Nishant Jindal

Conductor

$\boxed{q_{ind} \neq q}$ [Neutral Conductor]

Imp.

❖ Electric field and potential due to Induced Charges:-

① Find

a) Net Electric field at B $\Rightarrow 0 = (E_{net})_B$.

b) Electric field due to induced Charge.

↳ $(\vec{E}_{net})_B = (\vec{E}_{+q})_B + (\vec{E}_{induced})_B$

$\Downarrow$

$0 = (\vec{E}_{+q})_B + (\vec{E}_{induced})_B$

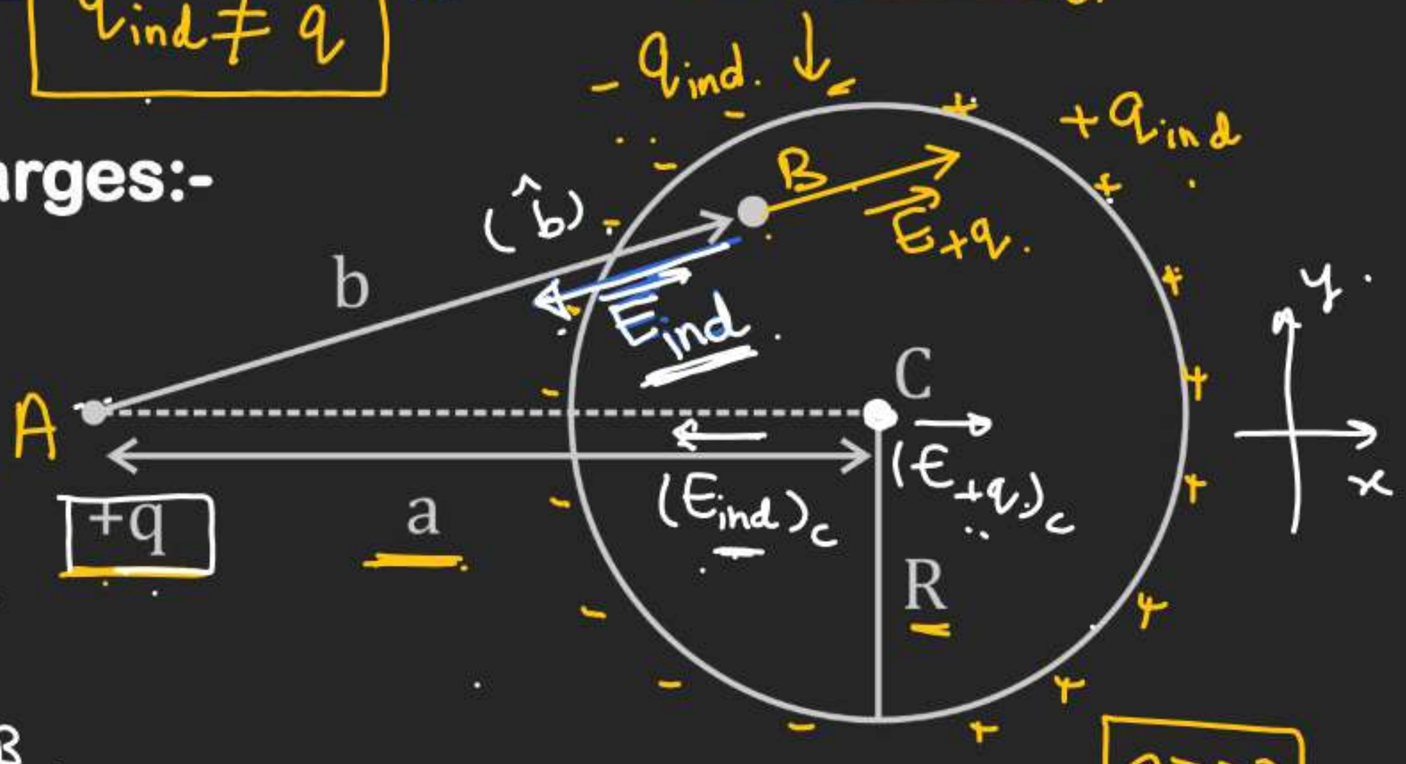
$(\vec{E}_{induced})_B = -(\vec{E}_{+q})_B = \left[\frac{-Kq}{b^2}\right]\hat{b}$

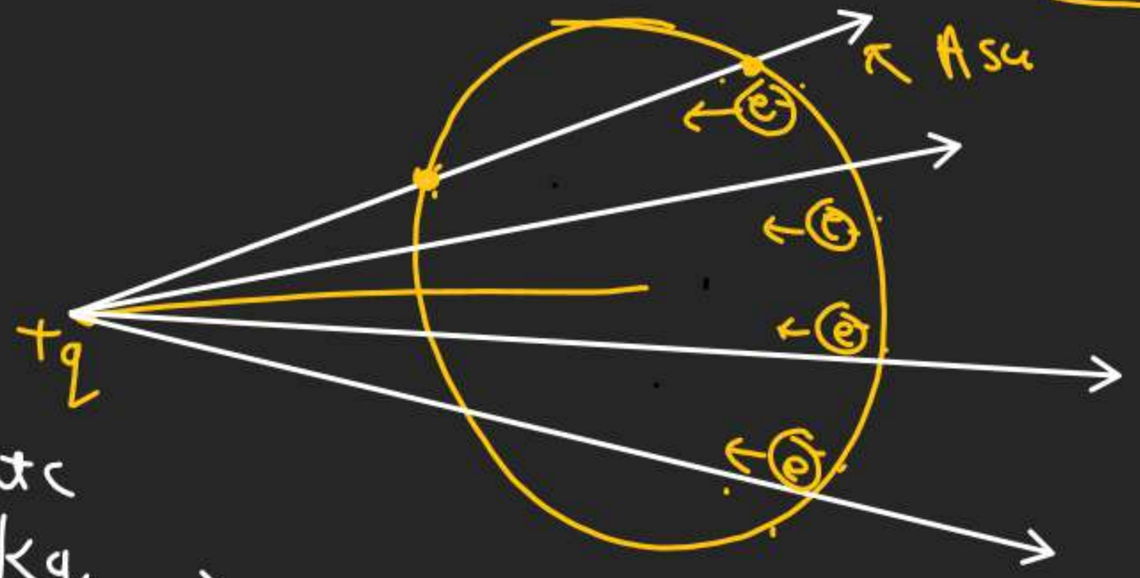
c) Electric field due to induced Charge at C

$(\vec{E}_{net})_c = (\vec{E}_{+q})_c + (\vec{E})_{induced\ at\ c}$

$\Downarrow$

$0 \Rightarrow (\vec{E}_{induced})_c = -\frac{Kq}{a^2}\hat{i}$





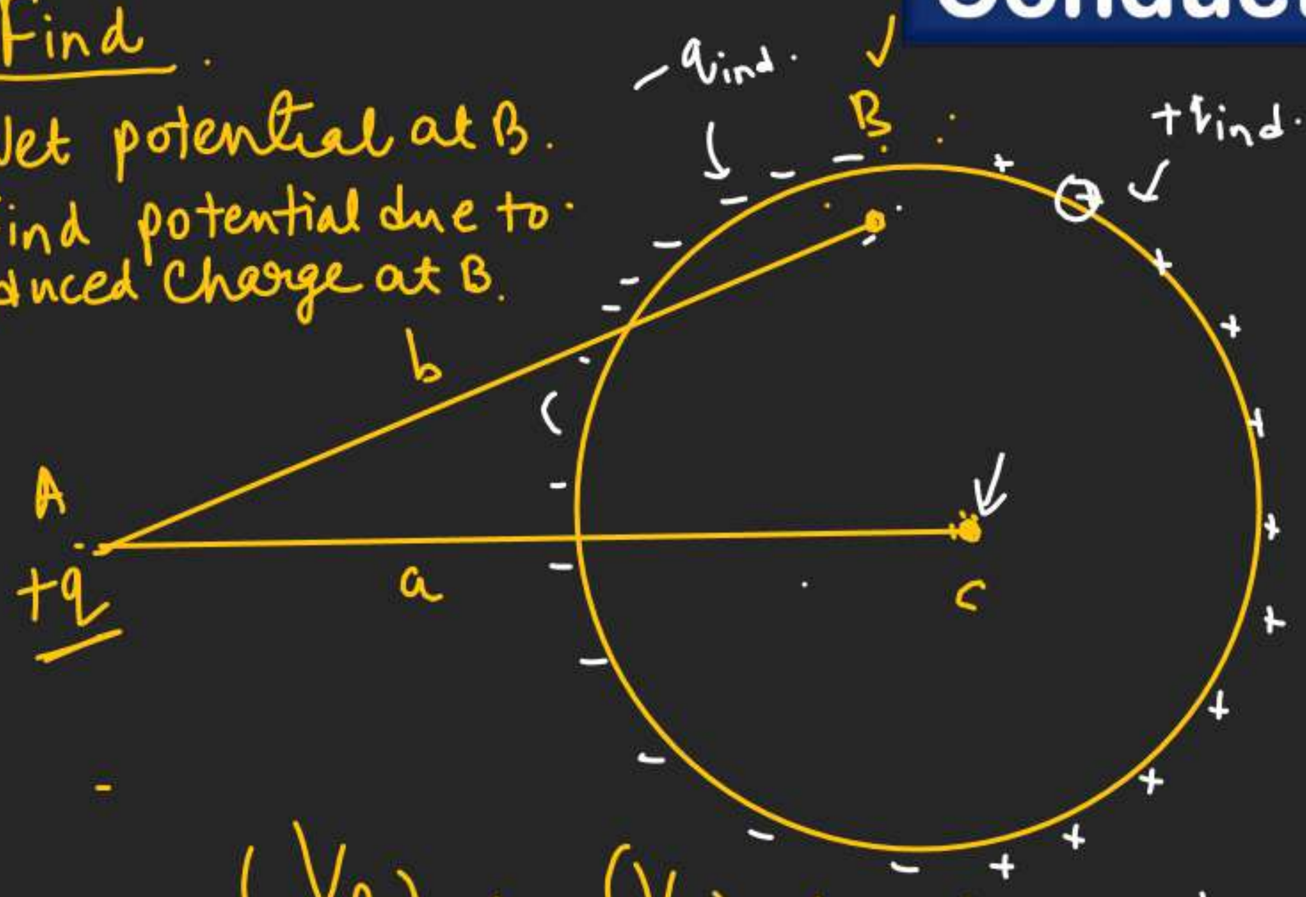
Nishant Jindal

Conductor

① Find.

① Net potential at B.

② Find potential due to induced charge at B.



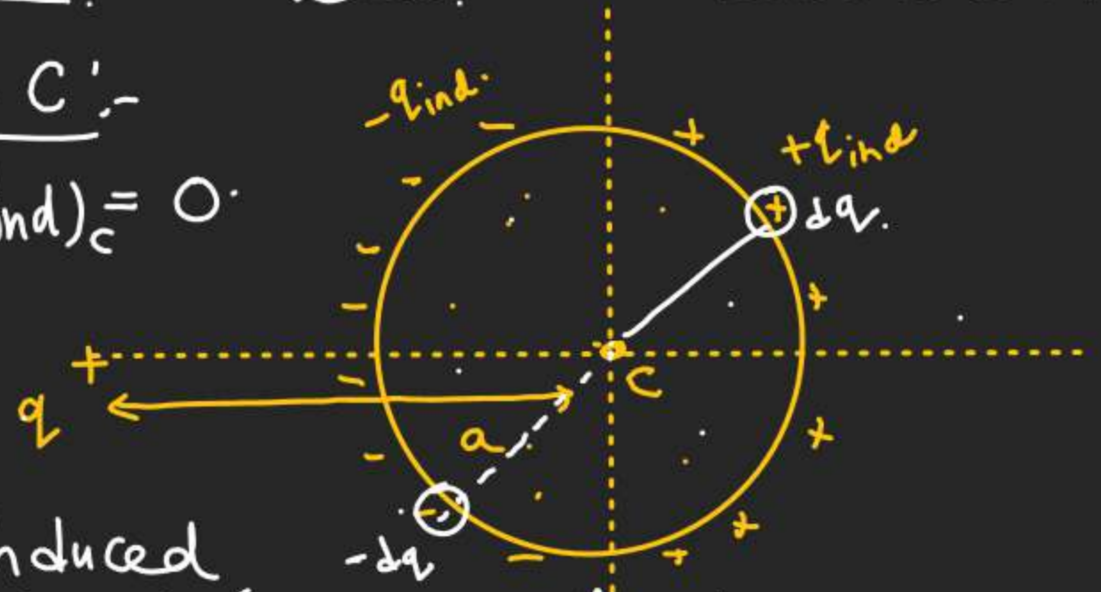
At B

$$(V_B)_{net} = (V_B)_{+q} + (V_B)_{\text{induced Charge}} \quad ??$$

At C :-

↳ $(V_{ind})_C = 0$.

↳ Induced Charge is Symmetrically distributed w.r.t C.



$$(V_B)_{net} = (V_C)_{net} = \frac{Kq}{a}$$

$$(V_B)_{+q} + (V_B)_{\text{induced Charge}} = \frac{Kq}{a}$$

$$(V_B)_{\text{induced charge}} = \frac{Kq}{a} - (V_B)_{+q} = \left[\frac{Kq}{a} - \frac{Kq}{b}\right]$$

$$(V_C)_{net} = (V_C)_{+q} + (V_C)_{\text{induced Charge}}$$

$$(V_C)_{+q} = \left(\frac{Kq}{a}\right) \qquad (V_C)_{\text{induced Charge}} = 0$$

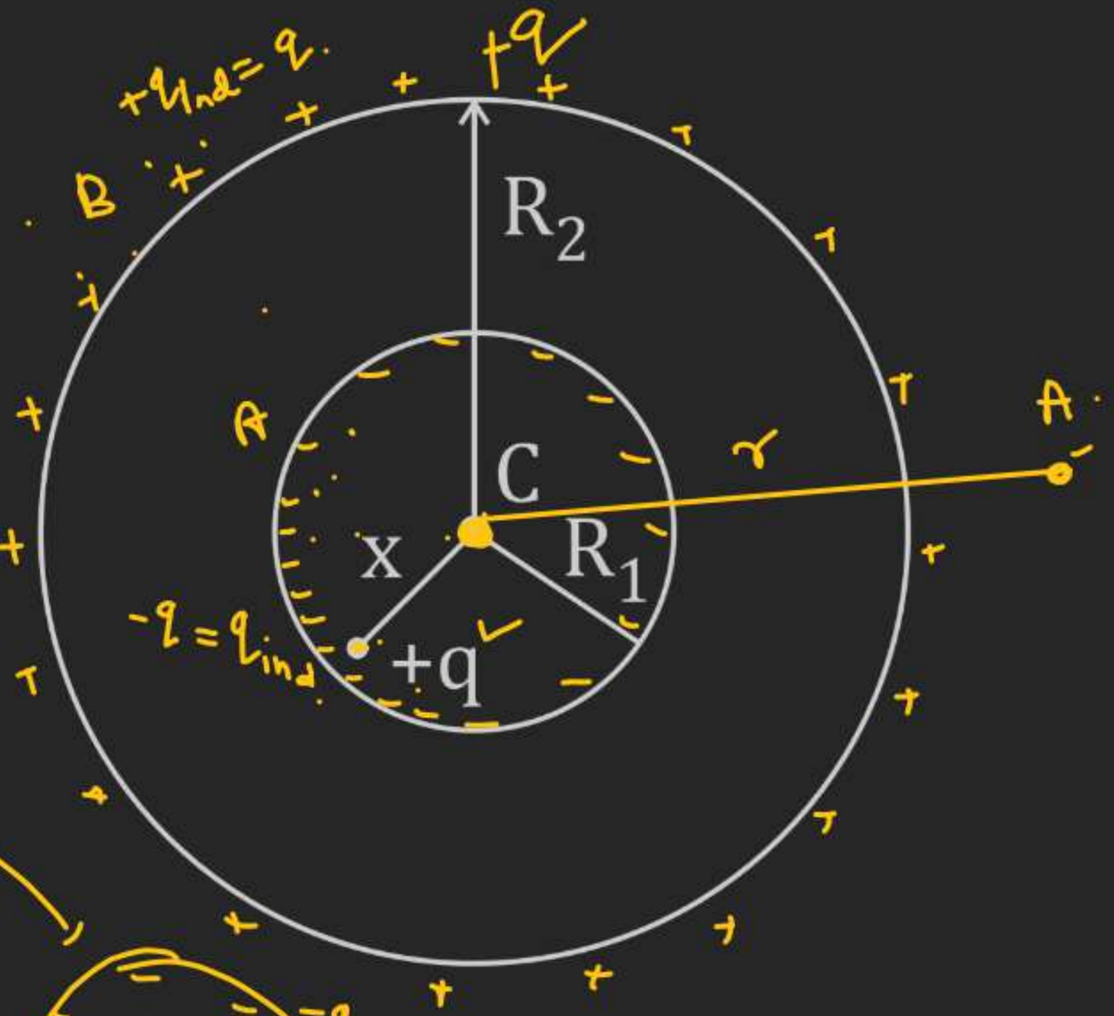
Conductor

Two Con-centric thin Conducting shells.

Charge '+q' is kept at a distance x from c.

✓ i) $V_c = ?$ $E_c = ?$

✓ ii) Find V_A and $E_A = ??$ ✓



A+B

$E_A = \left(\frac{kq}{r^2}\right)$

$V_A = \left(\frac{kq}{r}\right)$

✓

$E_c = $ +q —— x —— c $\rightarrow \left(\frac{kq}{x^2}\right)$

$V_c = \underline{(V_{+q})_c} + (V)_{\text{shell A at c}}$

$+ \left(V_{\text{shell B at c}}\right)$

$$\boxed{V_c = \frac{kq}{x} - \frac{kq}{R_1} + \frac{kq}{R_2}}$$

Nishant Jindal

Conductor

A conducting sphere of radius R has two spherical cavities of radius a and b. The cavities have charges q_a and q_b respectively at their centres. Find:

(a) The electric field and electric potential at a distance r

(i) r (distance from O, the centre of sphere $> R$) $\Rightarrow E = \frac{K(q_a+q_b)}{r^2}$

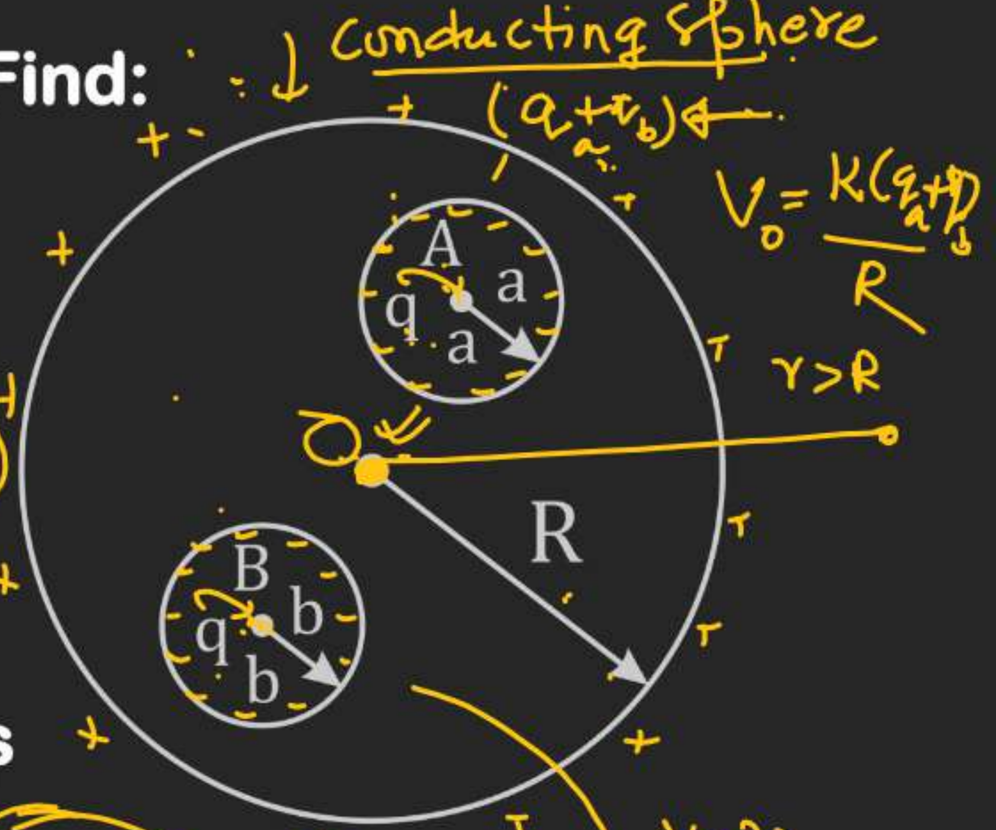
$V = \frac{K(q_a+q_b)}{r}$

(ii) r (distance from B, the centre of cavity b) $< b$ $\quad E = (Kq/r^2)$

(iii) r inside sphere but out side cavities. $\boxed{V = ??} \Leftarrow ??$

(b) Surface charge densities on the surface of radius R, radius a and radius b. $\rightarrow \sigma_R = \left(\frac{q_A+q_B}{4\pi R^2}\right), \sigma_B = \left(\frac{-q_b}{4\pi b^2}\right)$ (ii)

(c) $\boxed{\text{What is the force on } q_a \text{ and } q_b \text{ ? } \Rightarrow 0}$



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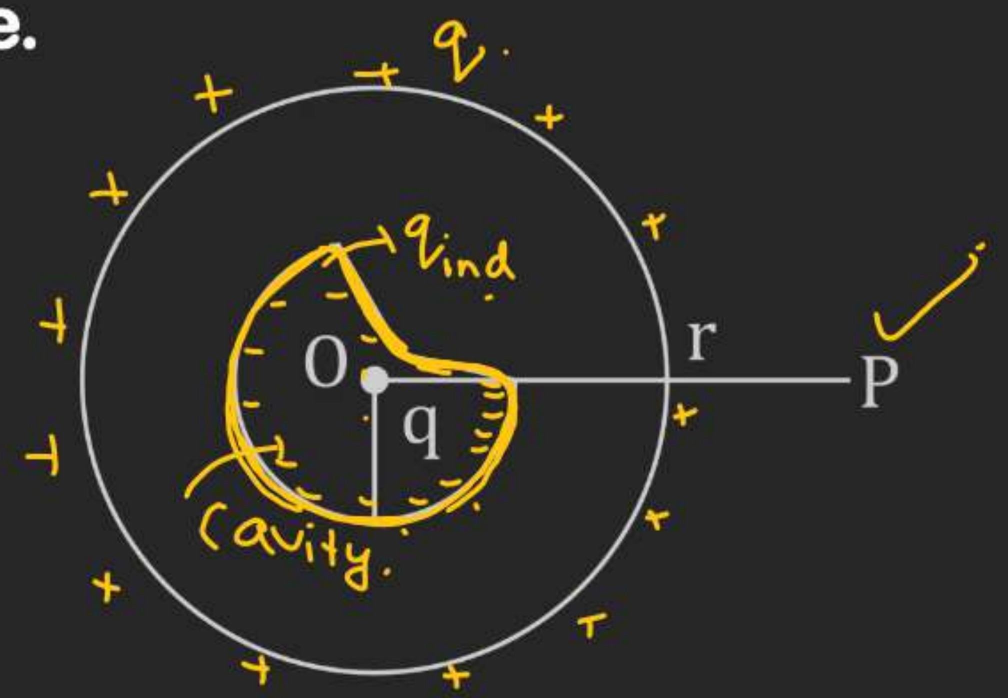
Conductor

\# The point charge q is within an electrically neutral conducting shell whose outer surface has spherical shape. Find the potential V at a point P lying outside the shell at a distance r from the centre O of the outer sphere.

$$V_P = \left(\frac{Kq}{r}\right) \text{Ans}$$



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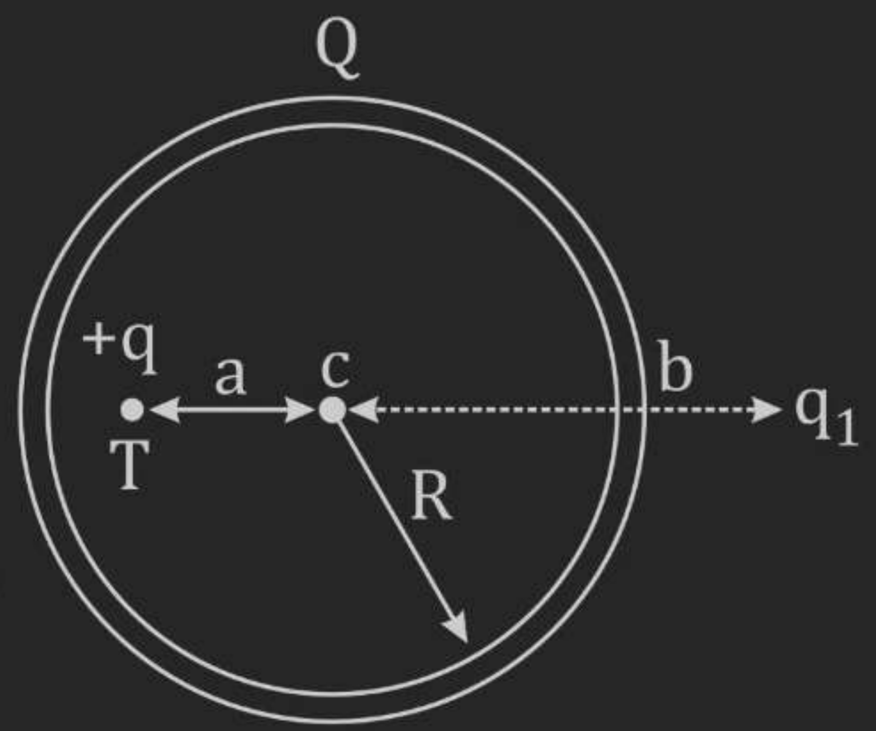
H.W.!

Conductor

A thin metallic spherical shell contains a charge Q over it. A point charge +q is placed inside the shell at point T separated from the centre by distance " a ". Another point charge q_1 is placed outside the shell at a distance b from the centre as shown in the adjacent Fig. Now select the correct statement(s) from the following.



(a) Electric field at the centre due to charge over outer surface of the shell is zero.

(b) Electric field at the centre due to charge over outer surface of the shell is $\frac{q_1}{4\pi\varepsilon_0 b^2}$.

(c) Electric potential at the centre due to all charges in space is $\frac{1}{4\pi\varepsilon_0}\left[\frac{q}{a}-\frac{q}{R}+\frac{Q}{R}+\frac{q_1}{b}\right]$.

(d) Electric potential at the centre due to all charges in space is $\frac{1}{4\pi\varepsilon_0}\left[\frac{q}{a}+\frac{Q}{R}+\frac{q_1}{b}\right]$.

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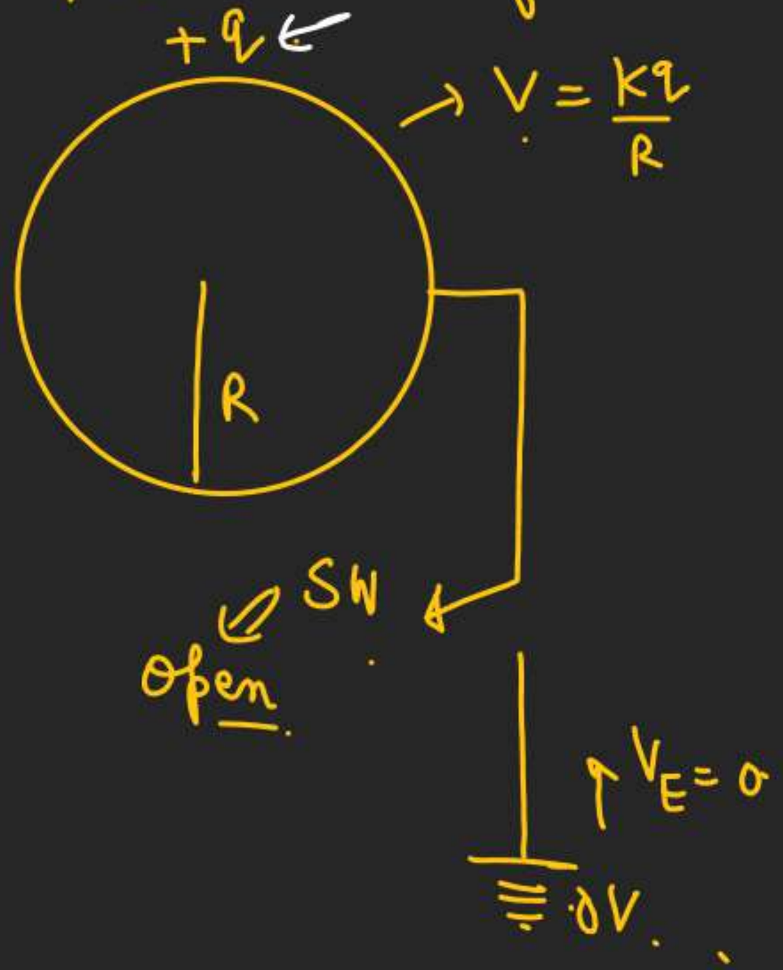
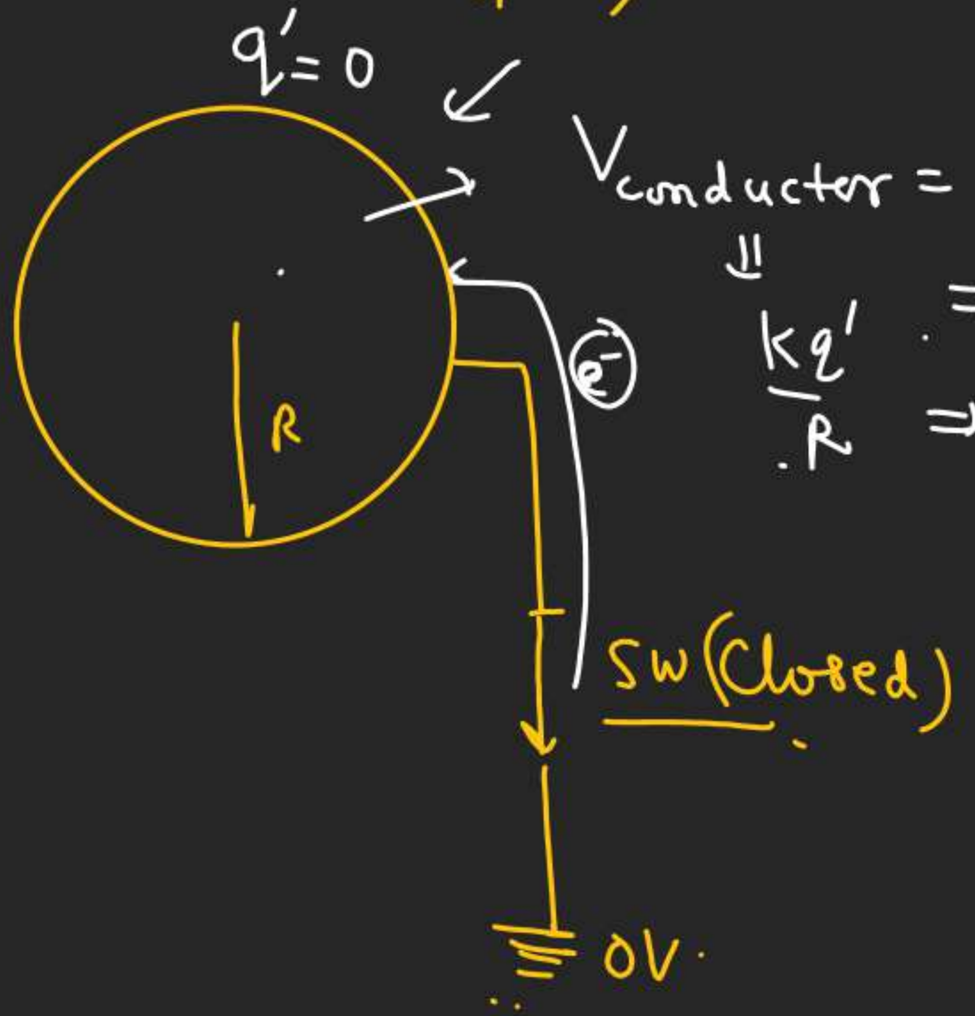
Conductor

(*) Earthing of a Conductor :-

* Earth is assumed to be infinite Source of equal and opposite charges. so, earth is alway electrically neutral.
* Potential of the earth is always zero.





$V_{conductor} = V_{earth}$

$\frac{kq'}{R} = 0$

$\Rightarrow \boxed{q' = 0}$

Note

If a Spherical Conductor is earthed then →
- Potential must be zero
- Charge on the conductor may be zero or may not

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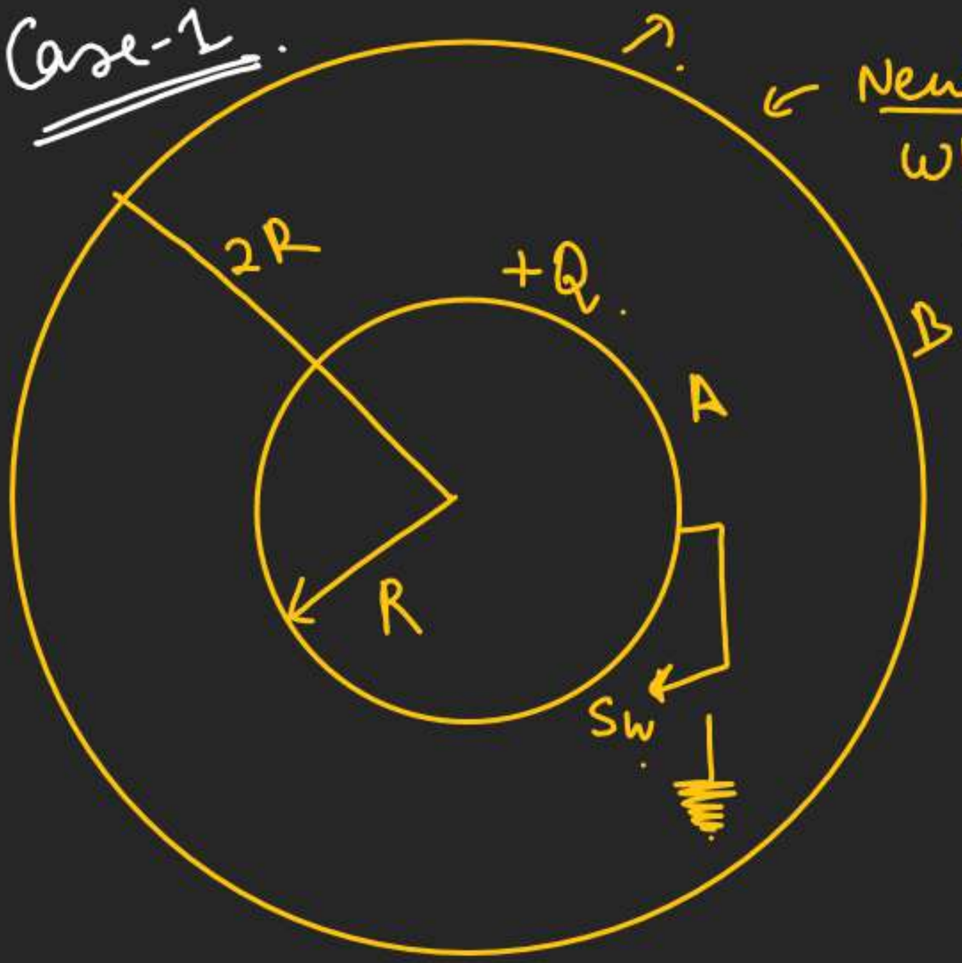
Conductor

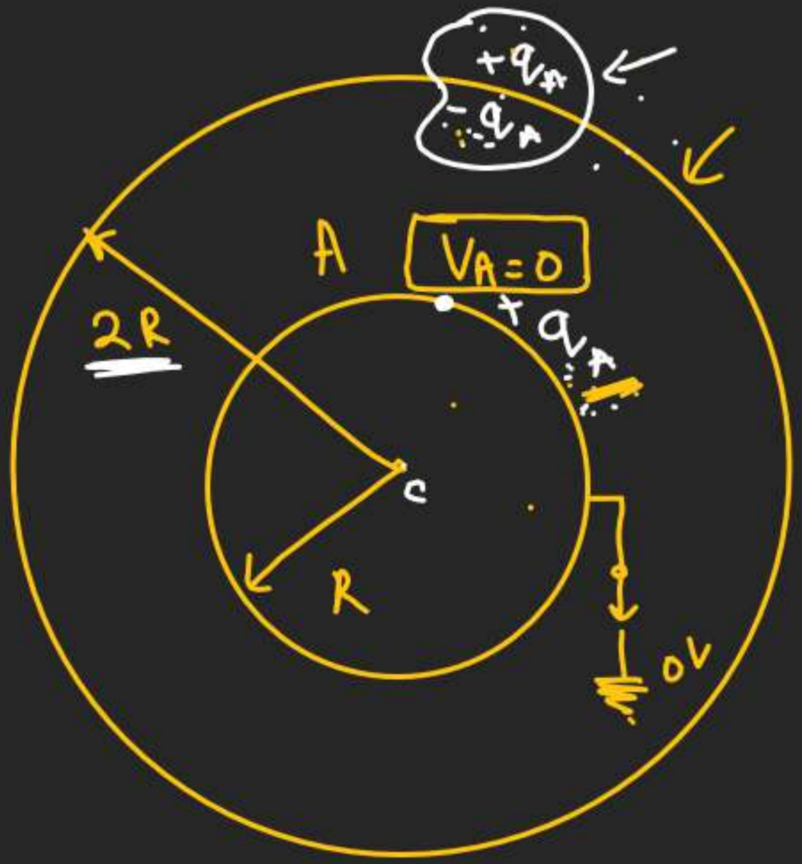
Case-1.



← Neutral

when switch is open.

Find Charge on both the Conductor When Switch is Closed.



$$V_A = \frac{Kq_A}{R} + \cancel{\left(\frac{-Kq_A}{2R}\right)} + \cancel{\left(\frac{Kq_A}{2R}\right)}$$

$$V_A = \frac{Kq_A}{R}$$

$$\Downarrow$$

$$0 = \frac{Kq_A}{R}$$

$$\boxed{q_A = 0}$$

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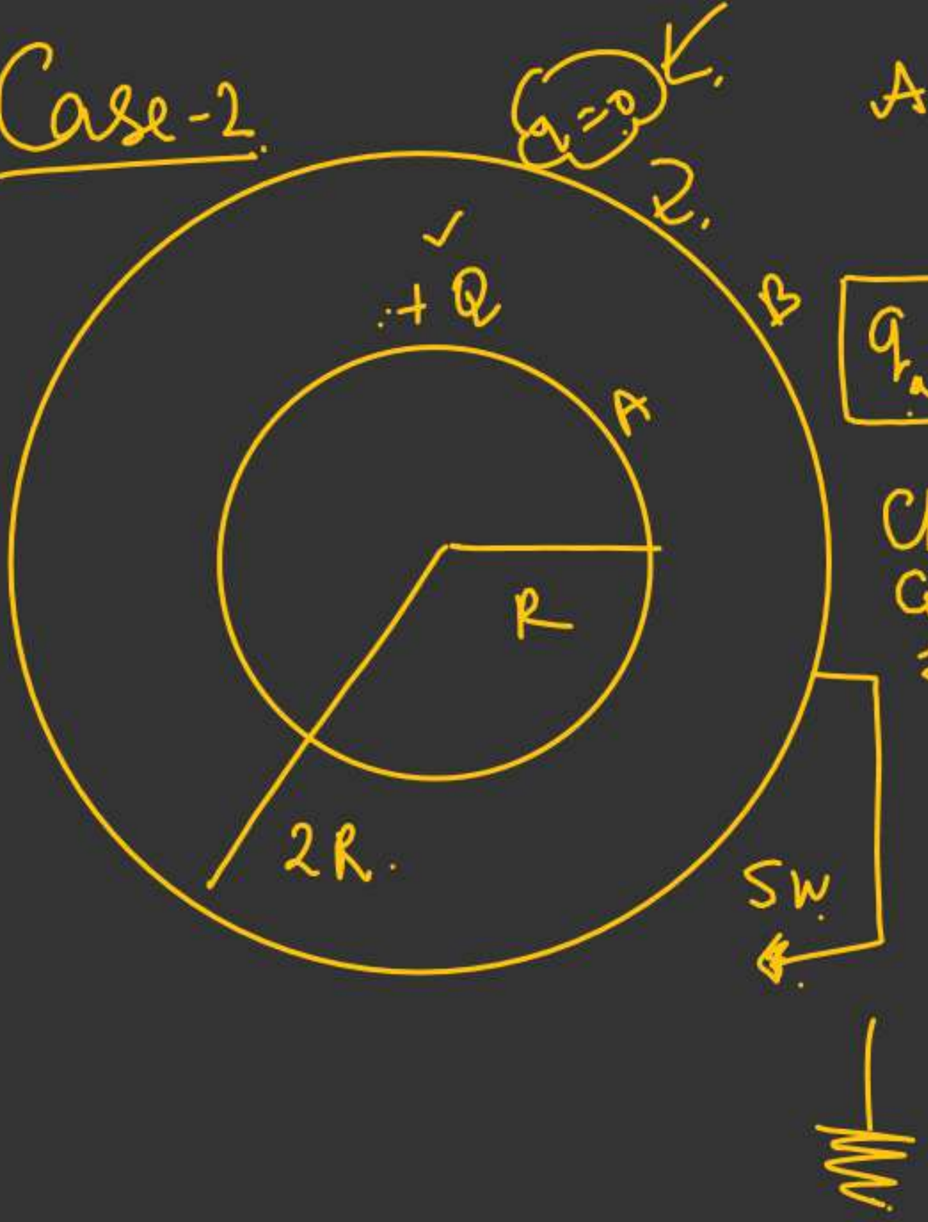
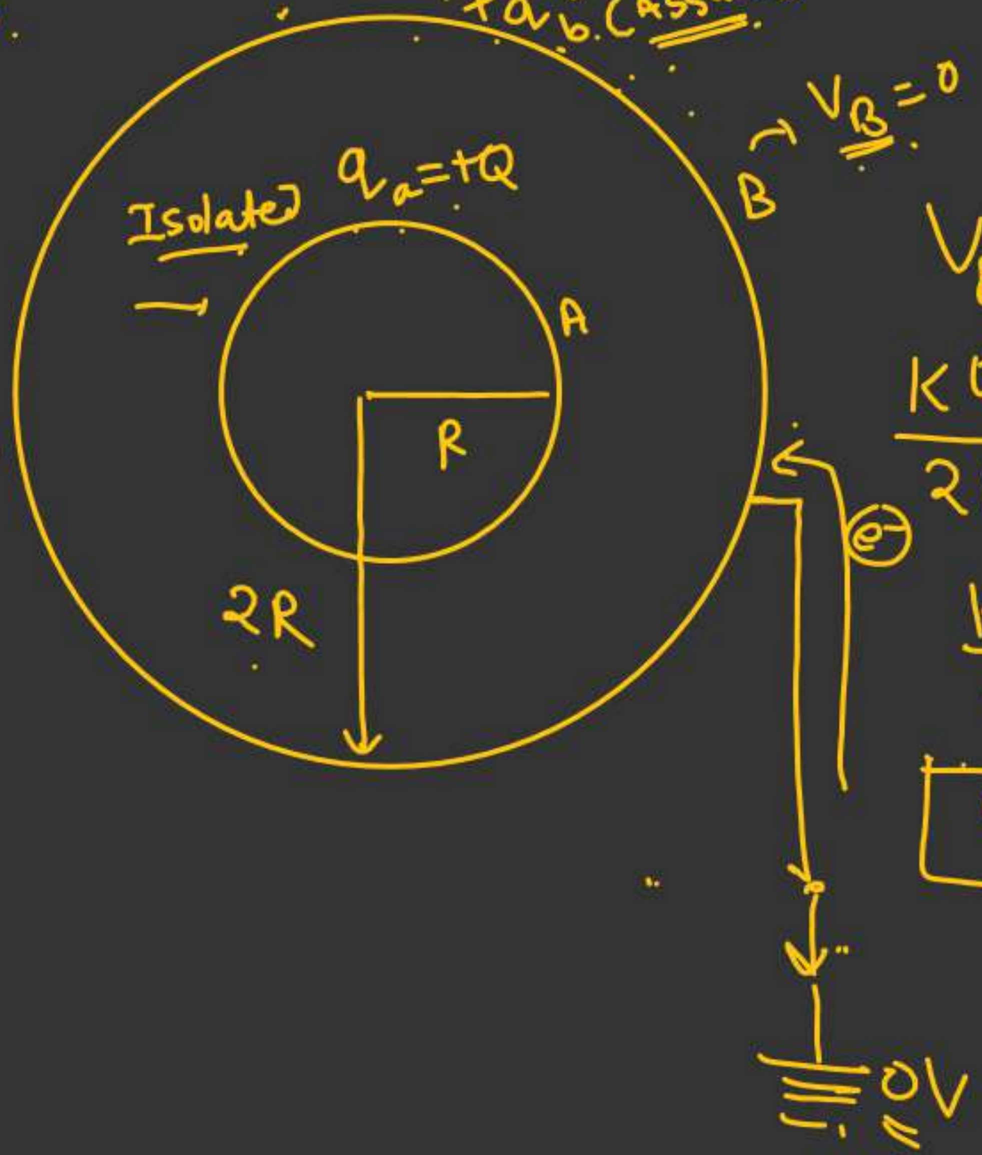
Case-2



$\boxed{q_a = +Q}$

Charge Conservation for Shell A

After sw closed, find Charge on Shell A and B.



$V_B = 0$.

$$\frac{KQ}{2R} + \frac{Kq_b}{2R} = 0$$

$$\frac{Kq_b}{2R} = \frac{-KQ}{2R}.$$

$$\boxed{q_b = -Q}$$

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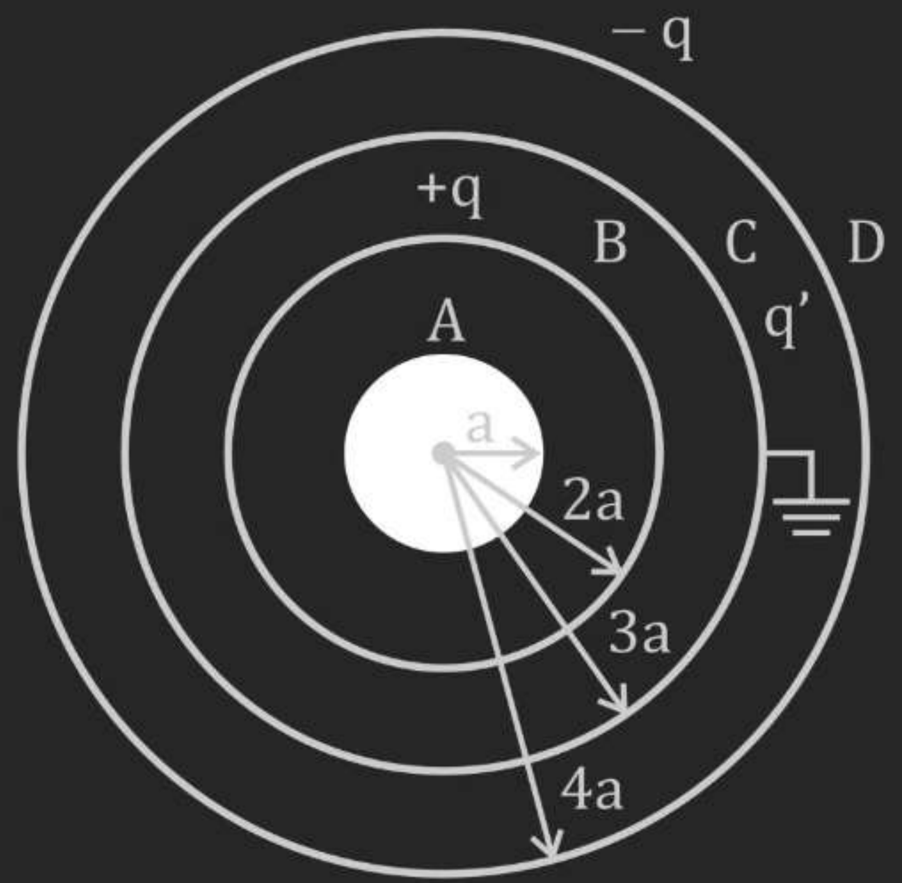
Conductor

H.W.

There are 4 concentric shells A, B, C and D of radius a, 2 a, 3 a, 4 a respectively. Shells B and D are given charges +9 and -9 respectively. Shell C is now earthed. Find the potential difference $V_A - V_C$.



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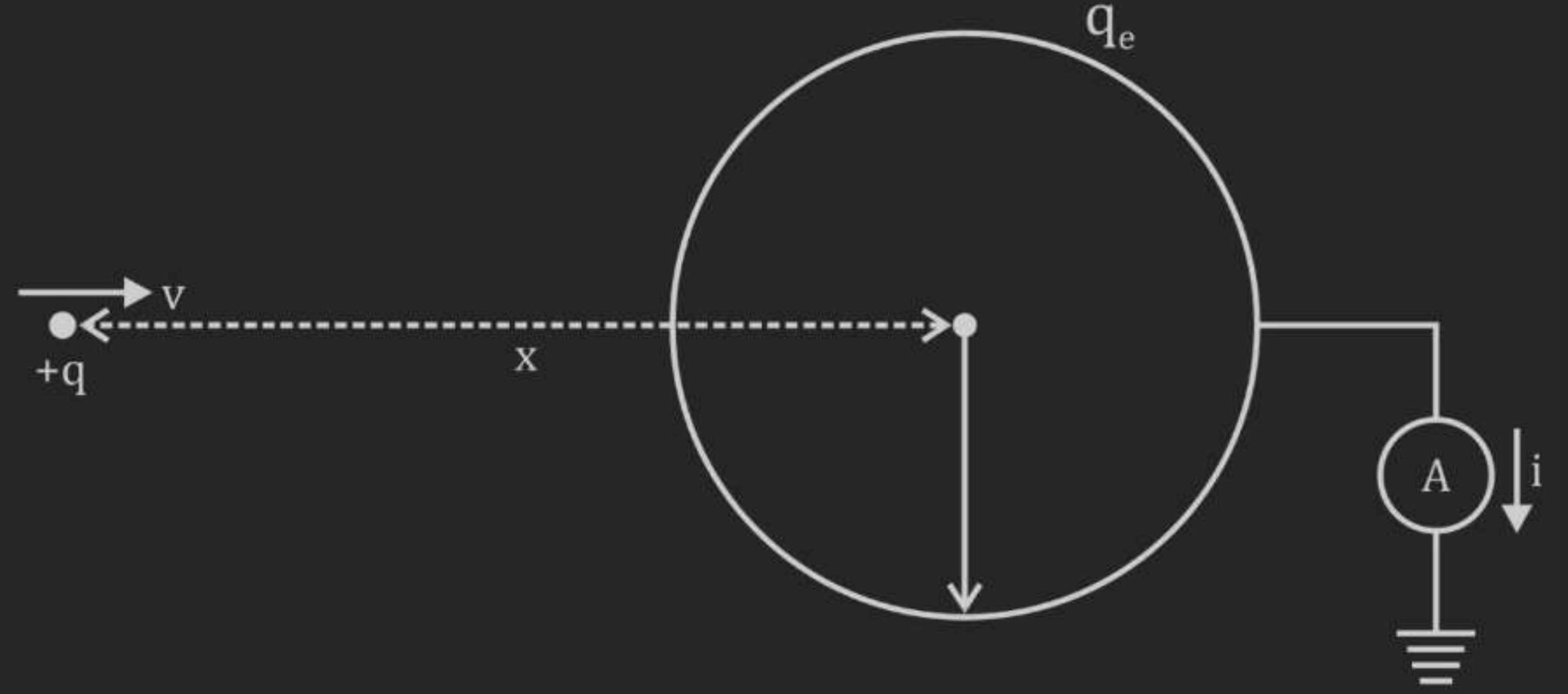
H.W

Conductor

❖ **Current due to Movement of Charges Through Earth:**



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Conductor

H.W.

Consider concentric spherical shells of negligible thickness. Initial charges on these shells are Q_1 and Q_2. Now inner shell is earthed.