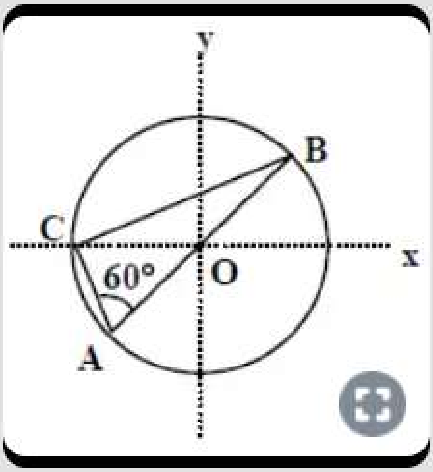
Consider a system of three charges $\frac{q}{3}$, $\frac{q}{3}$ and $-\frac{2q}{3}$ placed at points A, B and C, respectively, as shown in the figure. Take O to be the centre of the circle of radius R and angle CAB = 60°



A The electric field at point O is $\frac{q}{8\pi\epsilon_0 R^2}$ directed along the negative x-axis

B The potential energy of the system is zero

C The magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\epsilon_0 R^2}$

D The potential at point O is $\frac{q}{12\pi\epsilon_0 R}$

Correct option is C)

The electric field at O due to charges at A and B are cancel out because both charges are equal and same sign at A and B. Thus only charge at C will contribute the field at O.

The filed at O is $E = \frac{1}{4\pi\epsilon_0}\frac{(-2q/3)}{R^2} = -\frac{q}{6\pi\epsilon_0 R^2}$ along negative x axis.

Potential energy $U = \frac{1}{4\pi\epsilon_0}\left[\frac{(q^2/9)}{AB} + \frac{(-2q^2/9)}{BC} + \frac{(-2q^2/9)}{AC}\right] =$

$$\frac{1}{4\pi\epsilon_0}\left[\frac{(q^2/9)}{2R} + \frac{(-2q^2/9)}{2R(\sqrt{3}/2)} + \frac{(-2q^2/9)}{2R(1/2)}\right] \neq 0$$

The force between charges at B and C is $F = \frac{1}{4\pi\epsilon_0}\frac{(q/3)(-2q/3)}{BC^2} =$

$$-\frac{1}{4\pi\epsilon_0}\frac{2q^2}{9(2R\sin 60)^2} = -\frac{1}{4\pi\epsilon_0}\frac{2q^2}{9(4R^2 \times 3/4)}$$

$$|F| = \frac{q^2}{54\pi\epsilon_0 R^2}$$

Potential at O is $V = \frac{1}{4\pi\epsilon_0}\left[\frac{(q/3)}{OA} + \frac{(q/3)}{OB} + \frac{(-2q/3)}{OC}\right] =$

$$\frac{1}{4\pi\epsilon_0}\left[\frac{(q/3)}{R} + \frac{(q/3)}{R} + \frac{(-2q/3)}{R}\right] = 0$$