Coulomb's Law & Superposition

Electric force · 6 questions · step-by-step answers at the end

Name: Date: Score: / 6

USEFUL EQUATIONS

$F = k|q_1 q_2|/r^2$ $k = 1/(4\pi\varepsilon_0) = 8.99 \times 10^9\ \text{N·m}^2/\text{C}^2$ $\mathbf{F}_{\text{net}} = \Sigma \mathbf{F}_i$ $|F| = \sqrt{(\Sigma F_x^2 + \Sigma F_y^2)}$

Questions

Show your working in the space under each question.

1. Two charges attract with 0.60 N. The distance between them is doubled. What is the new force?

2. A +1.0 µC test charge sits at the origin. +4.0 µC is 0.30 m directly above it, and −3.0 µC is 0.40 m to its right. Find the net force on the test charge.

3. Both charges are doubled and their separation is halved. By what factor does the force change?

4. Two +2.0 µC charges sit at (−0.30 m, 0) and (+0.30 m, 0). Find the force on a +1.0 µC charge at (0, 0.40 m).

5. Four equal positive charges sit at the corners of a square. What is the net force on a charge at the centre?

6. If the distance between two charges is tripled and one charge is doubled, what happens to the force?

Step-by-step answers

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1. Inverse square: F/4 = **0.15 N**.

2. 1. From the +4.0 μC charge: $F_1 = (8.99 \times 10^9)(4.0 \times 10^{-6})(1.0 \times 10^{-6})/(0.30)^2 =$ 0.400 N, pushing **down** (repulsion).
2. From the −3.0 μC charge: $F_2 = (8.99 \times 10^9)(3.0 \times 10^{-6})(1.0 \times 10^{-6})/(0.40)^2 =$ 0.169 N, pulling **right** (attraction).
3. They're perpendicular: $F_{net} = \sqrt{(0.400^2 + 0.169^2)} =$ **0.43 N**.
4. Direction: $\tan\theta = 0.400/0.169 \rightarrow \theta =$ **67° below the +x axis**.

Answer: 0.43 N at 67° below +x

3. $(2 \times 2)/(½)^2 =$ **16**.

4. Each is 0.50 m away: F = 0.072 N. The x-components cancel and the y-components add: 2(0.072)(0.8) = **0.115 N, in the +y direction**.

5. **Zero**: opposite corners cancel in pairs.

6. F × 2/9, so it becomes **2/9** of the original.