

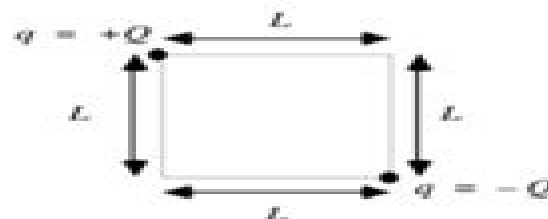
Samples of solutions to conceptual problems from chapter 19 Cutnell & Johnson 7E

2. A positive point charge and a negative point charge have equal magnitudes. One charge is fixed to one corner of a square, and the other is fixed to another corner. On which corners should the charges be placed, so that the same potential exists at the empty corners? Give your reasoning.

2. **REASONING AND SOLUTION** The potential at a point in space that is a distance r from a point charge q is given by Equation 19.6: $V = kq/r$. When more than one point charge is present, the total potential at any location is the algebraic sum of the individual potentials created by each charge at that location.

A positive point charge and a negative point charge have equal magnitudes. One of the charges is fixed to one corner of a square. If the other charge is placed opposite to the first charge along the diagonal of the square, then each charge will be the same distance L from the empty corners. The potential at each of the empty corners will be

$$V = \frac{k(+Q)}{L} + \frac{k(-Q)}{L} = 0$$



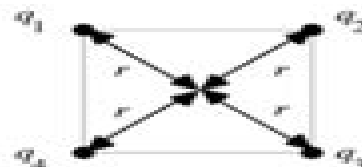
Therefore, if the potential at each empty corner is to be the same, then the charges must be placed at diagonally opposite corners as shown in the figure.

4. What point charges, all having the same magnitude, would you place at the corners of a square (one charge per corner), so that both the electric field and the electric potential (assuming a zero reference value at infinity) are zero at the center of the square? Account for the fact that the charge distribution gives rise to *both* a zero field and a zero potential.

4. **REASONING AND SOLUTION** Four point charges of equal magnitude are placed at the corners of a square as shown in the figure at the right.

The electric field at the center of the square is the *vector sum* of the electric field at the center due to each of the charges individually. The potential at the center of the square is equal to the *algebraic sum* of the potentials at the center due to each of the charges individually.

All four charges are equidistant from the center (a distance r in the figure). If two diagonal charges have the same magnitude and sign, then the electric field at the center due to these two charges have equal magnitude and opposite directions. Their resultant is, therefore, zero. Thus, the electric field at the center will be zero if each diagonal pair of charges has the same magnitude and sign.



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Solutions Manual [to Accompany] Physics, Third Edition, John D. Cutnell, Kenneth W. Johnson Mark J. Comella,1995

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