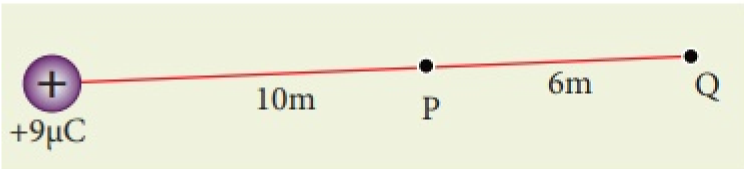
**EXAMPLE 1**

(a) Calculate the electric potential at points P and Q as shown in the figure below.

(b) Suppose the charge +9μC is replaced by -9μC find the electrostatic potentials at points P and Q




**Solution**

(a) Electric potential at point P is given by

$$V_P = \frac{1}{4\pi\varepsilon_\circ}\frac{q}{r_P} = \frac{9\times10^9\times9\times10^{-6}}{10} = 8.1\times10^3 V$$

Electric potential at point Q is given by

$$V_Q = \frac{1}{4\pi\varepsilon_\circ}\frac{q}{r_Q} = \frac{9\times10^9\times9\times10^{-6}}{16} = 5.06\times10^3 V$$

The potential difference between the points P and Q is given by

$\Delta V = V_P - V_Q = +3.04 \times 10^3 V$

(b) Suppose we replace the charge +9 μC by -9 μC, then the corresponding potentials at the points P and Q are,

$V_P = -8.1\times10^3$ V , $V_Q = -5.06 \times 10^3 V$

Note that in this case electric potential at the point Q is higher than at point P.

The potential difference or voltage between the points P and Q is given by

$\Delta V = V_P - V_Q = -3.04 \times 10^3 V$

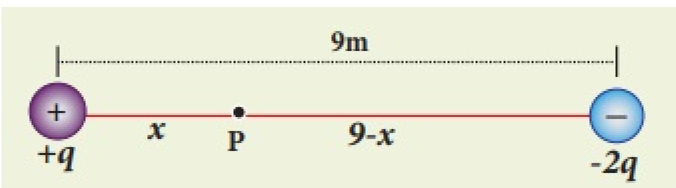
**EXAMPLE 2**

Consider a point charge +q placed at the origin and another point charge -2q placed at a distance of 9 m from the charge +q. Determine the point between the two charges at which electric potential is zero.

**Solution**

According to the superposition principle, the total electric potential at a point is equal to the sum of the potentials due to each charge at that point.

Consider the point at which the total potential zero is located at a distance x from the charge +q as shown in the figure.




The total electric potential at P is zero.

$$V_{tot} = \frac{1}{4\pi\varepsilon_\circ}\left(\frac{q}{x} - \frac{2q}{(9-x)}\right) = 0$$

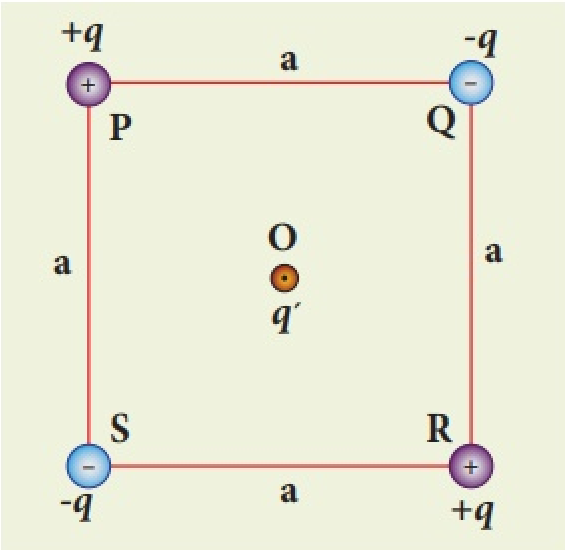
which gives $\dfrac{q}{x} = \dfrac{2q}{(9-x)}$

or $\dfrac{1}{x} = \dfrac{2}{(9-x)}$

Hence, $x = 3\text{ m}$

**EXAMPLE 3**

Four charges are arranged at the corners of the square PQRS of side a as shown in the figure. Find the work required to assemble these charges in the given configuration.




**Solution**

The work done to arrange the charges in the corners of the square is independent of the way they are arranged. We can follow any order.

(i) First, the charge +q is brought to the corner P. This requires no work since no charge is already present, $W_P = 0$

(ii) Work required to bring the charge –q to the corner Q:

$$W_Q = -q \times \frac{1}{4\pi\varepsilon_\circ}\frac{q}{a} = -\frac{1}{4\pi\varepsilon_\circ}\frac{q^2}{a}$$

(iii) Work required to bring the charge +q to the corner R:

$$W_R = q \times \frac{1}{4\pi\varepsilon_\circ}\left(-\frac{q}{a} + \frac{q}{\sqrt{2}a}\right)$$

$$= \frac{1}{4\pi\varepsilon_\circ}\frac{q^2}{a}\left(-1 + \frac{1}{\sqrt{2}}\right)$$

(iv)Work required to bring the fourth charge –q at the position S:

$$W_s = -q \times \frac{1}{4\pi\varepsilon_\circ}\left(\frac{q}{a} + \frac{q}{a} - \frac{q}{\sqrt{2}a}\right)$$

$$W_s = -\frac{1}{4\pi\varepsilon_\circ}\frac{q}{a}\left(2 - \frac{1}{\sqrt{2}}\right)$$