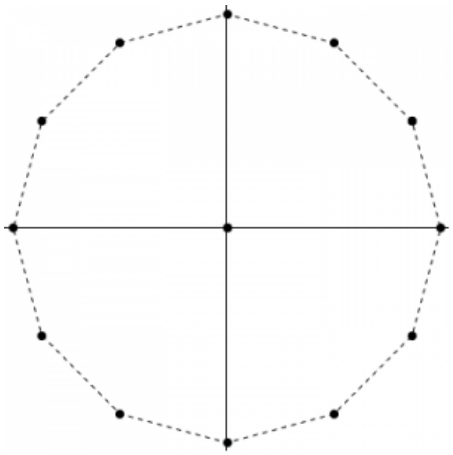
Answer on Question #60184, Physics / Electromagnetism |

12 equal charges are 'q' are situated at the corner of a regular 12-sided polygon.
what is
a)net force on test charge Q
b)electric field
c)potential
at the centre?

Solution:



a)

In order to find the net force on Q apply the principle of superposition and sum the forces acting on Q. The model for the net force on Q is

$$\vec{F}_Q = \sum_{n=1}^{12} \frac{1}{4\pi\epsilon_0}\frac{qQ}{R^2}\left(\cos\left(\frac{n\pi}{6}\right)\hat{i} + \sin\left(\frac{n\pi}{6}\right)\hat{j}\right)$$

By symmetry each nth radial contains two charges q which results in zero net force. For example,

$$\frac{1}{4\pi\epsilon_0}\frac{qQ}{R^2}\left(\cos\left(\frac{n\pi}{6}\right)\hat{i} + \sin\left(\frac{n\pi}{6}\right)\hat{j}\right) + \frac{1}{4\pi\epsilon_0}\frac{qQ}{R^2}\left(\cos\left(\frac{(n+6)\pi}{6}\right)\hat{i} + \sin\left(\frac{(n+6)\pi}{6}\right)\hat{j}\right) = \vec{0}$$

$$\frac{1}{4\pi\epsilon_0}\frac{qQ}{R^2}\left[\left(\cos\left(\frac{n\pi}{6}\right) + \cos\left(\frac{n\pi}{6}+\pi\right)\right)\hat{i} + \left(\sin\left(\frac{n\pi}{6}\right) + \sin\left(\frac{n\pi}{6}+\pi\right)\right)\hat{j}\right] = \vec{0}$$

Summing the six radials yields $\vec{F}_Q = 0$.

b)

Because of the symmetry, the net field is although equal zero.

$$\vec{E}_Q = 0$$

c)

Suppose distance from each point to center is *r:*

The electric potential does not "cancel" out, so this sum will add all potentials

$$V = 12\frac{kq}{r}$$