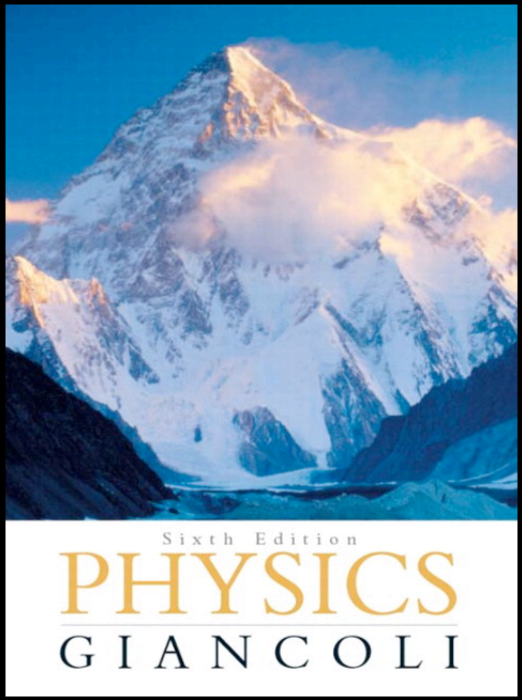


ConcepTest PowerPoints

Chapter 17

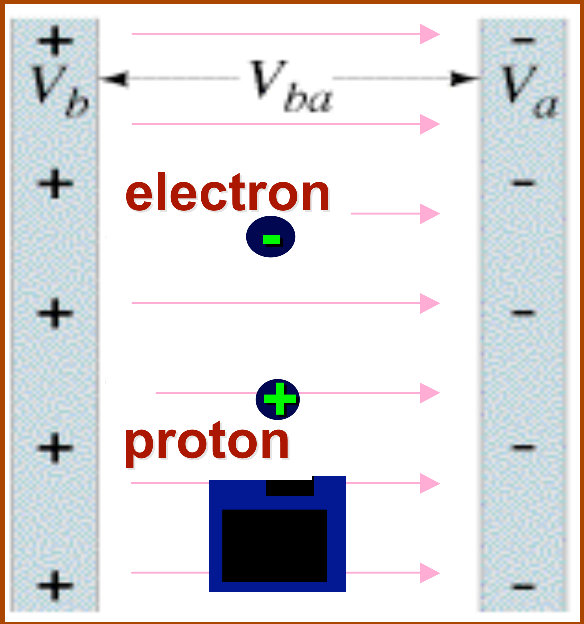
Physics: Principles with Applications, 6th edition

Giancoli

ConcepTest 17.1a Electric Potential Energy I

A proton and an electron are in a constant electric field created by oppositely charged plates. You release the proton from the positive side and the electron from the negative side. Which feels the larger electric force?

1) proton
2) electron
3) both feel the same force
4) neither – there is no force
5) they feel the same magnitude force but opposite direction



ConcepTest 17.1a Electric Potential Energy I

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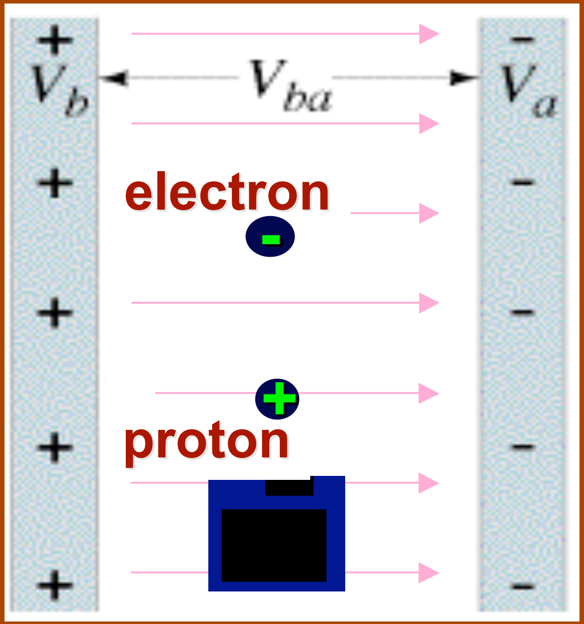
1) proton
2) electron
3) both feel the same force
4) neither – there is no force
5) they feel the same magnitude force but opposite direction

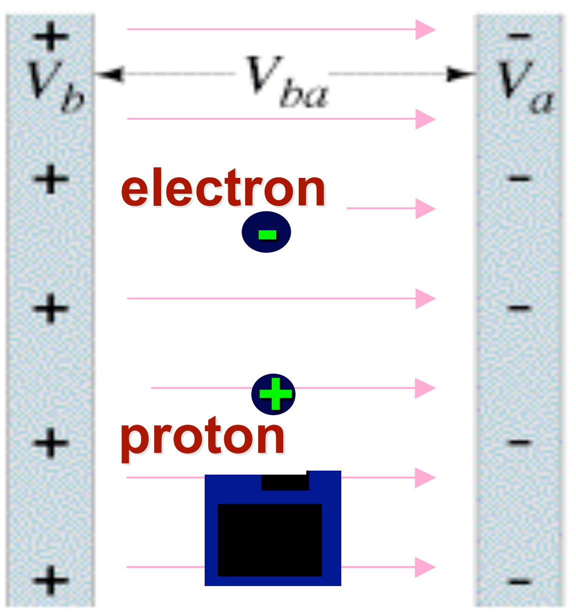
Since $F = qE$ and the proton and electron have the same charge in magnitude, they both experience the same force. However, the forces point in opposite directions because the proton and electron are oppositely charged.



ConcepTest 17.1b Electric Potential Energy II

A proton and an electron are in a constant electric field created by oppositely charged plates. You release the proton from the positive side and the electron from the negative side. Which has the larger acceleration?

1) proton
2) electron
3) both feel the same acceleration
4) neither – there is no acceleration
5) they feel the same magnitude acceleration but opposite direction

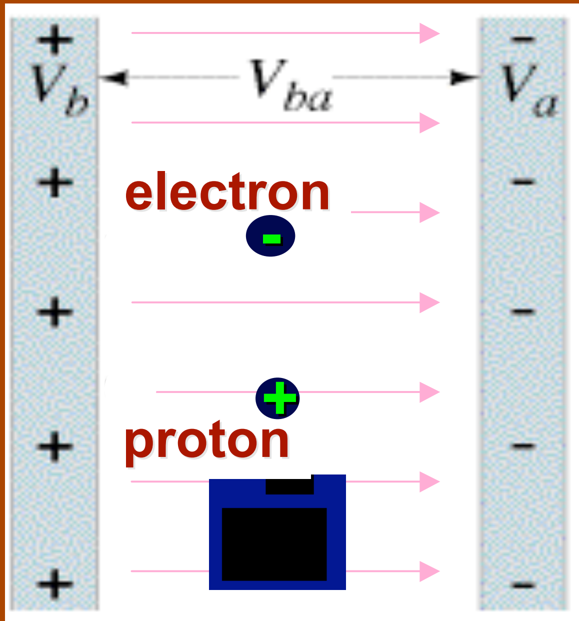


ConcepTest 17.1b Electric Potential Energy II

A proton and an electron are in a constant electric field created by oppositely charged plates. You release the proton from the positive side and the electron from the negative side. Which has the larger acceleration?

1) proton
2) electron
3) both feel the same acceleration
4) neither – there is no acceleration
5) they feel the same magnitude acceleration but opposite direction

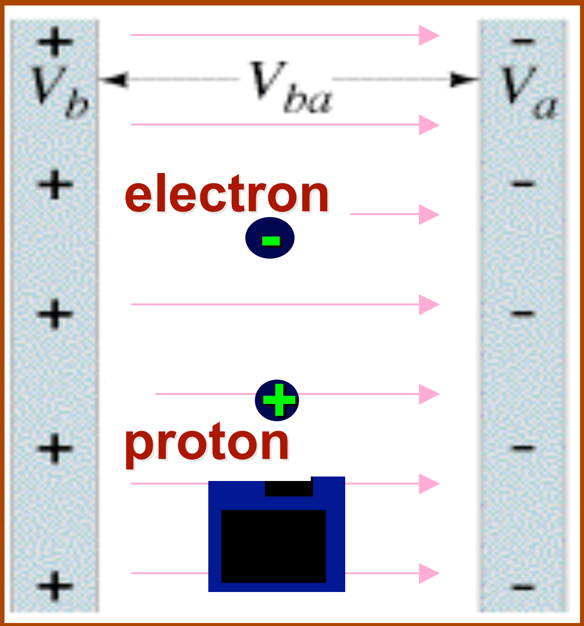
Since $F = ma$ and the electron is much less massive than the proton, then the electron experiences the larger acceleration.



ConcepTest 17.1c Electric Potential Energy III

A proton and an electron are in a constant electric field created by oppositely charged plates. You release the proton from the positive side and the electron from the negative side. When it strikes the opposite plate, which one has more KE?

1) proton
2) electron
3) both acquire the same KE
4) neither – there is no change of KE
5) they both acquire the same KE but with opposite signs

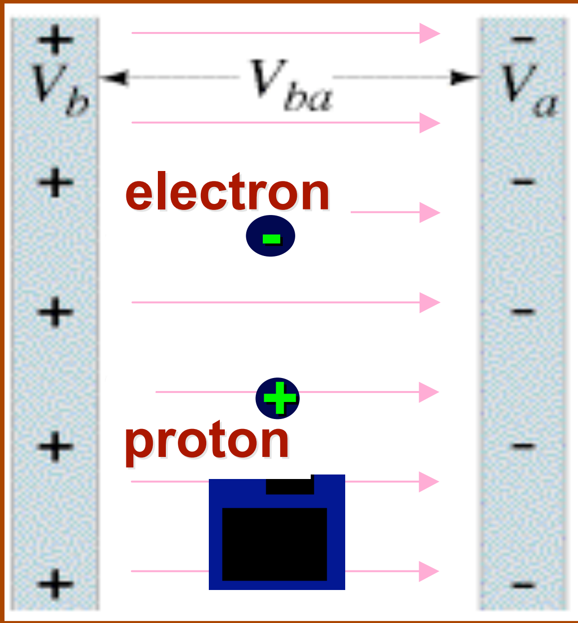


ConcepTest 17.1c Electric Potential Energy III

A proton and an electron are in a constant electric field created by oppositely charged plates. You release the proton from the positive side and the electron from the negative side. When it strikes the opposite plate, which one has more KE?

1) proton
2) electron
3) both acquire the same KE
4) neither – there is no change of KE
5) they both acquire the same KE but with opposite signs

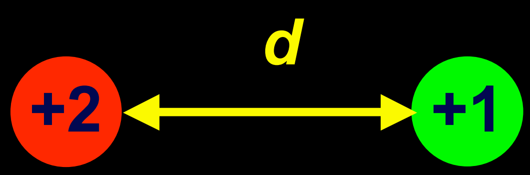
Since PE = qV and the proton and electron have the same charge in magnitude, they both have the same electric potential energy initially. Because energy is conserved, they both must have the same kinetic energy after they reach the opposite plate.



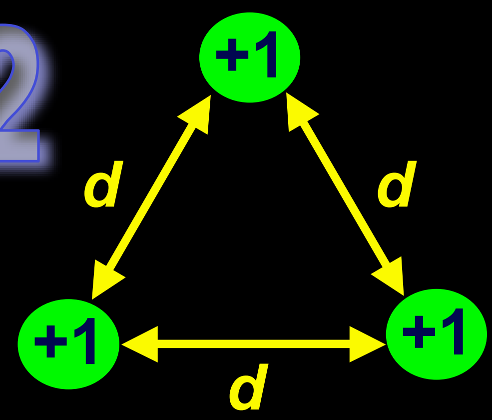
ConcepTest 17.2 Work and Potential Energy

Which group of charges took *more work* to bring together from a very large initial distance apart?

1



2



3 Both took the same amount of work

ConcepTest 17.2 Work and Potential Energy

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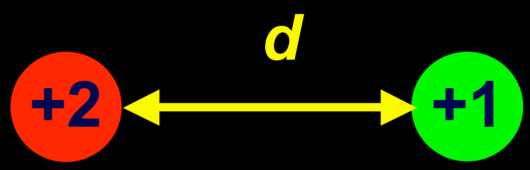
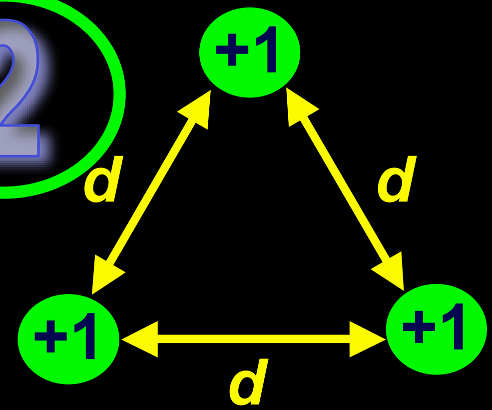
1



2



3 Both took the same amount of work

The work needed to assemble a collection of charges is the same as the total PE of those charges:

$$PE = k\frac{Q_1 Q_2}{r}$$

added over all pairs

For case 1: only 1 pair

$$PE = k\frac{(+2)(+1)}{d} = k\frac{2}{d}$$

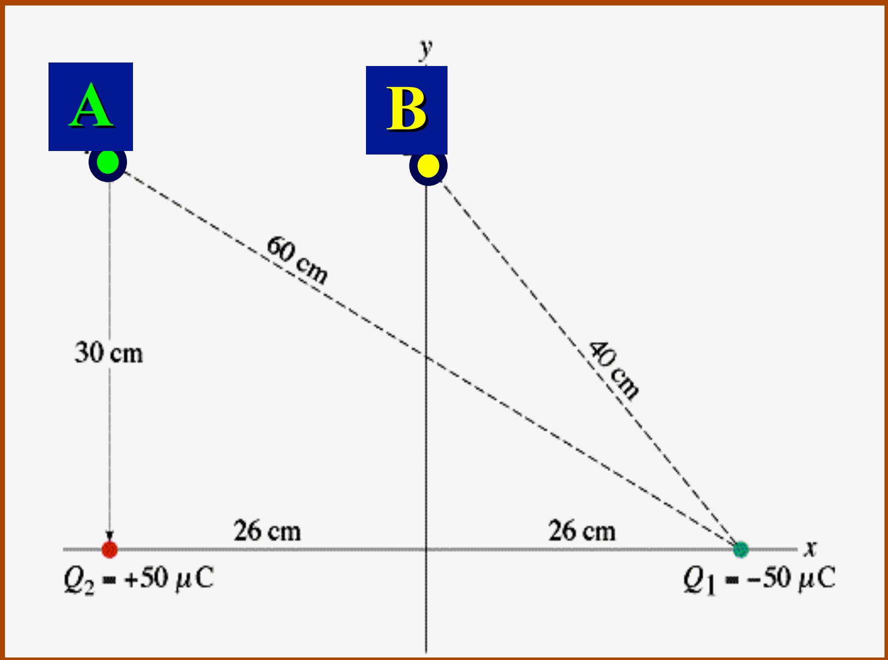
For case 2: there are 3 pairs

$$PE = 3k\frac{(+1)(+1)}{d} = 3k\frac{1}{d}$$

ConcepTest 17.3a Electric Potential I

What is the electric potential at point A?

1) $V > 0$
2) $V = 0$
3) $V < 0$

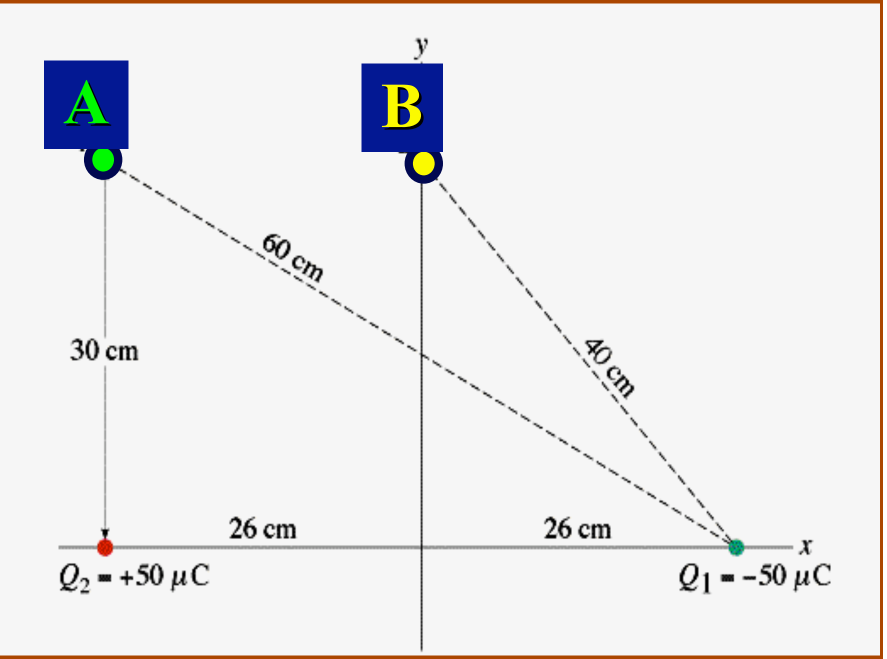


ConcepTest 17.3a Electric Potential I

What is the electric potential at point A?

1) $V > 0$
2) $V = 0$
3) $V < 0$

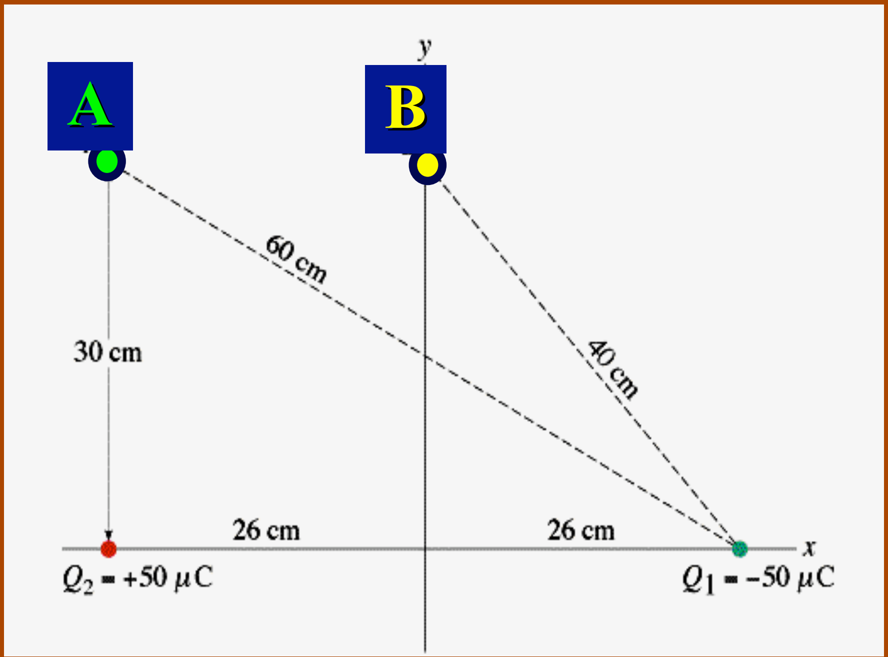
Since Q_2 (which is positive) is closer to point A than Q_1 (which is negative) and since the total potential is equal to $V_1 + V_2$, then the total potential is positive.



ConcepTest 17.3b Electric Potential II

What is the electric potential at point B?

1) $V > 0$
2) $V = 0$
3) $V < 0$

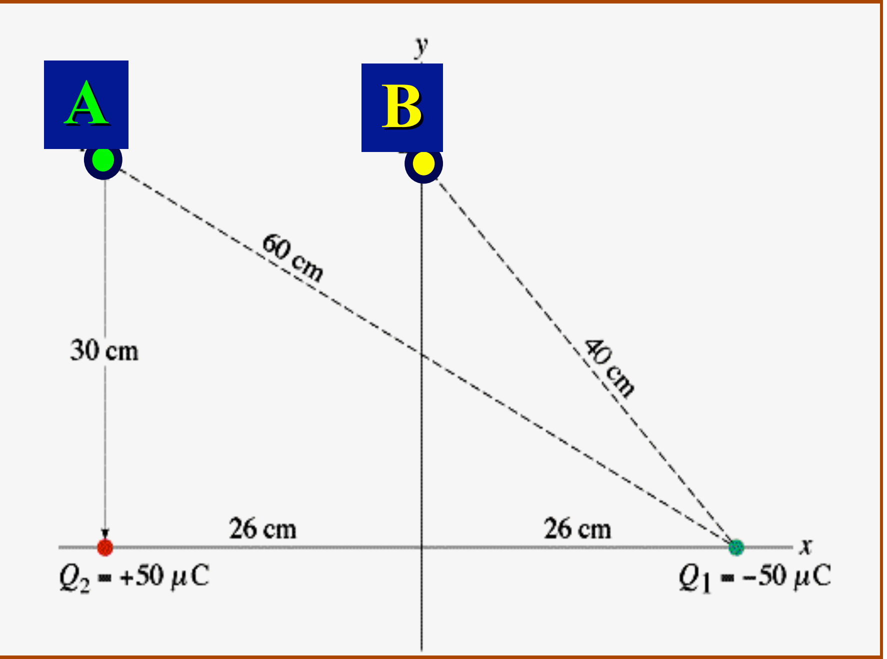


ConcepTest 17.3b Electric Potential II

What is the electric potential at point B?

1) $V > 0$
2) $V = 0$
3) $V < 0$

Since Q_2 and Q_1 are equidistant from point B, and since they have equal and opposite charges, then the total potential is zero.

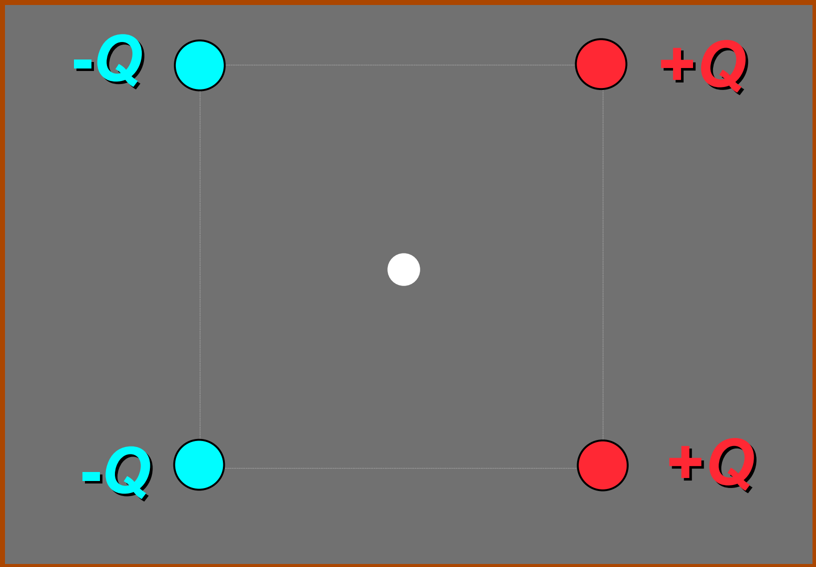


Follow-up: What is the potential at the origin of the *x-y* axes?

ConcepTest 17.4 Hollywood Square

Four point charges are arranged at the corners of a square. Find the **electric field *E*** and the **potential *V*** at the **center of the square**.

1) $E = 0 \quad V = 0$
2) $E = 0 \quad V \neq 0$
3) $E \neq 0 \quad V \neq 0$
4) $E \neq 0 \quad V = 0$
5) $E = V$ regardless of the value



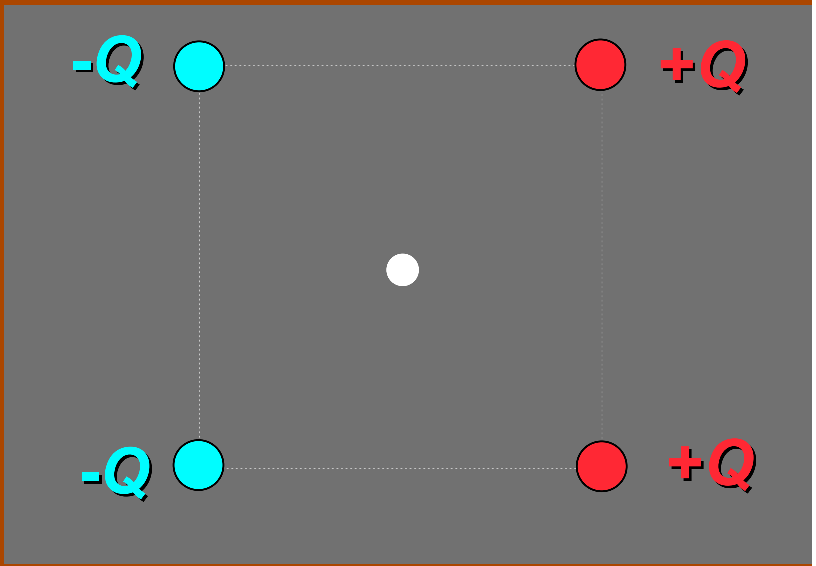
ConcepTest 17.4 Hollywood Square

Four point charges are arranged at the corners of a square. Find the electric field E and the potential V at the center of the square.

1) $E = 0$ $V = 0$
2) $E = 0$ $V \neq 0$
3) $E \neq 0$ $V \neq 0$
4) $E \neq 0$ $V = 0$
5) $E = V$ regardless of the value

The potential is zero: the scalar contributions from the two positive charges cancel the two minus charges.

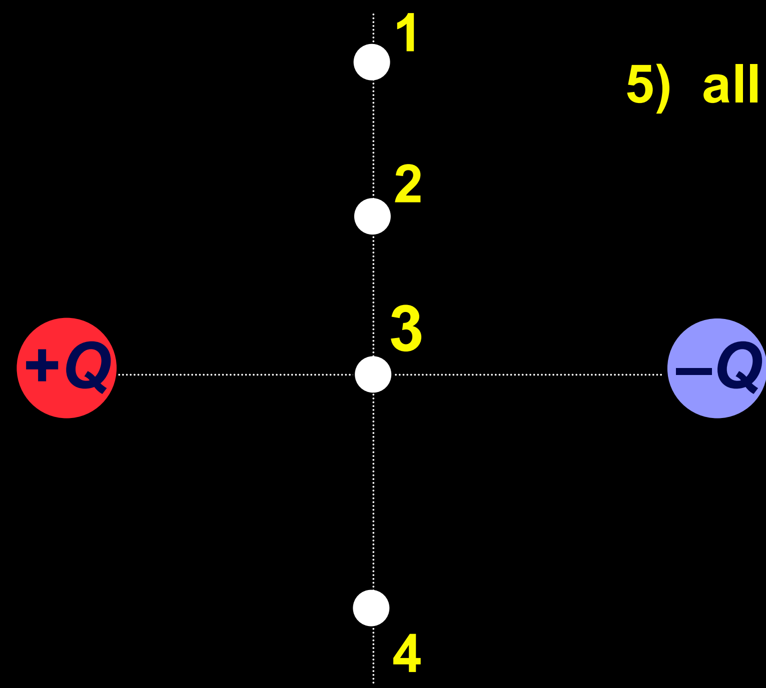
However, the contributions from the electric field add up as vectors, and they do not cancel (so it is non-zero).



Follow-up: What is the direction of the electric field at the center?

ConcepTest 17.5a Equipotential Surfaces I

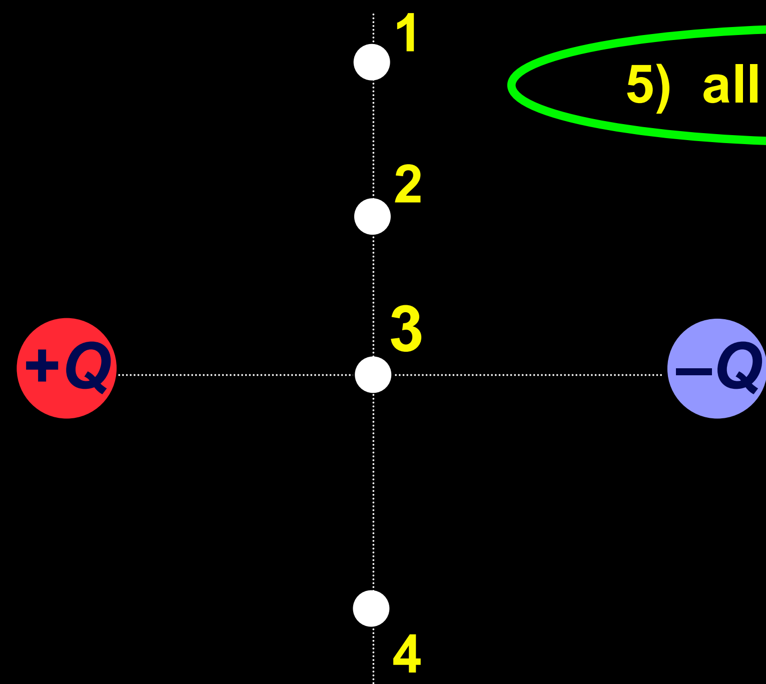
At which point does $V = 0$?



5) all of them

ConcepTest 17.5a Equipotential Surfaces I

At which point does $V = 0$?



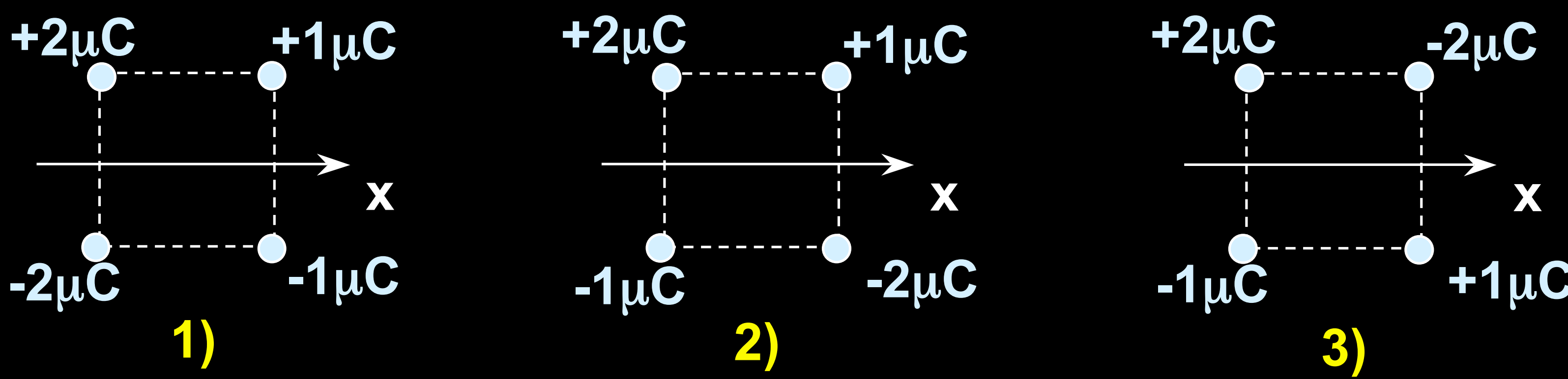
5) all of them

All of the points are equidistant from both charges. Since the charges are equal and opposite, their contributions to the potential **cancel out everywhere** along the mid-plane between the charges.

Follow-up: What is the direction of the electric field at all 4 points?

ConcepTest 17.5b Equipotential Surfaces II

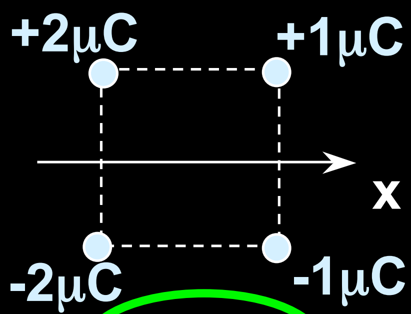
Which of these configurations gives *V* = 0 at all points on the *x*-axis?



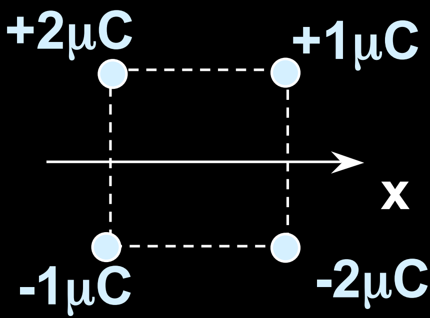
4) all of the above 5) none of the above

ConcepTest 17.5b Equipotential Surfaces II

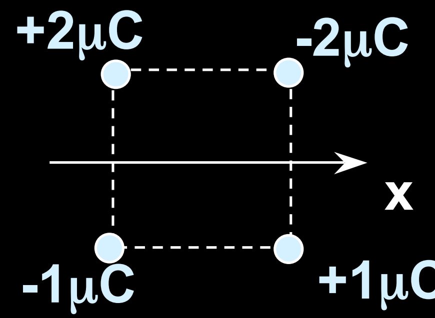
Which of these configurations gives *V* = 0 at all points on the *x*-axis?



1)



2)



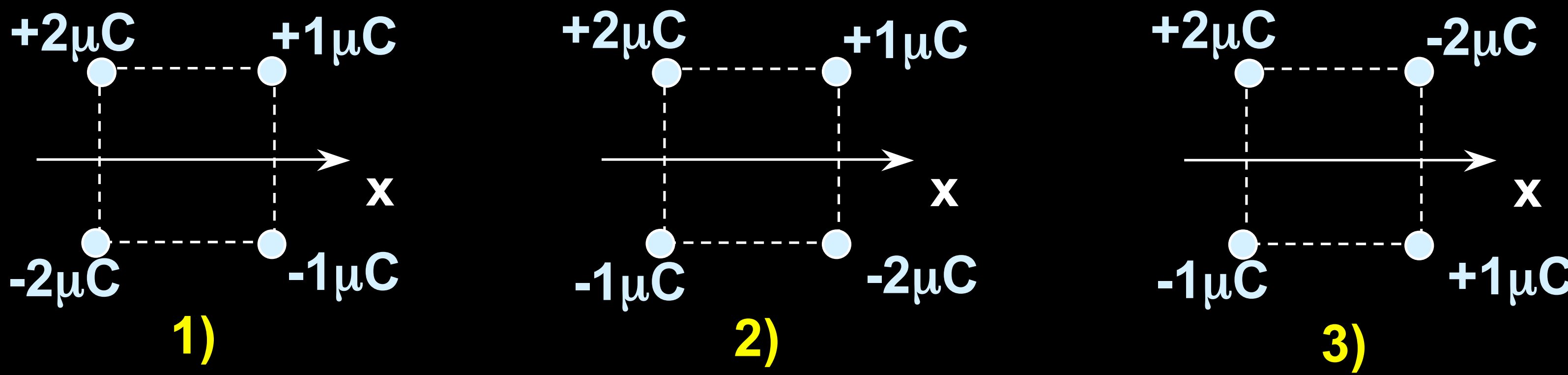
3)

4) all of the above 5) none of the above

Only in case (1), where opposite charges lie directly across the *x*-axis from each other, do the potentials from the two charges above the *x*-axis cancel the ones below the *x*-axis.

ConcepTest 17.5c Equipotential Surfaces III

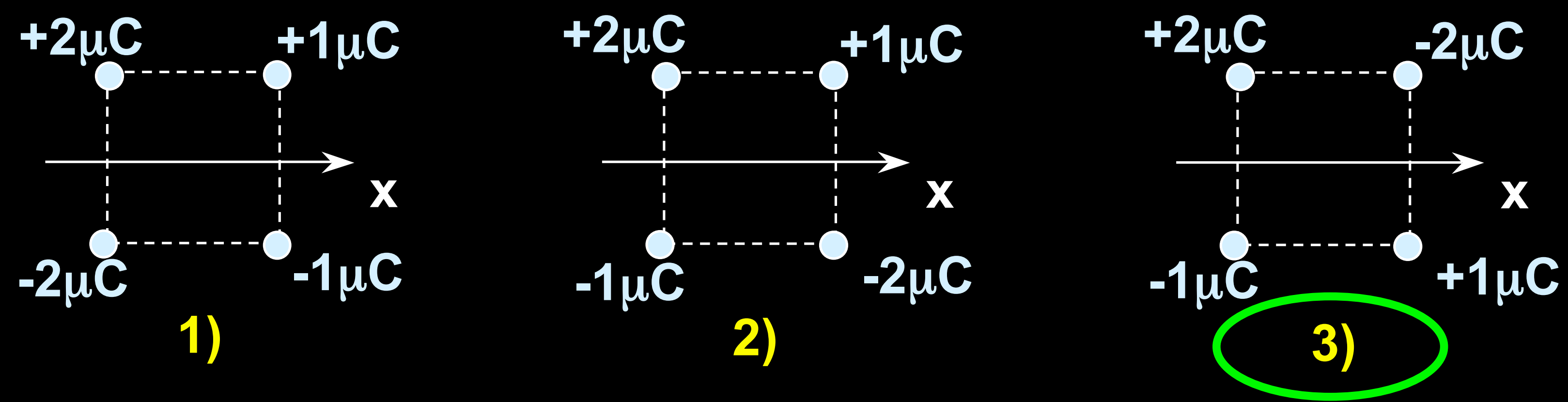
Which of these configurations gives *V* = 0 at all points on the *y*-axis?



4) all of the above **5) none of the above**

ConcepTest 17.5c Equipotential Surfaces III

Which of these configurations gives *V* = 0 at all points on the *y*-axis?



4) all of the above 5) none of the above

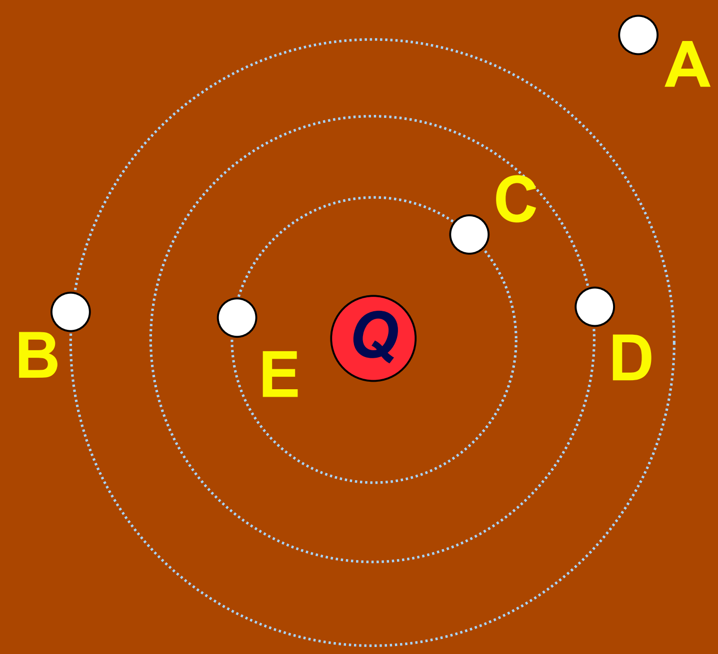
Only in case (3), where opposite charges lie directly across the *y*-axis from each other, do the potentials from the two charges above the *y*-axis cancel the ones below the *y*-axis.

Follow-up: Where is *V* = 0 for configuration #2?

ConcepTest 17.6 Equipotential of Point Charge

Which two points have the same potential?

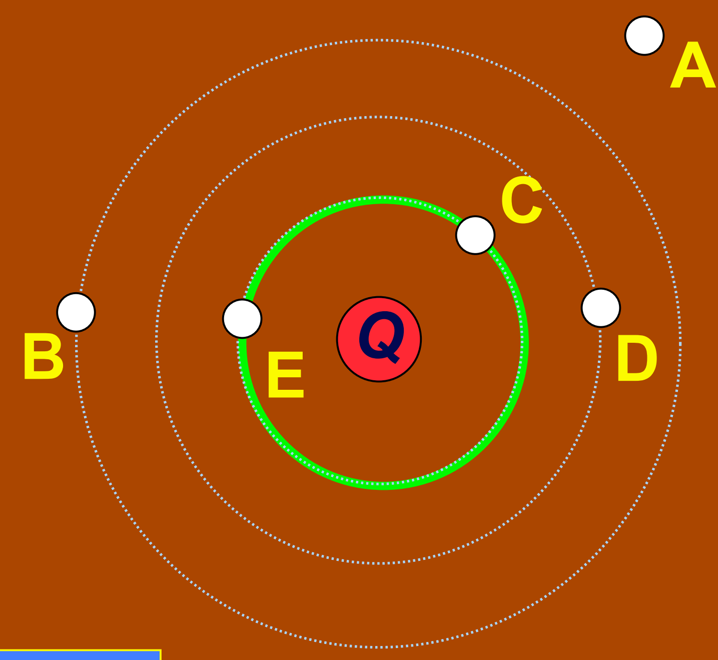
1) A and C
2) B and E
3) B and D
4) C and E
5) no pair



ConcepTest 17.6 Equipotential of Point Charge

Which two points have the **same** potential?

1) A and C
2) B and E
3) B and D
4) C and E
5) no pair



Since the potential of a point charge is:

$$V = k\frac{Q}{r}$$

only points that are at the **same distance** from charge Q are at the **same potential**. This is true for points C and E.

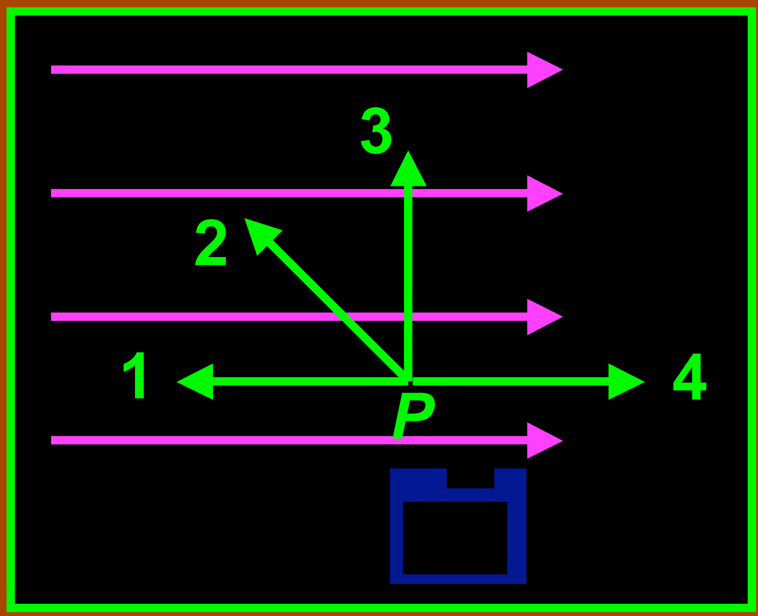
They lie on an ***Equipotential Surface***.

Follow-up: Which point has the smallest potential?

ConcepTest 17.7a Work and Electric Potential I

Which requires the *most work*, to move a positive charge from *P* to points 1, 2, 3 or 4 ? All points are the same distance from *P*.

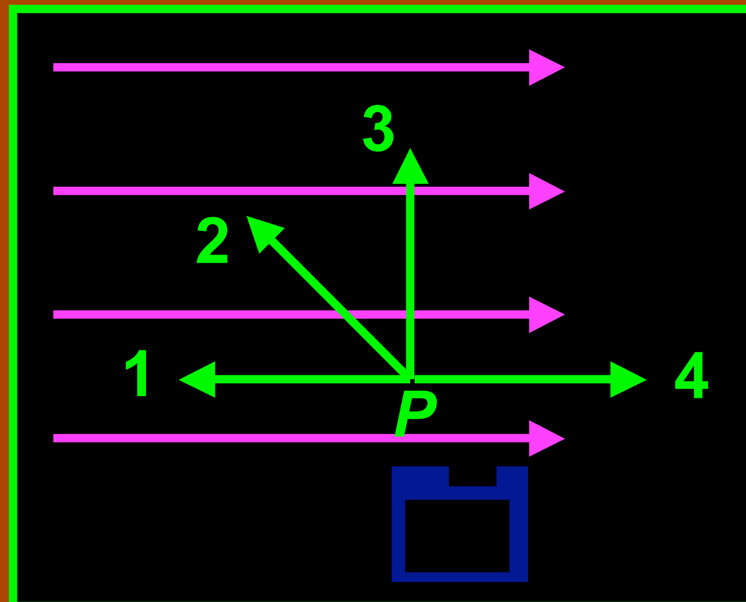
1) $P \rightarrow 1$
2) $P \rightarrow 2$
3) $P \rightarrow 3$
4) $P \rightarrow 4$
5) all require the same amount of work



ConcepTest 17.7a Work and Electric Potential I

Which requires the ***most work***, to move a **positive** charge from ***P*** to points 1, 2, 3 or 4 ? All points are the same distance from ***P***.

1) *P* → 1
2) *P* → 2
3) *P* → 3
4) *P* → 4
5) all require the same amount of work

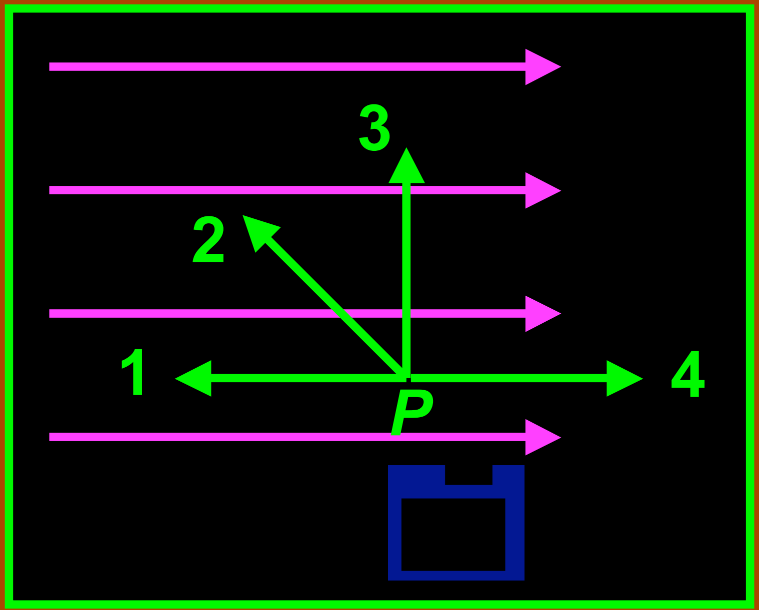


For **path #1**, you have to push the positive charge ***against*** the *E* field, which is **hard to do**. By contrast, path #4 is the easiest, since the field does all the work.

ConcepTest 17.7b Work and Electric Potential II

Which requires *zero work*, to move a positive charge from *P* to points 1, 2, 3 or 4 ? All points are the same distance from *P*.

1) *P* → 1
2) *P* → 2
3) *P* → 3
4) *P* → 4
5) all require the same amount of work

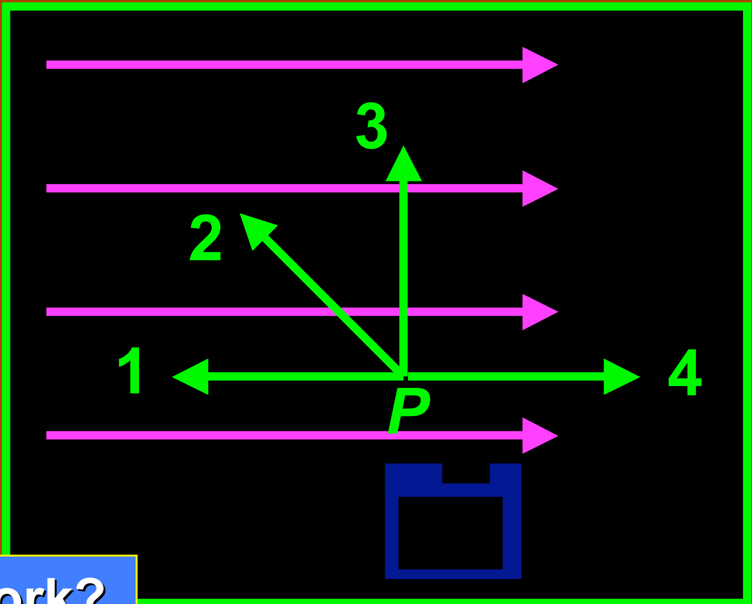


ConcepTest 17.7b Work and Electric Potential II

Which requires ***zero work***, to move a **positive** charge from ***P*** to points **1**, **2**, **3** or **4** ? All points are the same distance from ***P***.

1) $P \rightarrow 1$
2) $P \rightarrow 2$
3) $P \rightarrow 3$
4) $P \rightarrow 4$
5) all require the same amount of work

For **path #3**, you are moving in a direction perpendicular to the field lines. This means you are moving along an equipotential, which requires no work (by definition).

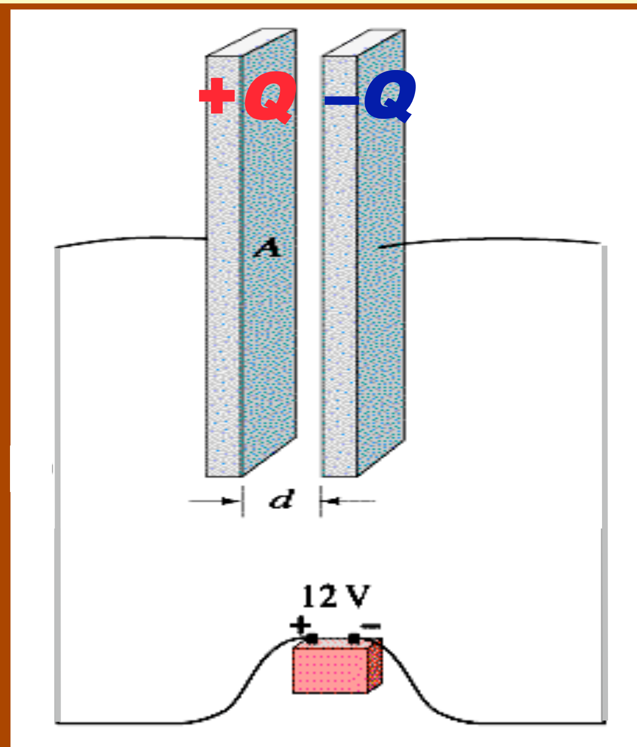


Follow-up: Which path requires the least work?

ConcepTest 17.8 Capacitors

Capacitor C_1 is connected across a battery of 5 V. An identical capacitor C_2 is connected across a battery of 10 V. Which one has the most charge?

1) C_1
2) C_2
3) both have the same charge
4) it depends on other factors

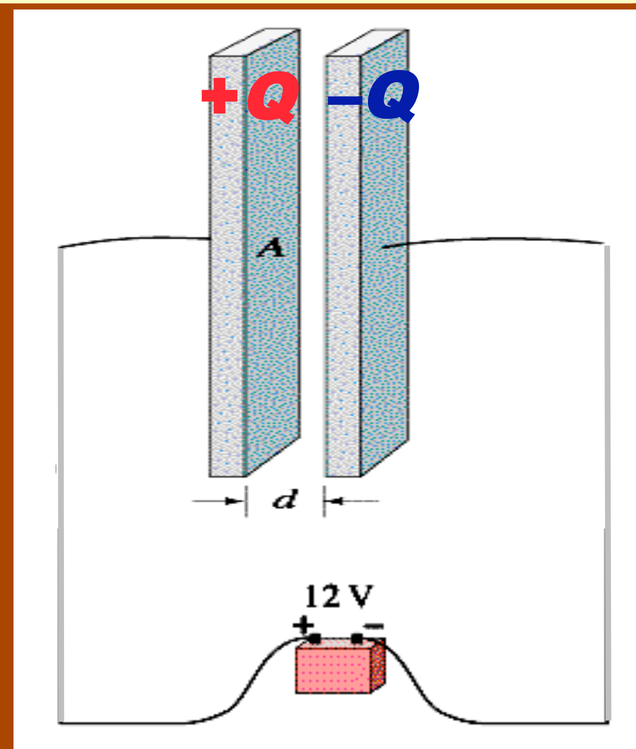


ConcepTest 17.8 Capacitors

Capacitor C_1 is connected across a battery of 5 V. An identical capacitor C_2 is connected across a battery of 10 V. Which one has the most charge?

1) C_1
2) C_2
3) both have the same charge
4) it depends on other factors

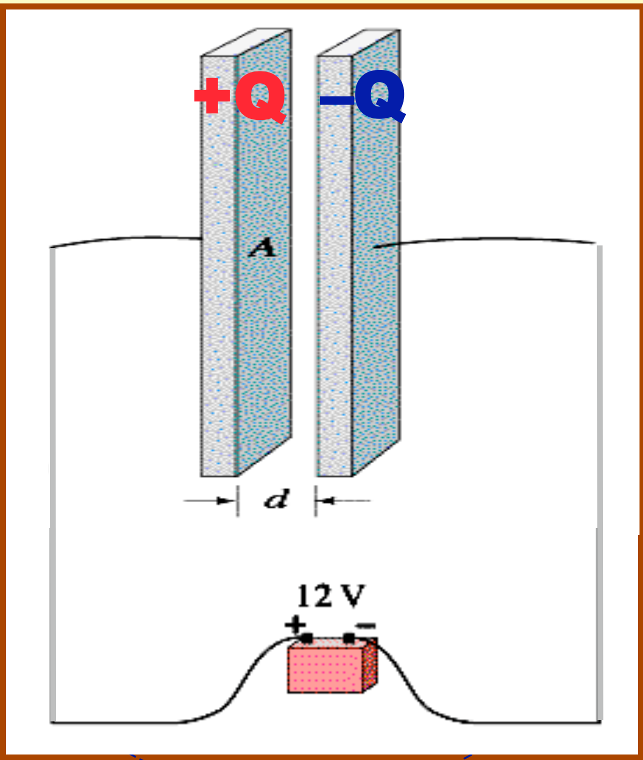
Since $Q = C\,V$ and the two capacitors are identical, the one that is connected to the greater voltage has the most charge, which is C_2 in this case.



ConcepTest 17.9a Varying Capacitance I

What must be done to a capacitor in order to increase the amount of charge it can hold (for a constant voltage)?

1) increase the area of the plates
2) decrease separation between the plates
3) decrease the area of the plates
4) either (1) or (2)
5) either (2) or (3)



ConcepTest 17.9a Varying Capacitance I

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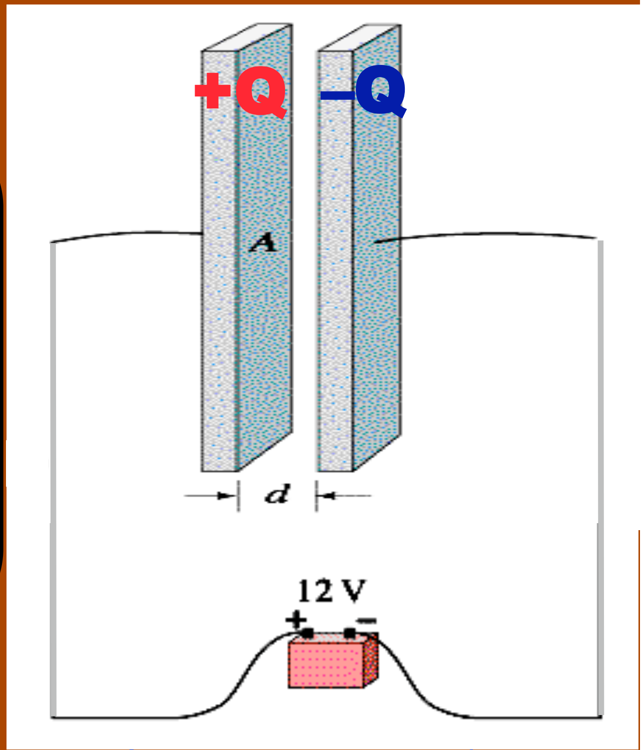
1) increase the area of the plates
2) decrease separation between the plates
3) decrease the area of the plates
4) either (1) or (2)
5) either (2) or (3)

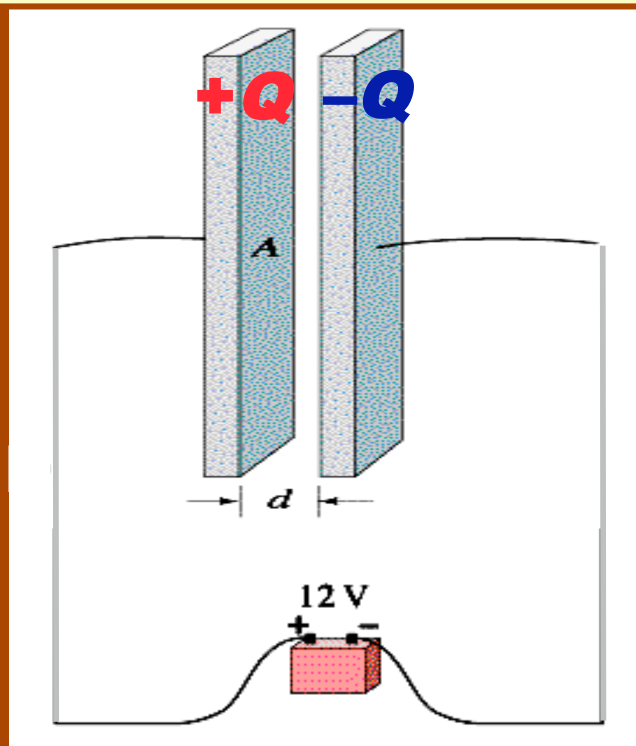
Since $Q = C\,V$, in order to increase the charge that a capacitor can hold at constant voltage, one has to **increase its capacitance**. Since the capacitance is given by $\blacksquare = \varepsilon_{\blacksquare} \frac{\blacksquare}{\blacksquare}$, that can be done by either **increasing A** or **decreasing d**.



ConcepTest 17.9b Varying Capacitance II

A parallel-plate capacitor initially has a voltage of 400 V and *stays connected to the battery*. If the plate spacing is now doubled, what happens?

1) the voltage decreases
2) the voltage increases
3) the charge decreases
4) the charge increases
5) both voltage and charge change

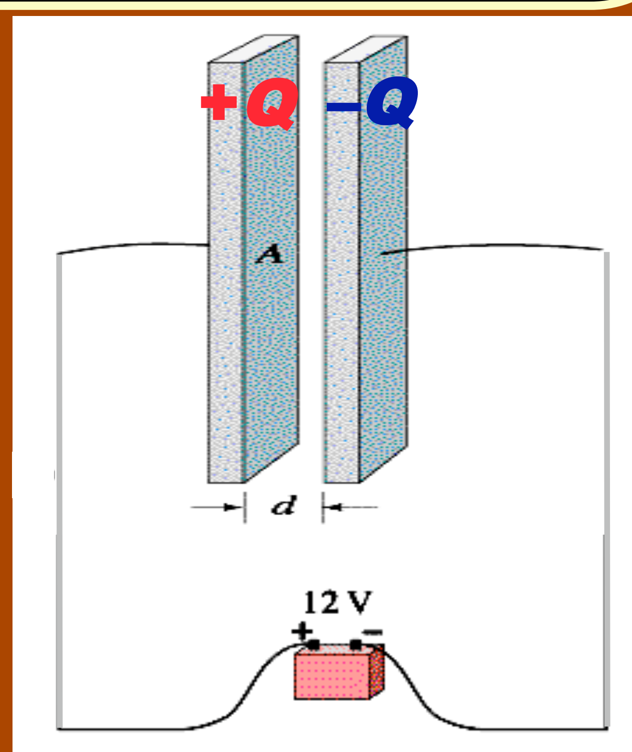


ConcepTest 17.9b Varying Capacitance II

A parallel-plate capacitor initially has a voltage of **400 V** and ***stays connected to the battery***. If the plate spacing is now **doubled**, what happens?

1) the voltage decreases
2) the voltage increases
3) the charge decreases
4) the charge increases
5) both voltage and charge change

Since the battery stays connected, the voltage must remain constant ! Since [redacted] when the spacing *d* is doubled, the capacitance *C* is halved. And since $Q = C V$, that means the **charge must decrease**.

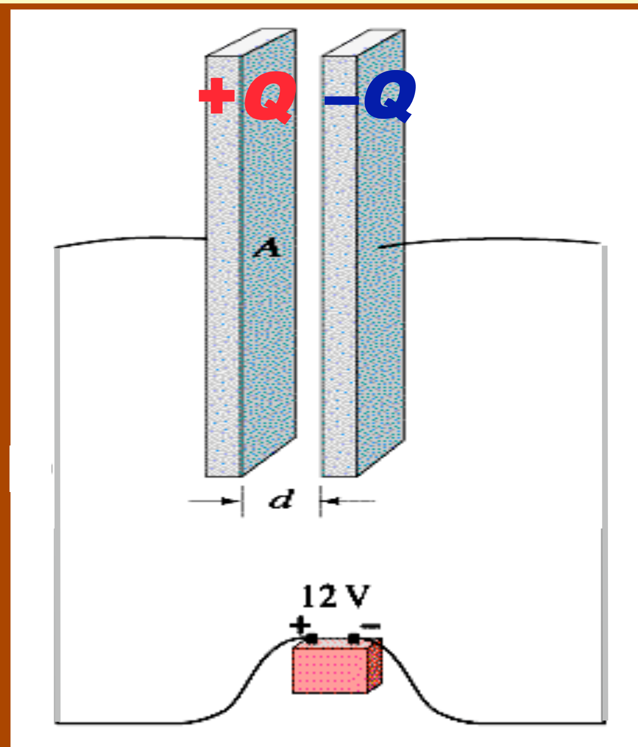


Follow-up: How do you increase the charge?

ConcepTest 17.9c Varying Capacitance III

A parallel-plate capacitor initially has a potential difference of 400 V and is then disconnected from the charging battery. If the plate spacing is now doubled (without changing Q), what is the new value of the voltage?

1) 100 V
2) 200 V
3) 400 V
4) 800 V
5) 1600 V



ConcepTest 17.9c Varying Capacitance III

A parallel-plate capacitor initially has a potential difference of **400 V** and is then disconnected from the charging battery. If the plate spacing is now **doubled** (without changing *Q*), what is the new value of the voltage?

1) 100 V
2) 200 V
3) 400 V
4) 800 V
5) 1600 V

Once the battery is disconnected, *Q* has to remain constant, since no charge can flow either to or from the battery. Since [redacted] = ε [redacted] when the spacing *d* is doubled, the capacitance *C* is halved. And since $Q = C\,V$, that means the **voltage must double**.