Group #	Student	Last Name	First Name
	1		
	2		
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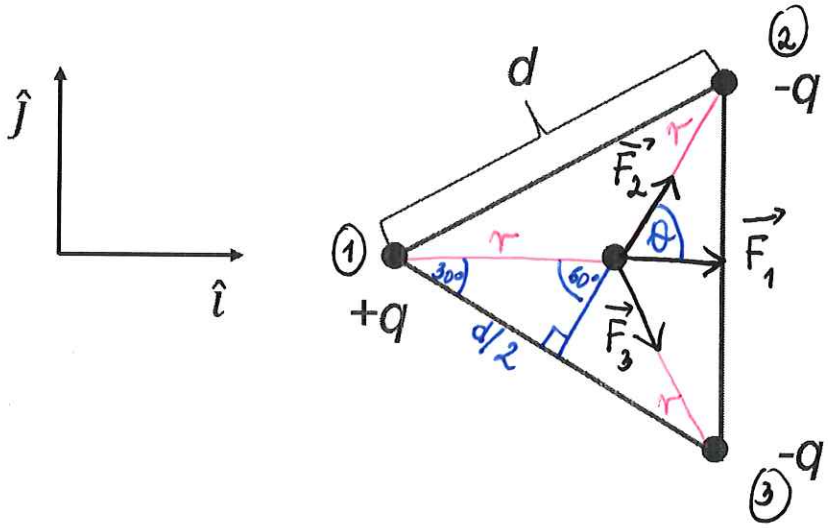
(10 marks) Three charges are placed in the corners of the equilateral triangle with side-length d as shown on the diagram below. All charges are equal in magnitude, and their sign is indicated on the diagram below. What is the net force (magnitude and direction) on the positive charge of the same magnitude located in the center of the triangle due to the other three charges? Note: the outer charges are placed equidistant from the center charge.



The parts below walk you through related questions, and the steps with which to solve this problem. Please show all work in the boxes provided and then choose the correct answer at the bottom

1. **(1.5 marks)** On the diagram above draw the distances r for the different Coulomb's law pairs that are needed to solve this question (0.5 mark). From properties of 30-60-90 triangles find the value of the distances as a function of d (1 mark).

$\frac{d/2}{r} = \cos 30°$, $r \cos 30° = \frac{d}{2}$, $r = \frac{d}{2\cos 30°}$

$r = \frac{d}{2 \cdot \sqrt{3}/2} = \frac{d}{\sqrt{3}}$

If other method used to find r geometrically – grant mark.

2. **(2 marks)** On the diagram above, draw and label the forces on the central charge due to each surrounding charge (2 marks). Make sure that the correct magnitude and direction are accurately portrayed (0.5 mark). Indicate any angles needed for find the components of the forces (0.5 marks).

3. **(1.5 mark)** Will any of the force vector components cancel? (0.5) Explain (1 mark).

(0.5)

Yes. There is a symetry along x- axis. Y- components of $\vec{F}_3$ and $\vec{F}_2$ cancel. $\vec{F}_1$ has only x- component.

1 mark.

4. **(1 mark)** Write a mathematical expression for the magnitude of the force from each of the charges on the central charge.

$$|\vec{F}_1| = |\vec{F}_2| = |\vec{F}_3| = \frac{kq^2}{\left(\frac{d}{\sqrt{3}}\right)^2} = \frac{3kq^2}{d^2}$$

5. **(3 marks)** Using the principle of superposition, find the net force (magnitude and direction) on the central charge due to the surrounding charges (1 mark). Remember to show your work (2 marks).

$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$ 1 mark

As stated in 3. → y-components cancel.

$F_{net,x} = F_1 + F_2 \cdot \cos\theta + F_3 \cos\theta$ 1 mark $\quad \theta = 60°$, $\cos\theta = \frac{1}{2}$

$F_{net,x} = \frac{3kq^2}{d^2} + 2 \cdot \frac{3kq^2}{d^2} \cdot \frac{1}{2} = \frac{6kq^2}{d^2}$ 1 mark, $\vec{F}_{net} = \frac{6kq^2}{d^2}\hat{i}$

(1 mark for the correct answer) Circle answer below:

A. $3\frac{kq^2}{d^2}\hat{i}$ B. $-3\frac{kq^2}{d^2}\hat{j}$ C. $6\frac{kq^2}{d^2}\hat{i}$ D. $6\sqrt{3}\frac{kq^2}{d^2}\hat{i}$