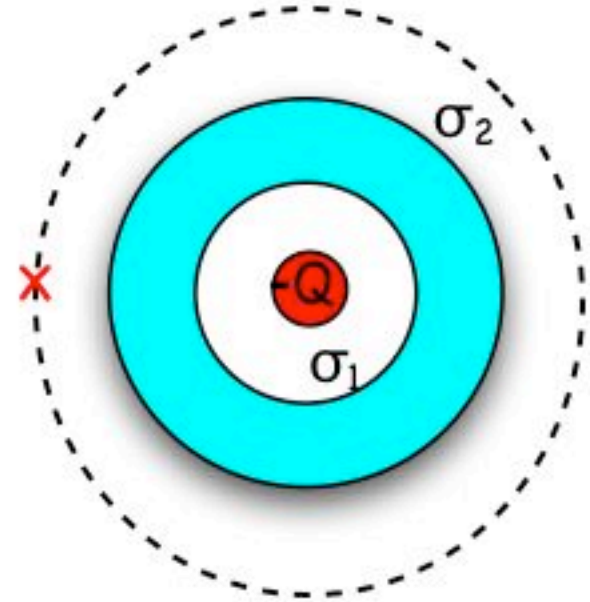
Consider the following two topologies:

a) A solid non-conducting sphere carries charge Q = -3 μC , and is surrounded by an uncharged conducting spherical shell.

b) Same as (a) but conducting shell removed.



Compare the electric field at point X in cases a and b:

1) $E_a < E_b$ 2) $E_a = E_b$ 3) $E_a > E_b$

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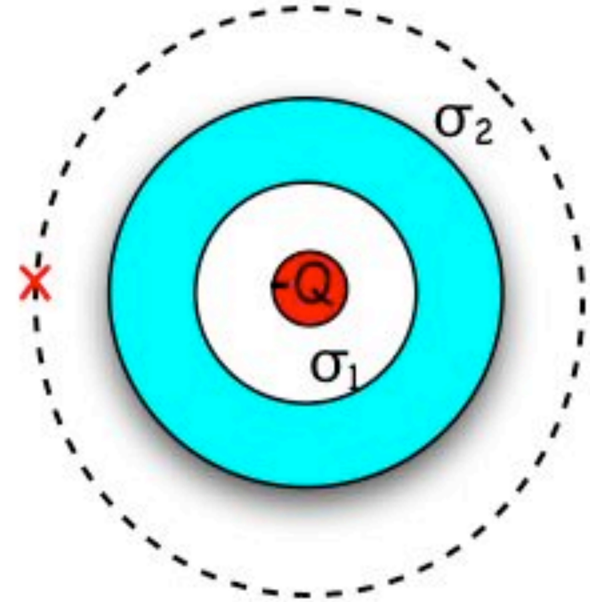

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Select a sphere passing through the point X as the Gaussian surface.

How much charge does it enclose?

Answer: -Q, whether or not the uncharged shell is present.

(The field at point X is determined only by the objects with NET CHARGE.)

Consider the following topologies:

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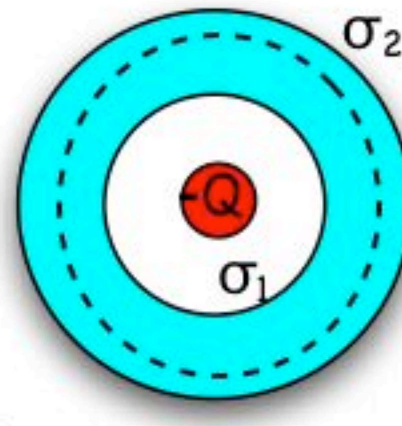

What is the surface charge density σ_1 on the inner surface of the conducting shell?

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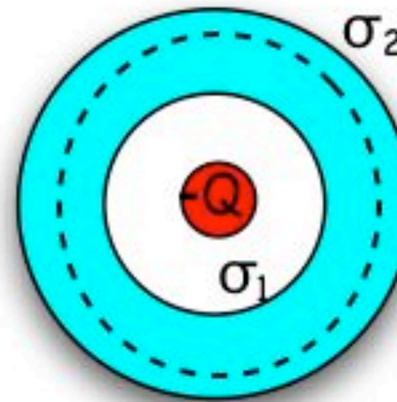

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Inside the conductor, we know the field: $E = 0$.
Select a Gaussian surface inside the conductor

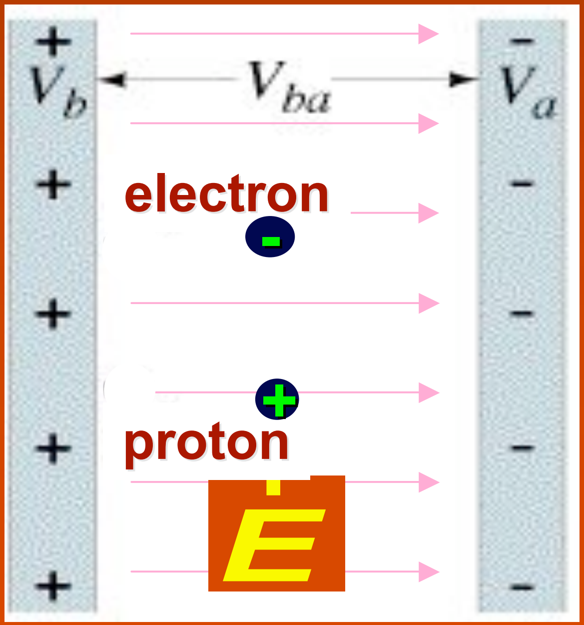
Since $E = 0$ on this surface, the total enclosed charge must be 0
Therefore σ_1 must be positive, to cancel the charge $-Q$

By the way, to calculate the actual value: $\sigma_1 = Q/(4\ \pi\ r_1^2)$

ConcepTest 24.1c 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



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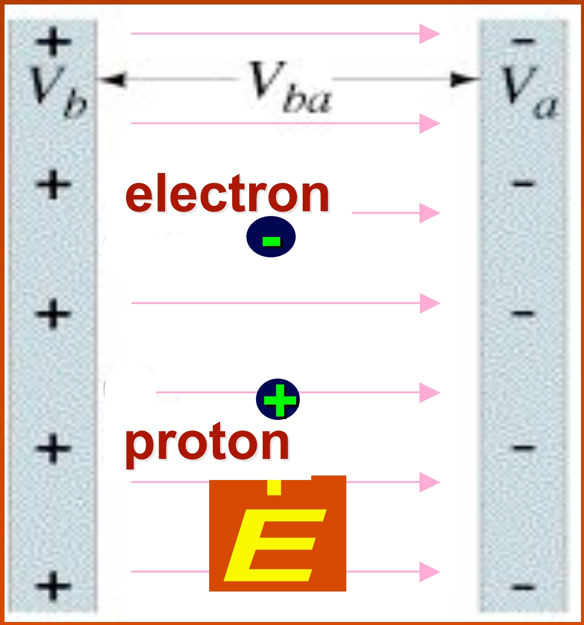
Since PE = qV and the proton and electron have the same charge in magnitude, they both have the same electric potential energy initially. Because energy is conserved, they both must have the same kinetic energy after they reach the opposite plate.



ConcepTest 24.4 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.

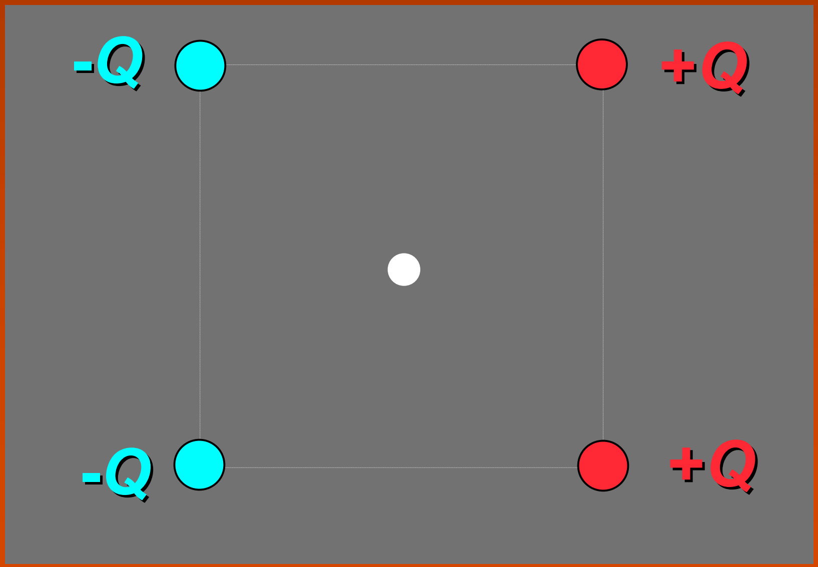
1) $E = 0$ $V = 0$

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



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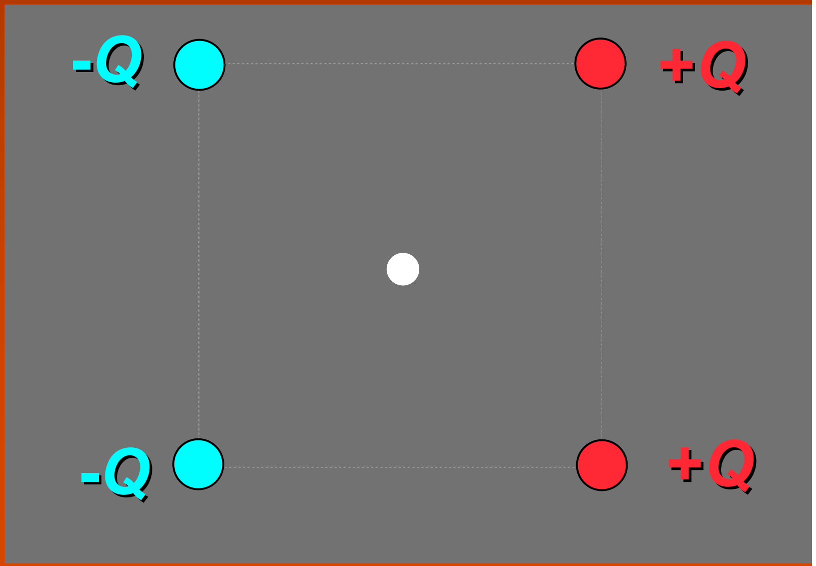
The **potential is zero**: the scalar contributions from the two positive charges cancel the two minus charges.

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

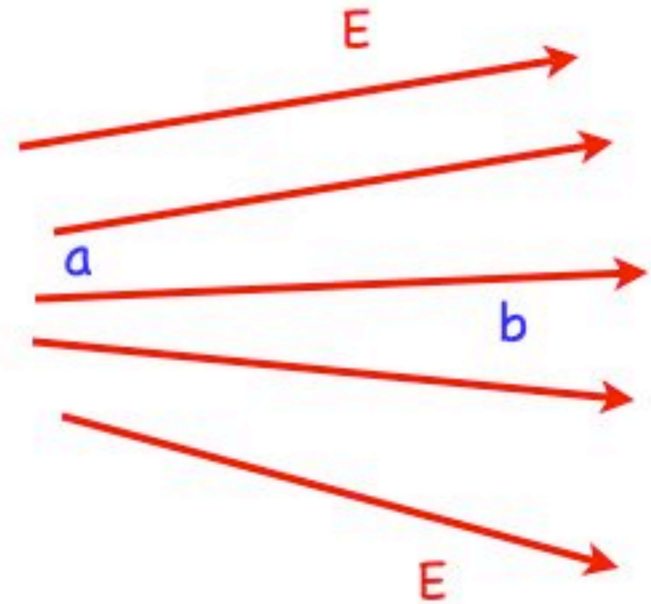


Follow-up: What is the direction of the electric field at the center?

Question

Two points a) and b) are located where there is an electric field. Is the potential difference $\Delta V = V_b - V_a$

i) positive   ii) negative   iii) zero?



Answer

Two points a) and b) are located where there is an electric field. Is the potential difference $\Delta V = V_b - V_a$

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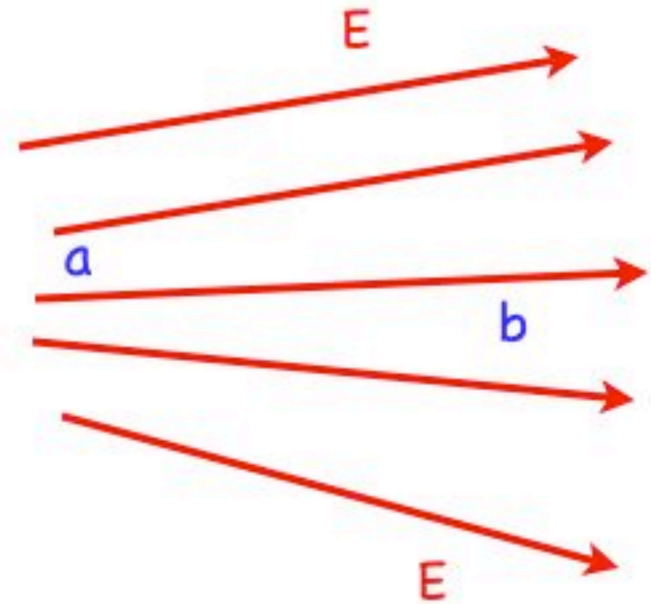


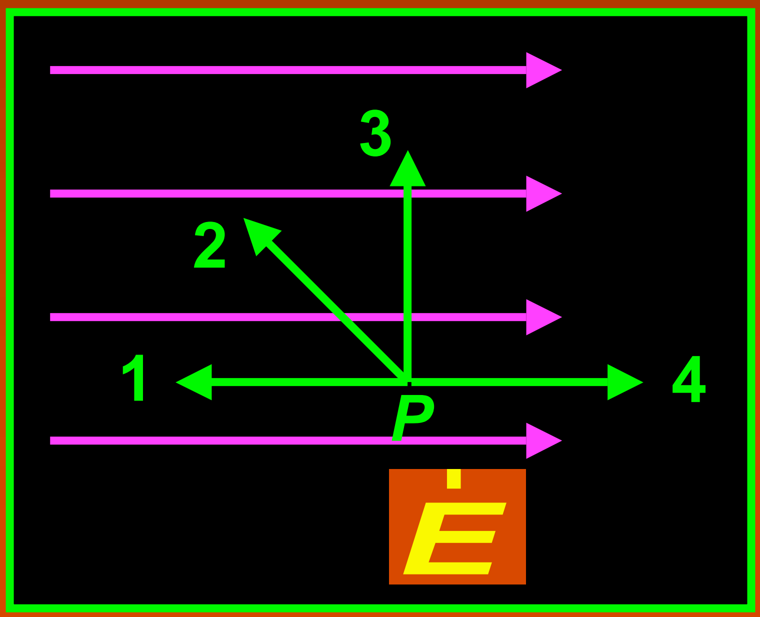
$$\Delta V = -\int_a^b \vec{E} \cdot d\vec{s}$$

Electric field lines always point in the direction of decreasing electric potential

ConcepTest 24.7b 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



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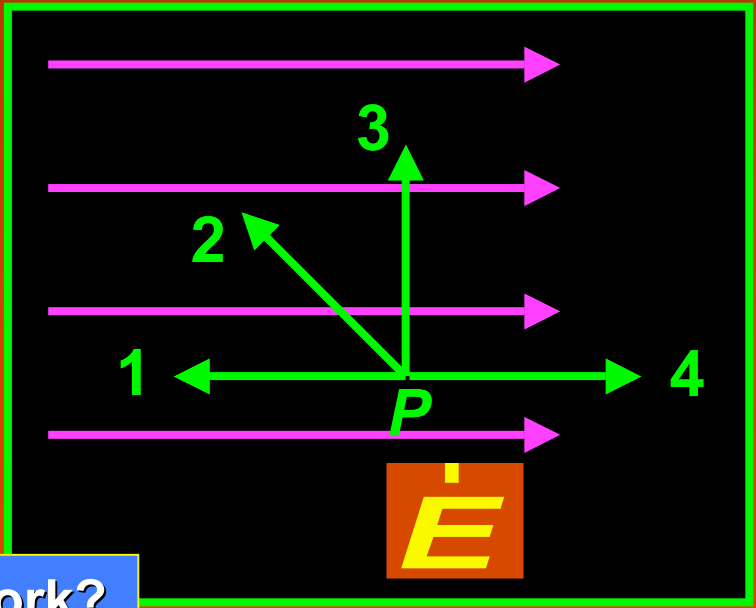
3) $P \rightarrow 3$

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?