

27. In Figure P15.27, determine the point (other than infinity) at which the total electric field is zero.

Solution The electric field at any point will be the resultant of two contributions, one from each of the charges shown in the figure. The sum of two vectors can be zero only if the two vectors have the same magnitude and opposite directions.

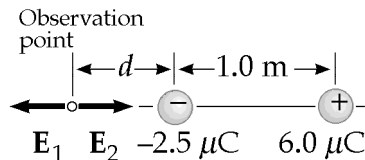


Figure P15.27

The electric field due to a positive charge points away from the charge, while the field of a negative charge points toward the charge. If, at the observation point, the contributions \mathbf{E}_1 and \mathbf{E}_2 are to have opposite directions, it is necessary that the observation point lie somewhere on the line connecting the two charges. Also, the observation point cannot be between the charges since the two contributions have the same directions there. Since the two contributions must also have the same magnitude, the distance from the observation point to the smaller charge must be less than the distance to the larger charge. Therefore, the observation point must be located some distance d to the left of the $-2.5 \mu\text{C}$ charge as shown. To solve for d ,

require that $|\mathbf{E}_2| = |\mathbf{E}_1|$ or $\frac{k_e |-2.5 \mu\text{C}|}{d^2} = \frac{k_e |6.0 \mu\text{C}|}{(d + 1.0 \text{ m})^2}$

This reduces to $2.5(d + 1.0 \text{ m})^2 = 6.0d^2$ or $d + 1.0 \text{ m} = \pm\sqrt{\frac{6.0}{2.5}}d = \pm 1.55d$

Solving, $d = \frac{1.0 \text{ m}}{+1.55 - 1} = 1.8 \text{ m}$ and $d = \frac{1.0 \text{ m}}{-1.55 - 1} = -0.39 \text{ m}$

The negative solution is unacceptable because it refers to a point located between the two charges where the two contributions have equal magnitudes but are in the same direction. Thus, the only point (other than at a infinite distance from both charges) where the resultant field is zero is located on the line connecting the two charges and 1.8 m to the left of the $-2.5 \mu\text{C}$ charge. ◇