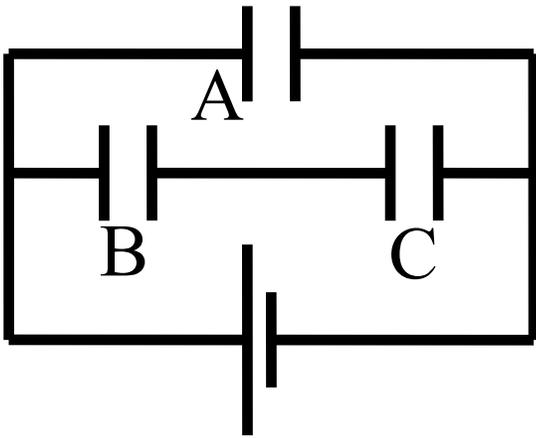


A point charge  $+Q$  is placed at the center of the conductors. If a wire is used to connect the two conductors, then positive charge will flow

1. From the inner to the outer conductor
2. From the outer to the inner conductor
3. Not at all

# Capacitor Circuit

Three identical capacitors are connected to a battery as pictured.



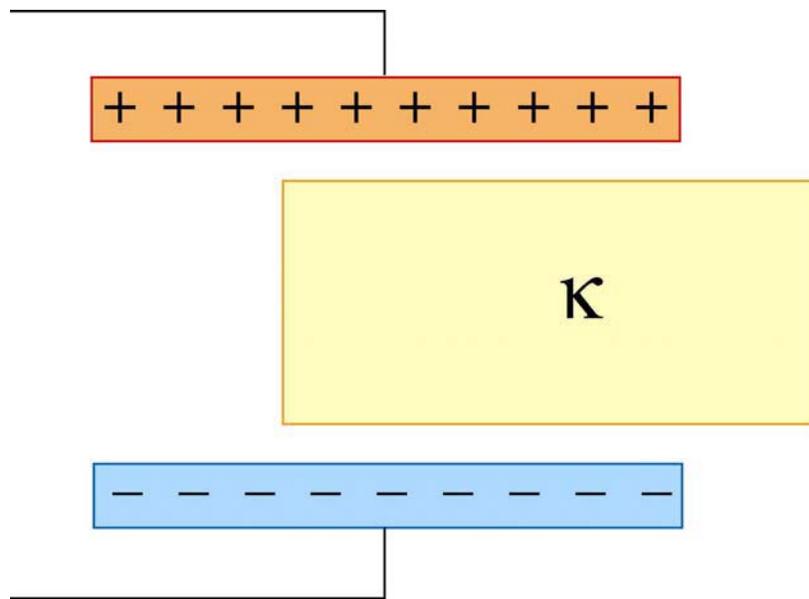
The battery is then disconnected.

How do the charge on A, B & C compare before and after the battery is removed?

<b>BEFORE;</b>	<b>AFTER</b>
1. $Q_A = Q_B = Q_C$ ;	No Change
2. $Q_A = Q_B = Q_C$ ;	$Q_A > Q_B = Q_C$
3. $Q_A = Q_B = Q_C$ ;	$Q_A < Q_B = Q_C$
4. $Q_A > Q_B = Q_C$ ;	No Change
5. $Q_A > Q_B = Q_C$ ;	$Q_A = Q_B = Q_C$
6. $Q_A < Q_B = Q_C$ ;	No Change
7. $Q_A < Q_B = Q_C$ ;	$Q_A = Q_B = Q_C$

# Dielectric in a Capacitor

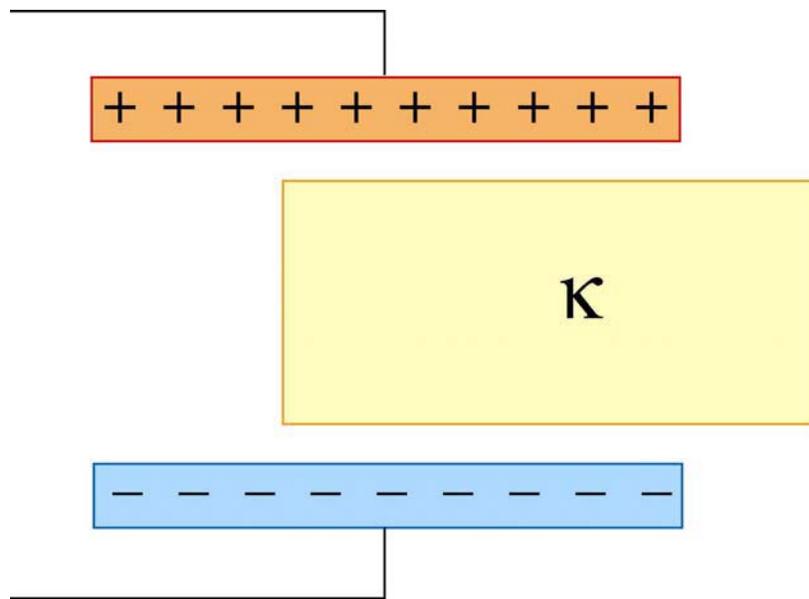
A parallel plate capacitor is charged to a total charge  $Q$  and the battery removed. A slab of material with dielectric constant  $\kappa$  is inserted between the plates. The **charge** stored in the capacitor



1. Increases
2. Decreases
3. Stays the Same

# Dielectric in a Capacitor

A parallel plate capacitor is charged to a total charge  $Q$  and the battery removed. A slab of material with dielectric constant  $\kappa$  is inserted between the plates. The **energy** stored in the capacitor



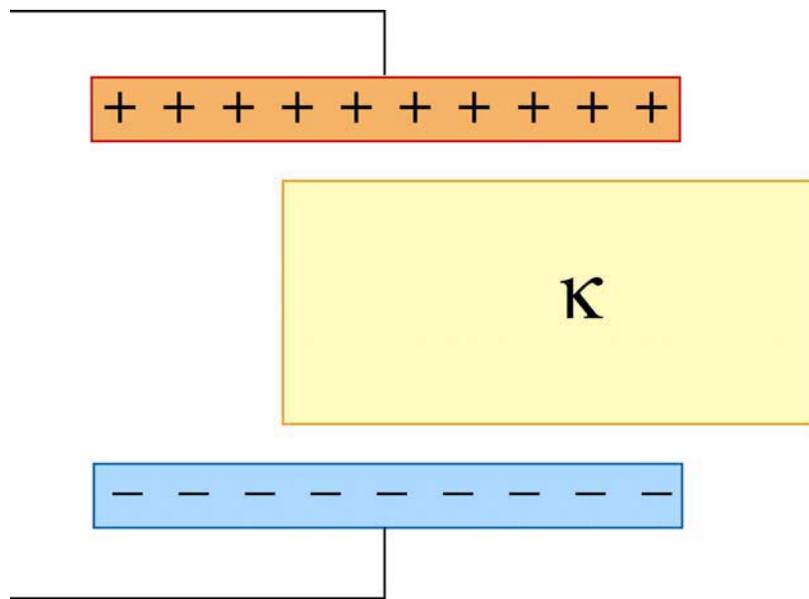
1. Increases
2. Decreases
3. Stays the Same

# Dielectric in a Capacitor

A parallel plate capacitor is charged to a total charge  $Q$  and the battery removed.

A slab of material with dielectric constant  $\kappa$  is inserted between the plates.

**The force on the dielectric**



1. pulls in the dielectric
2. pushes out the dielectric
3. is zero