Parishram (2025)

Physics

DPP: 3

Electrostatic Potential and Capacitance

Q1 Two points are at distances a and $b(a < b)$ from a long wire having charge per unit length λ. The potential difference between the points is proportional to:

(A) $\frac{b}{a}$

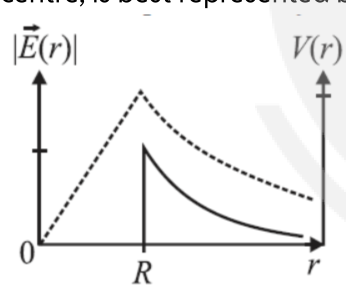
(B) $\frac{b^2}{a^2}$

(C) $\sqrt{\frac{b}{a}}$

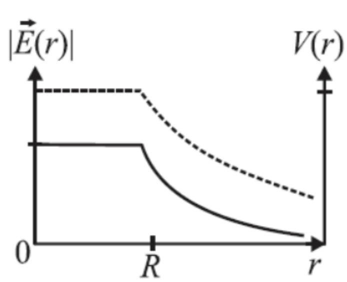
(D) $\ln \frac{b}{a}$

Q2 Consider a thin spherical shell of radius R with its centre at the origin, carrying uniform positive surface charge density. The variation of the magnitude of the electric field $|\vec{E}(r)|$ and the electric potential $V(r)$ with the distance r from the centre, is best represented by which graph

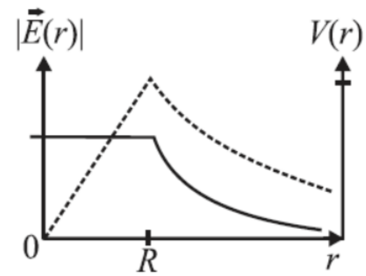
(A)



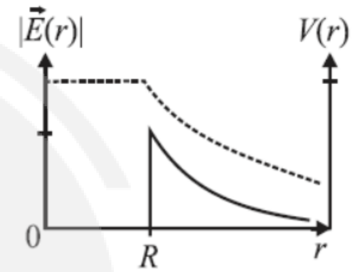
(B)



(C)



(D)



Q3 A conducting sphere of radius R is given a charge Q. The electric potential and the electric field at the centre of the sphere respectively are

(A) $\frac{Q}{4\pi\varepsilon_0 R}$ and zero

(B) $\frac{Q}{4\pi\varepsilon_0 R}$ and $\frac{Q}{4\pi\varepsilon_0 R^2}$

(C) Both are zero

(D) Zero and $\frac{Q}{4\pi\varepsilon_0 R^2}$

Q4 A semi-circular ring of radius R is having uniform charge density λ. Find the potential at the centre of the ring.

(A) $2\lambda/\varepsilon_0$

(B) $\lambda/4\varepsilon_0$

(C) $\lambda/3\varepsilon_0$

(D) λ/ε_0

Q5 A rod of length L lies along the x-axis with its left end at the origin. It has charge Q uniformly distributed. Find the electric potential at point x = 2L.

(A) $\frac{kQ}{L}$

(B) $\frac{KQ\log_e 2}{L}$

(C) $\frac{2KQ}{L}$

(D) $\frac{KQ}{L}\log 4$

Answer Key

Q1	(D)
Q2	(D)
Q3	(A)
Q4	(B)
Q5	(B)

Hints & Solutions

Note: scan the QR code to watch video solution

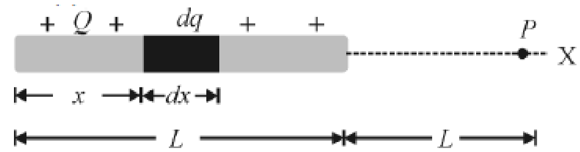
Q1 Video Solution:

Q2 Video Solution:

Q3 Video Solution:

Q4 Video Solution:

Q5 Text Solution:



Charge per unit length $\lambda = \frac{Q}{L}$

Taking O as origin, take an element of small length dx at distance x from the origin.

Charge on element $dq = \lambda dx$

Small potential at P due to dq

$$dV = \frac{1}{4\pi^2\varepsilon_0} \cdot \frac{dq}{(2L-x)} = \frac{Q}{4\pi\varepsilon_0 L} \frac{dx}{(2L-x)}$$

$$V_P = \frac{Q}{4\pi\varepsilon_0 L} \int_o^L \frac{dx}{(2L-x)}$$

$$I = \int_o^L \frac{dx}{(2L-x)} = \frac{\left|\log_e (2L-x)\right|_0^L}{-1}$$

$$= -\left[\log_e (2L-L) - \log_e (2L-0)\right]$$

$$= -\log_e \left(\frac{L}{2L}\right) = -\log_e \left(\frac{1}{2}\right) = \log_e 2$$

$$V_P = \frac{1}{4\pi\varepsilon_0} \frac{Q\log_e 2}{L}$$