

PHYSICS • CLASS 12

CHAPTER 2

Electrostatic Potential and Capacitance

NCERT SOLUTIONS



ZERO POTENTIAL — EXERCISE 2.1

Q. Two charges $+5 \times 10^{-8} \text{ C}$ and $-3 \times 10^{-8} \text{ C}$ are 16 cm apart. At which points on the line joining them is the potential zero? Take the potential at infinity as zero.

Answer: Put the positive charge at $x = 0$ and the negative charge at $x = 16 \text{ cm}$. Distances in the equations below are in centimetres; the common conversion factor cancels.

Between the charges:

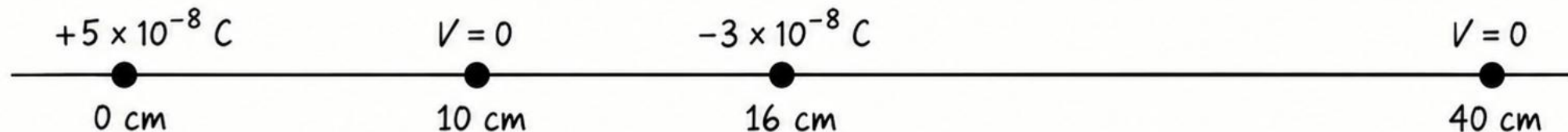
$$\begin{aligned}\frac{5}{x} &= \frac{3}{16-x} \\ 5(16-x) &= 3x \\ 80 - 5x &= 3x \\ x &= 10 \text{ cm.}\end{aligned}$$

Beyond the negative charge:

$$\begin{aligned}\frac{5}{x} &= \frac{3}{x-16} \\ 5(x-16) &= 3x \\ 5x - 80 &= 3x \\ x &= 40 \text{ cm.}\end{aligned}$$

To the left of the positive charge, its larger magnitude and shorter distance make the potential positive; there is no solution there.

The two finite points are 10 cm and 40 cm from the positive charge, towards the negative charge.



POTENTIAL AT THE CENTRE — EXERCISE 2.2

Q. A regular hexagon of side 10 cm has a charge of $+5 \mu\text{C}$ at each vertex. Calculate the potential at its centre.

Answer:

In a regular hexagon, the centre-to-vertex distance equals the side length. Potential is a scalar, so all six positive contributions add.

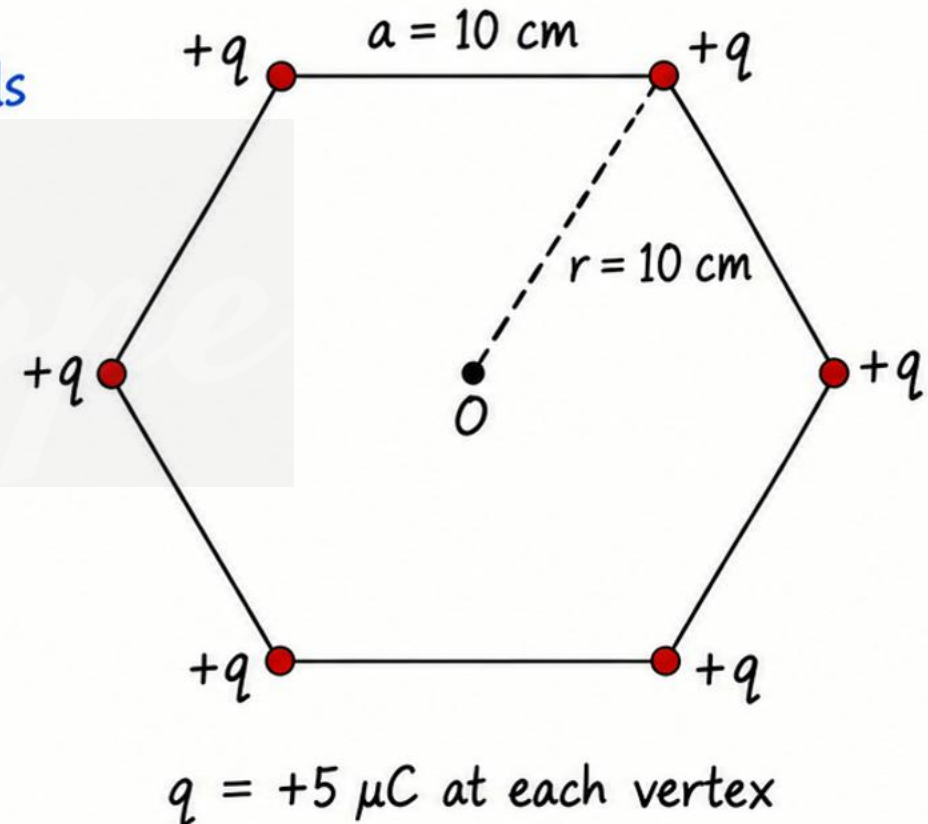
$$r = a = 10 \text{ cm} = 0.10 \text{ m}$$

$$q = 5 \mu\text{C} = 5 \times 10^{-6} \text{ C}$$

$$V = \frac{6kq}{r}$$

$$V = \frac{6(9 \times 10^9)(5 \times 10^{-6})}{0.10}$$

$$V = +2.7 \times 10^6 \text{ V}$$



EQUIPOTENTIAL SURFACE – EXERCISE 2.3

Q. Charges $+2 \mu\text{C}$ and $-2 \mu\text{C}$ are at A and B, 6 cm apart.

(a) Identify an equipotential surface.

(b) Give the electric-field direction at every point on it.

Answer:

(a) The plane perpendicular to AB through its midpoint is an equipotential surface. Every point P on this plane is equally far from the two charges.

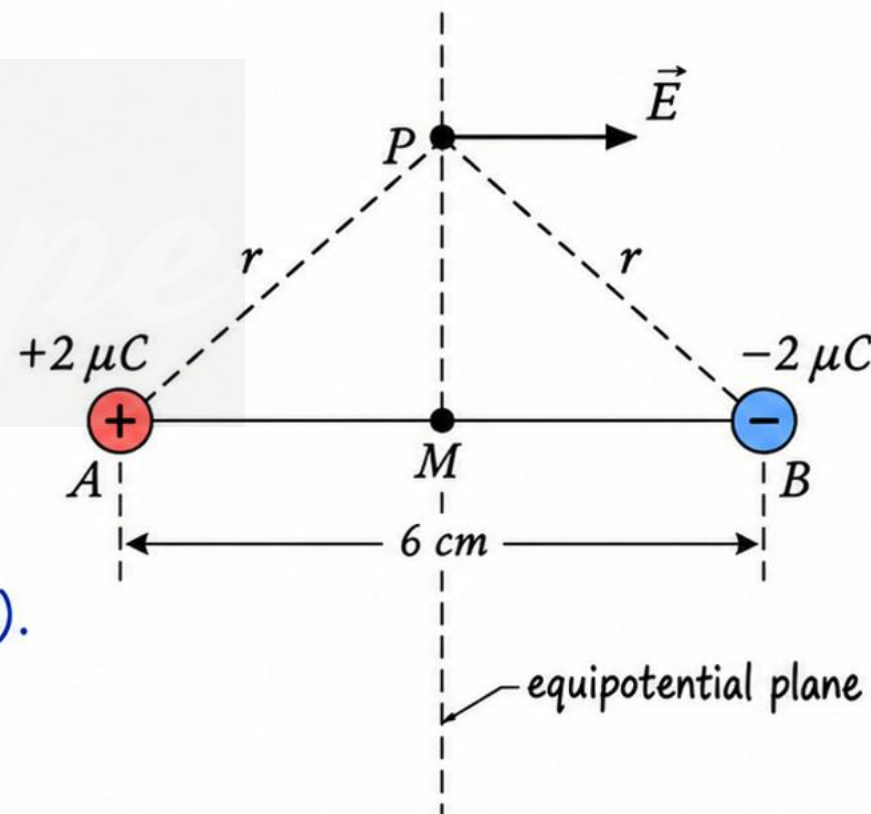
$$AP = BP = r$$

$$V(P) = \frac{k(2 \times 10^{-6})}{r} - \frac{k(2 \times 10^{-6})}{r} = 0.$$

(b) The electric field is perpendicular to this plane and parallel to AB, directed from A (positive) towards B (negative). The components parallel to the plane cancel; the components along AB add.

$V = 0$, but $E \neq 0$ at finite points on the plane.

Cross-section of the plane:



FIELD OF A CONDUCTOR – EXERCISE 2.4

Q. A spherical conductor of radius 12 cm carries charge $+1.6 \times 10^{-7} \text{ C}$ uniformly on its surface. Find the electric field (a) inside, (b) just outside, and (c) 18 cm from its centre.

(a) Inside:

Answer:

In electrostatic equilibrium, the field inside a conductor is zero.

$$E = 0 \text{ N/C}$$

(b) Just outside:

Answer:

$$\begin{aligned} R &= 0.12 \text{ m} \\ E &= \frac{kQ}{R^2} \\ &= \frac{(9 \times 10^9)(1.6 \times 10^{-7})}{(0.12)^2} \\ &= \frac{1440}{0.0144} \end{aligned}$$

$$E = 1.0 \times 10^5 \text{ N/C}$$

(c) At $r = 0.18 \text{ m}$:

Answer:

$$\begin{aligned} E &= \frac{kQ}{r^2} \\ &= \frac{(9 \times 10^9)(1.6 \times 10^{-7})}{(0.18)^2} \\ &= \frac{1440}{0.0324} \end{aligned}$$

$$E \approx 4.44 \times 10^4 \text{ N/C}$$

Outside, the sphere acts like a point charge at its centre. Both nonzero fields point radially outward because the charge is positive. Use distance from the centre, not from the surface.

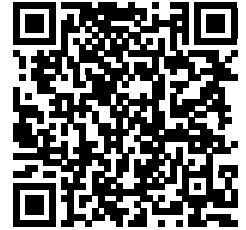


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