Answer on Question #54367-Physics-Other

Four corners each equal to Q are placed at the four corners of the square and a charges q is placed at the center of the square. If the system is in equilibrium then the value of q is

(1)Q/2(1+2√2)

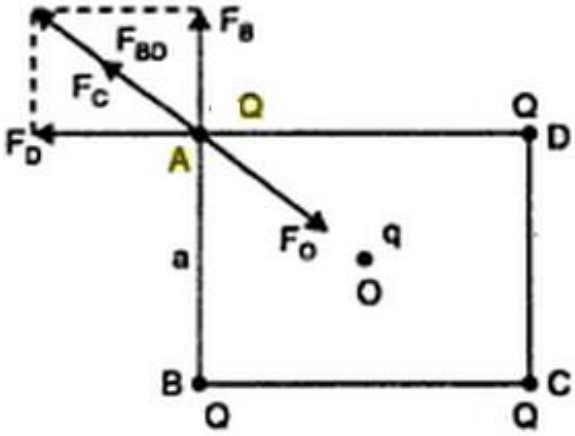
(2)-Q/4(1+2√2)

(3)Q/4(1+2√2)

(4)-Q/2(1+2√2)

Solution

Consider the equilibrium of charge Q at A.



$$F_B = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2}$$

$$F_D = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{a^2}$$

$$F_{BD} = \sqrt{2}F_D = \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}Q^2}{a^2}$$

$$F_C = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(\sqrt{2}a)^2} = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2}$$

$$F_O = \frac{1}{4\pi\varepsilon_0}\frac{-qQ}{\left(\frac{\sqrt{2}a}{2}\right)^2} = \frac{1}{4\pi\varepsilon_0}\frac{-2qQ}{a^2}$$

For equilibrium

$$F_{BD} + F_C = F_O$$

$$\frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}Q^2}{a^2} + \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2} = \frac{1}{4\pi\varepsilon_0}\frac{-2qQ}{a^2}$$

$$q = -\frac{Q}{4}\left(1 + 2\sqrt{2}\right).$$

Answer: (2)-Q/4(1+2√2).