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DPP – 7 (Electrostatics)

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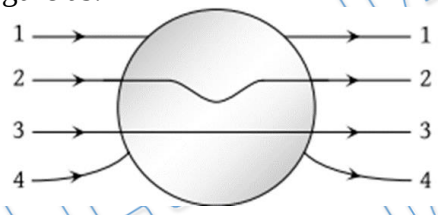
Q 1. In a region with a uniform electric field, the number of lines of force per unit area is E. If a spherical metallic conductor is placed in the area, the field inside the conductor will be :

(a) zero (b) E

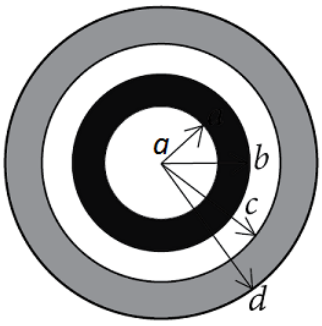
(c) more than E (d) less than E

Q 2. A metallic solid sphere is placed in a uniform electric field. The lines of force follow the path(s) shown in figure as:



(a) 1 (b) 2 (c) 3 (d) 4

Q 3. A small conducting spherical shell with inner radius a and outer radius b is concentric with a larger conducting spherical shell with inner radius c and outer radius d (as shown in Fig). The inner shell has total charge +2q and the outer shell has charge +4q. Calculate the electric field in terms of q and the distance r from the common centre of the two shells for: a < r < b.

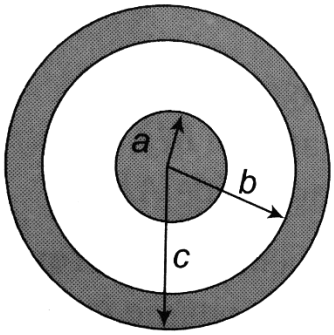


(a) zero (b) $\frac{1}{4\pi\varepsilon_o}\frac{2q}{r^2}$

(c) $-\frac{1}{4\pi\varepsilon_o}\frac{6q}{r^2}$ (d) $\frac{1}{4\pi\varepsilon_o}\frac{q}{r^2}$

Q 4. A solid conducting sphere of radius a has a net positive charge 2Q. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere

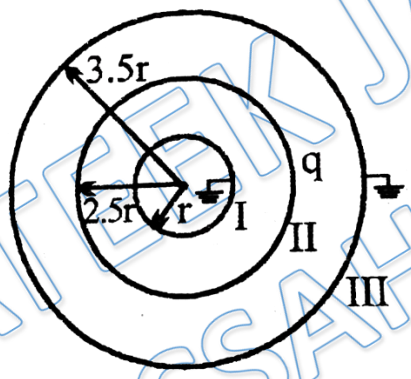
and has a net charge –Q. The surface charge density on the inner and outer surfaces of the spherical shell will be:



(a) $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$ (b) $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

(c) zero, $\frac{Q}{4\pi c^2}$ (d) none of the above

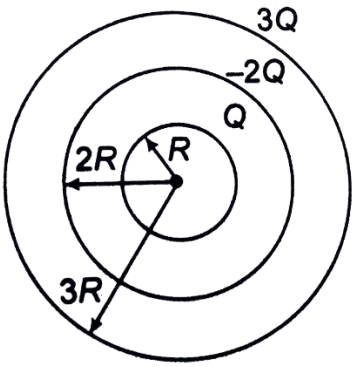
Q 5. Figure shows three concentric conducting spherical shells with inner and outer shells earthed and the middle shell is given a charge q. The final charge on shell 1 and 3 are:



(a) $\frac{4}{25}q, \frac{21}{25}q$ (b) $\frac{4}{25}q, -\frac{21}{25}q$

(c) $-\frac{4}{25}q, -\frac{21}{25}q$ (d) none of the above

Q 6. Three concentric conducting spherical shells of radii R, 2R and 3R carry charges Q, -2Q and 3Q, respectively. Find the electric potential at r = R:



(a) $\frac{1}{4\pi\varepsilon_o}\frac{Q}{R}$ (b) $-\frac{1}{4\pi\varepsilon_o}\frac{Q}{R}$

(c) $\frac{1}{4\pi\varepsilon_o}\frac{3Q}{R}$ (d) none of the above

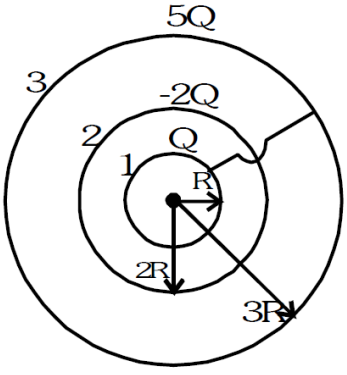
Q 7. Three concentric conducting spherical shells of radii R, 2R and 3R carry charges Q, -2Q and 3Q, respectively. Compute the magnitude of electric field at $r = \frac{5}{2}R$:(where r is the radial distance from the centre)

Q) Three concentric conducting spherical shells of radii R, 2R and 3R carry charges Q, -2Q and 3Q, respectively. Compute the magnitude of electric field at r = $\frac{5}{2}$R:(where r is the radial distance from the centre)

(a) $\frac{Q}{4\pi\varepsilon_o R^2}$ (b) $\frac{Q}{24\pi\varepsilon_o R^2}$
(c) $\frac{Q}{25\pi\varepsilon_o R^2}$ (d) $\frac{Q}{45\pi\varepsilon_o R^2}$

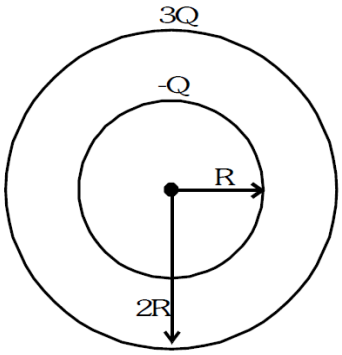
Q 8. Three concentric conducting spherical shells carry charges as +4Q on the inner shell, -2Q on the middle shell and -5Q on the outer shell. The charge on the inner surface of the outer shell is:
(a) Q (b) 4Q
(c) -Q (d) -2Q

Q 9. Find charge on outer surface of spherical shell-2 after joining the inner most shell and outer most shell by a conducting wire:



(a) $\frac{3Q}{2}$ (b) $-\frac{3Q}{2}$
(c) $-2Q$ (d) Q

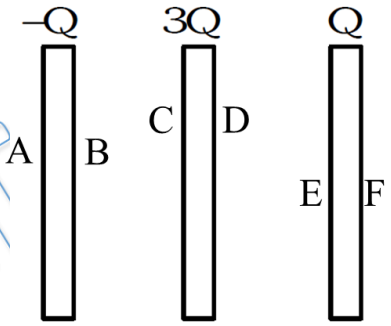
Q 10. Two conducting hollow spherical shells of radii R and 2R carry charges – Q and 3Q respectively. How much charge will flow into the earth if inner shell is grounded ?



(a) $\frac{3Q}{2}$ (b) $-\frac{3Q}{2}$

(c) $\frac{Q}{2}$ (d) $-\frac{Q}{2}$

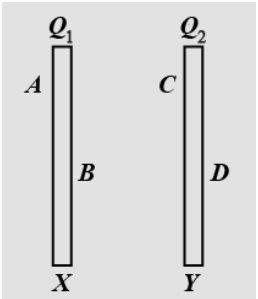
Q 11. Figure shows three large metallic plates with charges – Q, 3Q and Q respectively. Determine the final charge on face C:



(a) $\frac{5Q}{2}$ (b) $-\frac{5Q}{2}$

(c) $\frac{Q}{2}$ (d) $-\frac{Q}{2}$

Q 12. Two large, parallel conducting plates X and Y, kept close to each other, are given charges Q_1 and Q_2 ($Q_1 > Q_2$). The four surfaces of the plates are A, B, C and D, as shown in figure. Then:



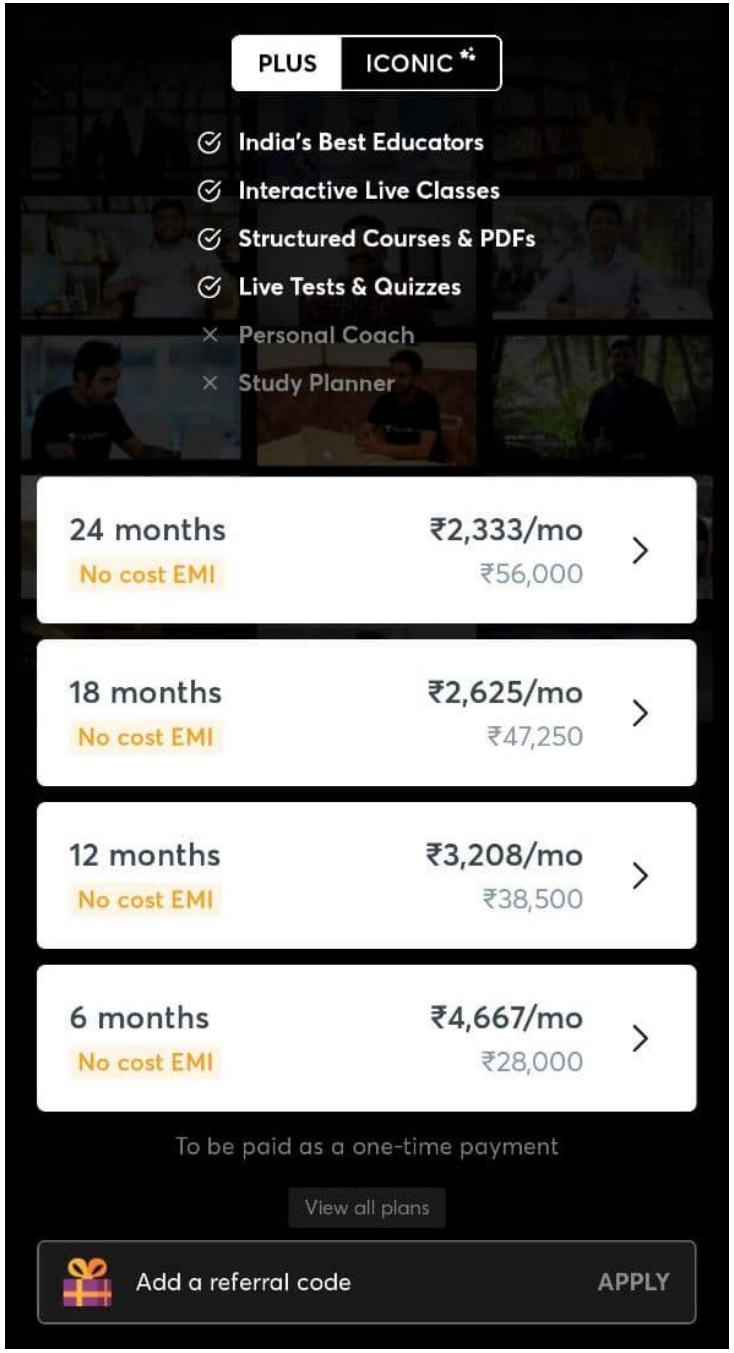
(a) The charge on A is $\frac{1}{2}(Q_1 + Q_2)$ (b) The charge on B is $\frac{1}{2}(Q_1 - Q_2)$

(c)The charge on C is $-\frac{1}{2}(Q_1 - Q_2)$ (d) All of the above are correct

Q 13. How does the charge densities of conductors vary on an irregularly shaped conductor?
(a) Less at sharp and high at flat portion
(b) High at sharp and less at flat portion
(c) Remains constant
(d) Zero at sharp and high at flat portion

Answer Key

Q.1 a	**Q.2 d**	**Q.3 a**	**Q.4 a**	**Q.5 c**
Q.6 a	**Q.7 c**	**Q.8 d**	**Q.9 b**	**Q.10 c**
Q.11 a	**Q.12 d**	**Q.13 b**		



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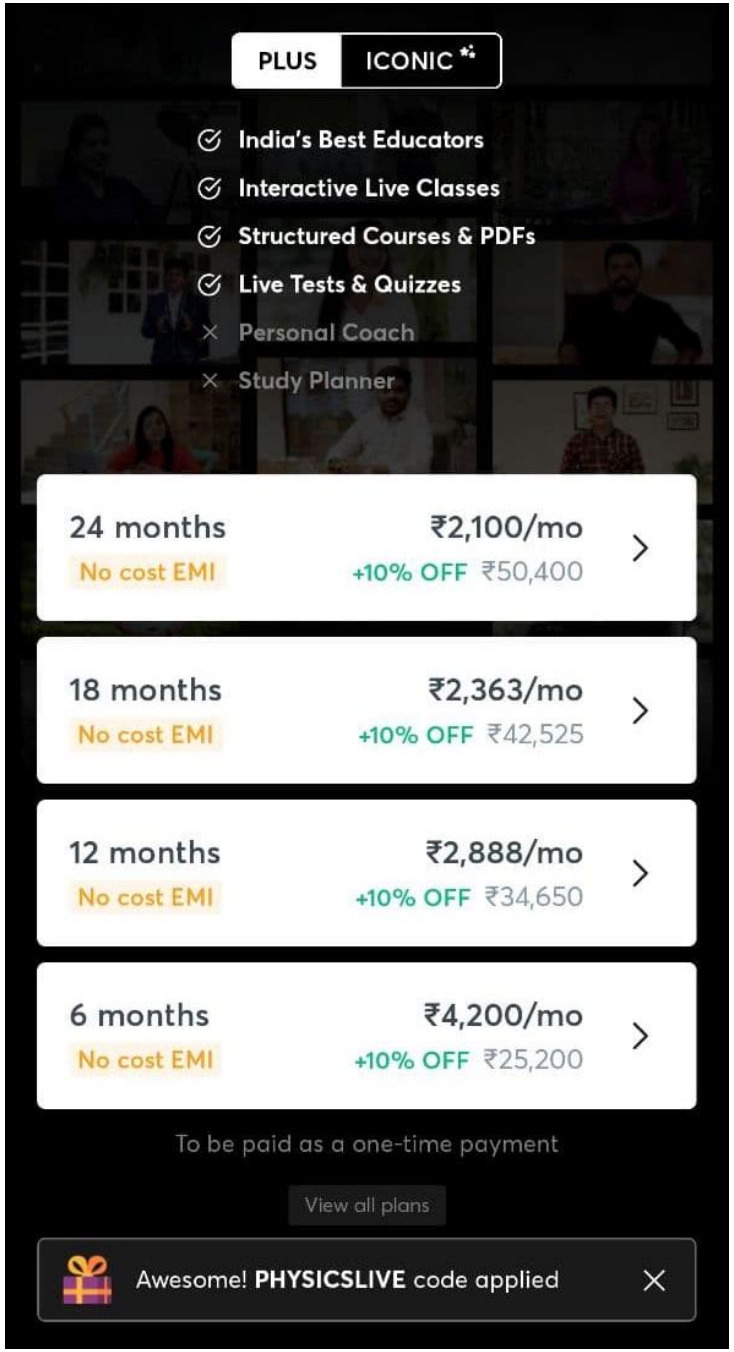
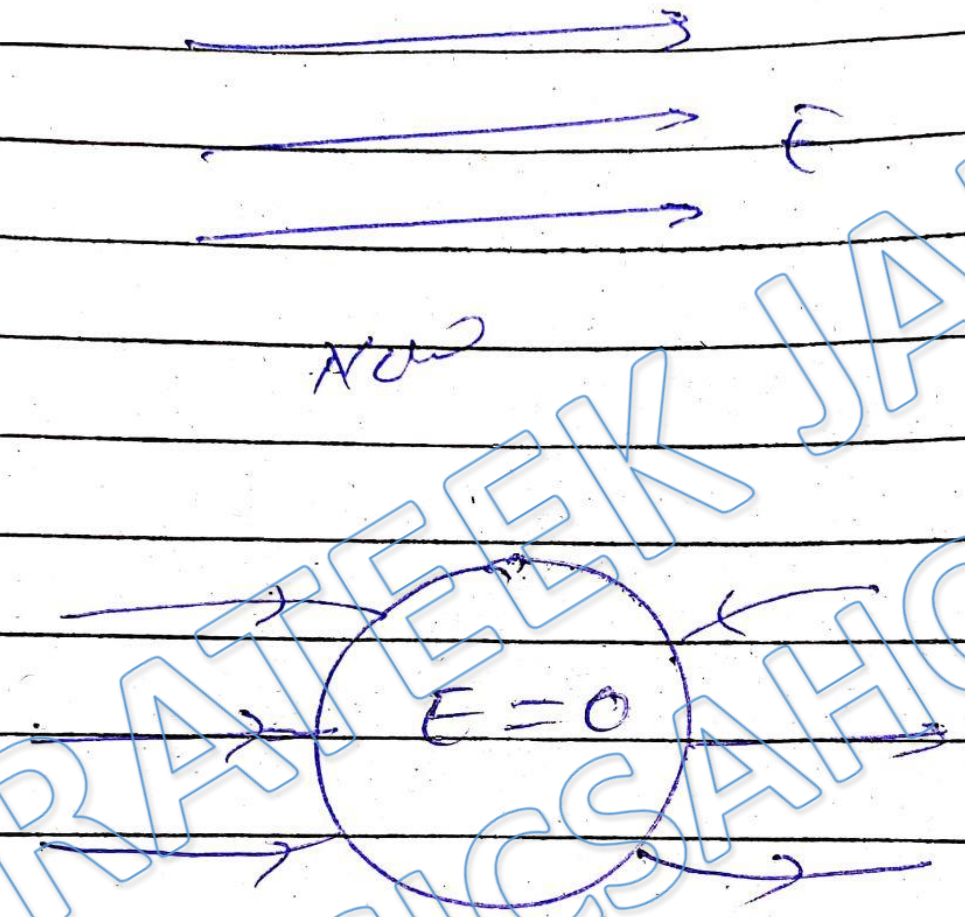


Written Solution

DPP-7 Electrostatics : Conductors

By Physicsaholics Team

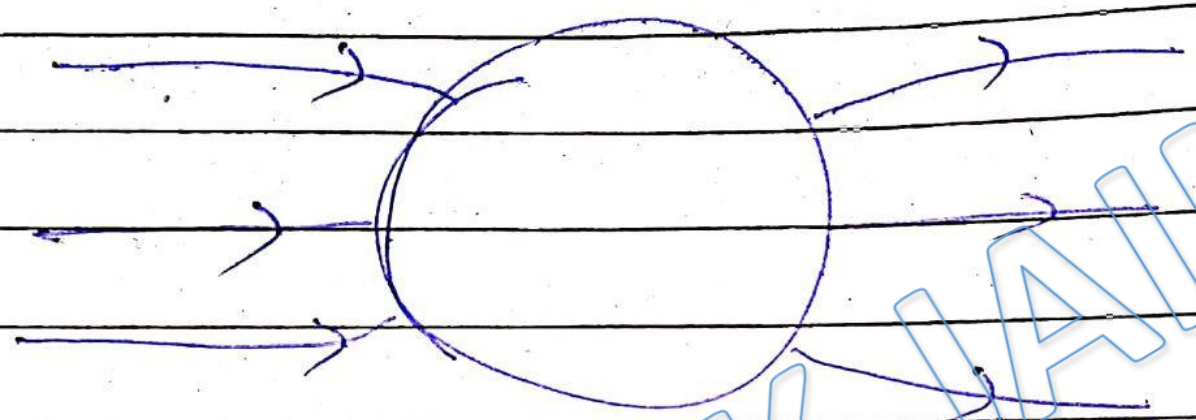
Solution: 1



Electric field inside the conductor is zero.

Ans. a

Solution: 2



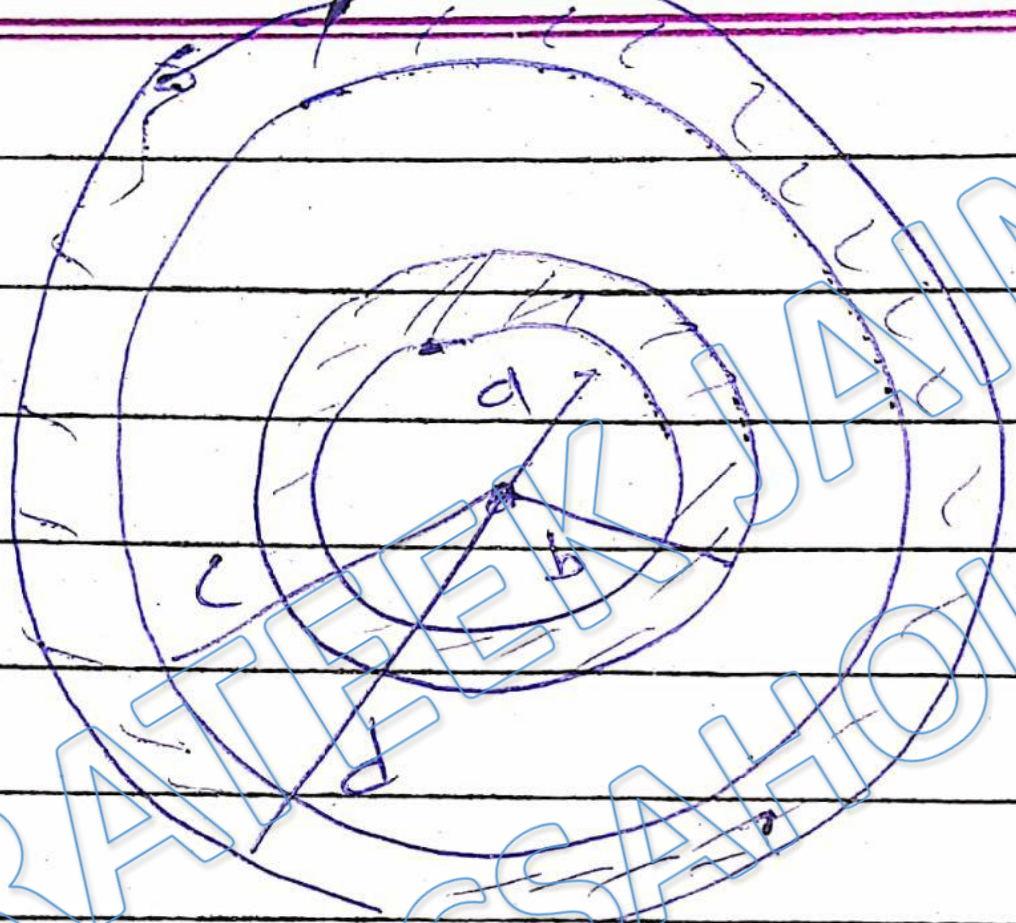
Electric field line are perpendicular to conductors.

and Electric field inside the conductor is zero

∴ line '4' is correct

Ans. d

Solution: 3

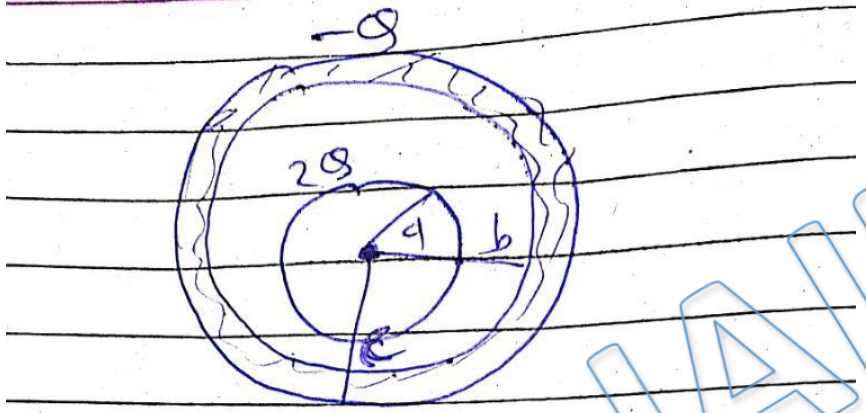


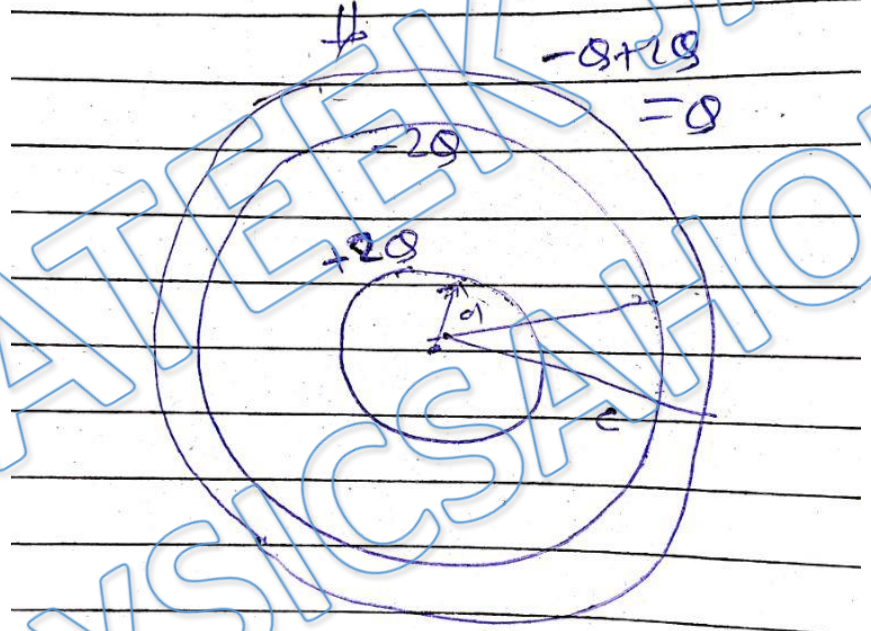
from a to b ⇒ conductor

$\therefore \boxed{E = \text{zero}}$

Ans. a

Solution: 4



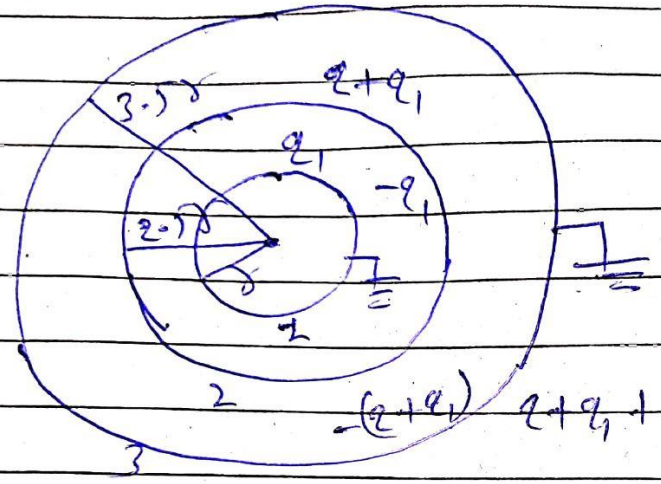


$$\sigma_{in} = \frac{-2Q}{4\pi b^2}$$

$$\sigma_{out} = \frac{Q}{4\pi c^2}$$

Ans. a

Solution: 5



$V_1 = V_3 = \text{zero}$

$$V_1 = \frac{kq_1}{r} + \frac{k(q)}{2.5r} + \frac{kq_2}{3.5r} = 0 \quad \text{— (1)}$$

$$V_3 = \frac{kq_1}{3.5r} + \frac{kq}{3.5r} + \frac{kq_2}{3.5r} = 0 \quad \text{— (2)}$$

From eq^n (1) & (2)

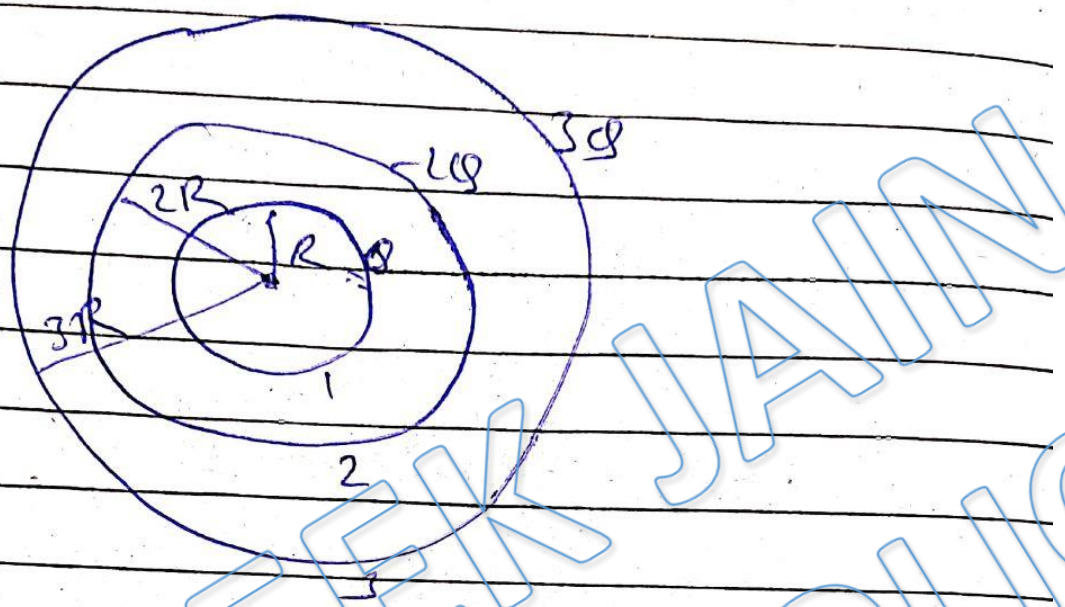
$$q_1 + \frac{2}{5}q + \frac{2}{7}q_2 = 0$$

$$q_1 + q + q_2 = 0$$

$$\Rightarrow q_1 = -\frac{4}{25}q \; ; \; q_2 = -\frac{21}{25}q$$

Ans. c

Solution: 6



$$V_1 = \frac{kQ}{R} + \frac{k(-2Q)}{2R} + \frac{k(+3Q)}{3R}$$

$$= \frac{kQ}{R} - \frac{kQ}{R} + \frac{kQ}{3R}$$

$$= +\frac{kQ}{R}$$

$$\boxed{V_1 = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}}$$

Ans. a

Solution: 7

at $r = \frac{5}{2}R$

$$E = \frac{kQ}{\left(\frac{5}{2}R\right)^2} + \frac{k(-2Q)}{\left(\frac{5}{2}R\right)^2} + 0$$

$$= \frac{4kQ}{25R^2} - \frac{8kQ}{25R^2}$$

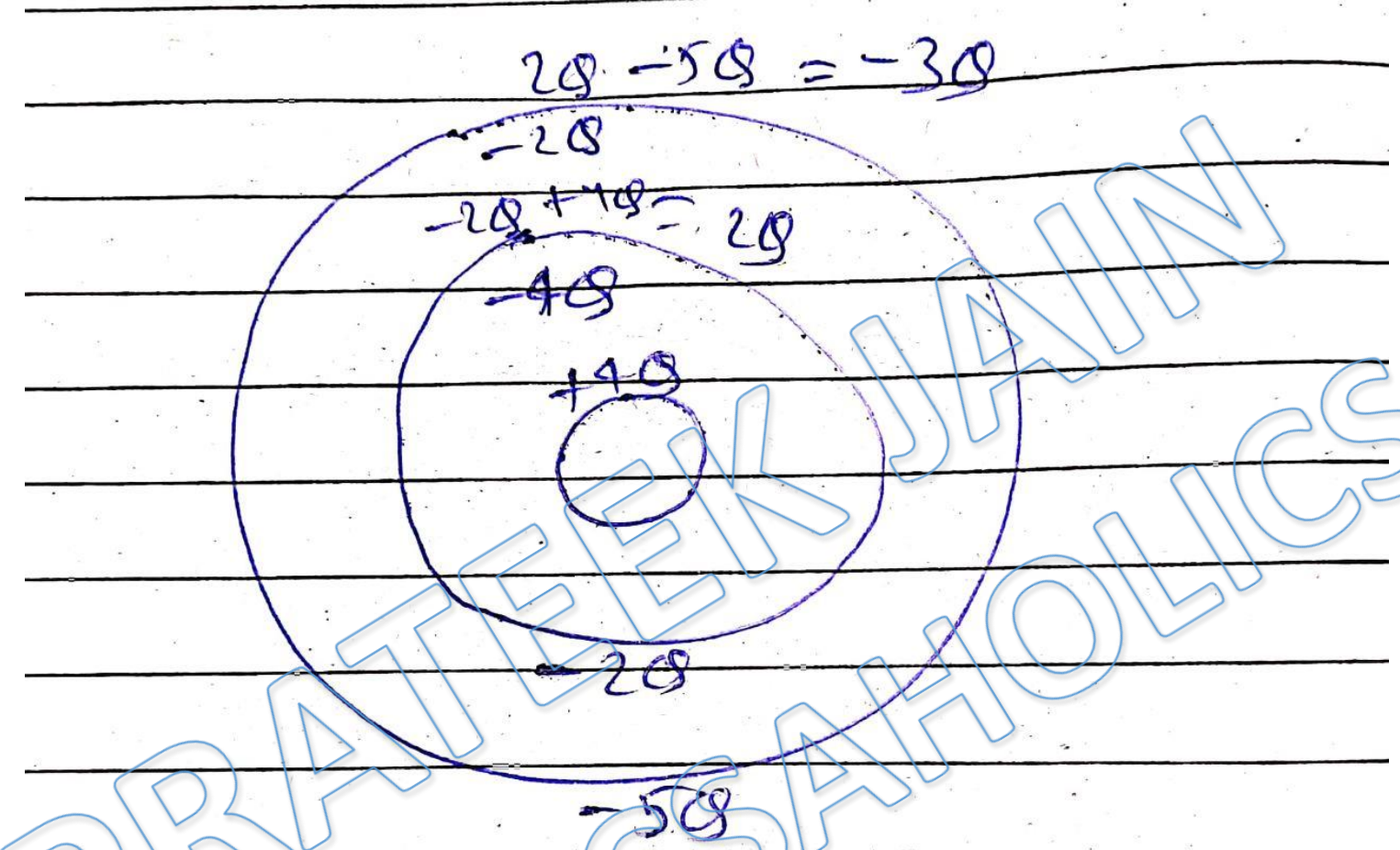
$$= \frac{-4kQ}{25R^2} = \frac{-4}{25}\frac{1}{4\pi\epsilon_0}\frac{Q}{R^2}$$

$$\boxed{E = \frac{-Q}{25\pi\epsilon_0 R^2}}$$

$$\boxed{|E| = \frac{Q}{25\pi\epsilon_0 R^2}}$$

Ans. c

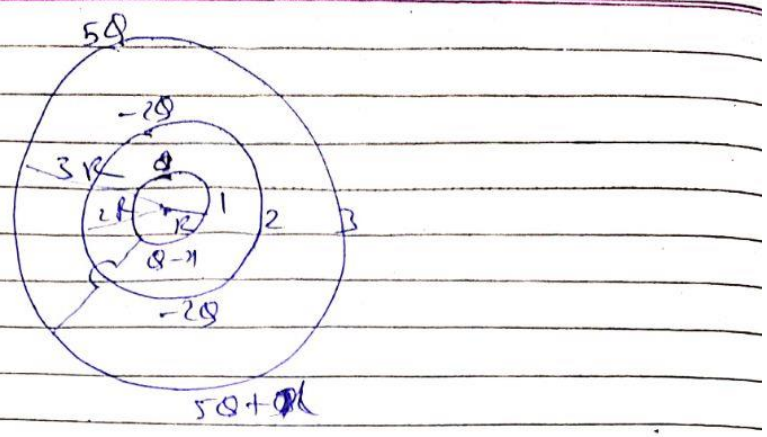
Solution: 8



∴ Charge on the inner surface of the outer shell is :- −2Q

Ans. d

Solution: 9



$V_1 = V_3$

$$\frac{K(Q-x)}{R} + \frac{K(-2Q)}{2R} + \frac{K(5Q+x)}{3R}$$

$$= \frac{K(Q-x)}{3R} + \frac{K(-2Q)}{3R} + \frac{K(5Q+x)}{3R}$$

$$(Q-x) - Q + K(5Q+x)$$

$$= \frac{Q-x}{3} + \frac{(-2Q)}{3} + \frac{5Q+x}{3}$$

$$-x + \frac{5Q+x}{3} = \frac{Q-x-2Q+5Q+x}{3}$$

$$\frac{5Q-2x}{3} = \frac{4Q}{3}$$

$$Q = 2x$$

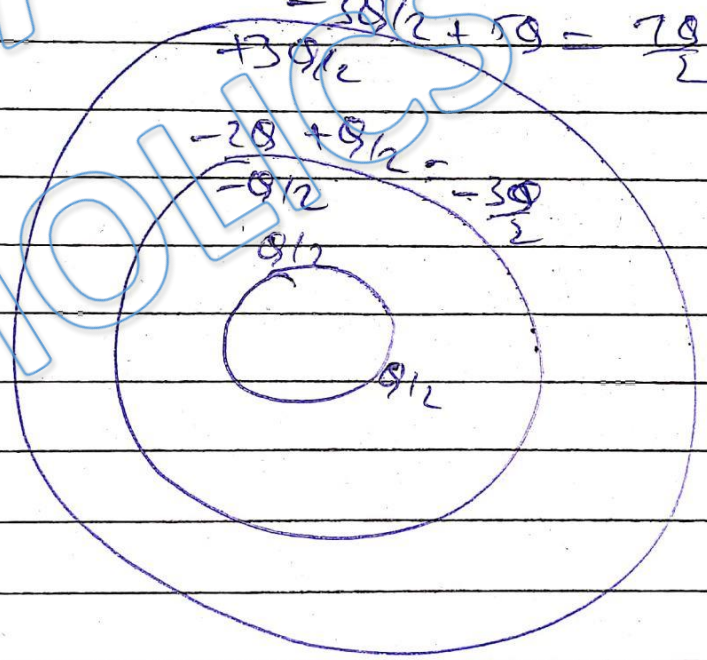
$$\boxed{x = Q/2}$$

NCO $\quad Q - Q/2 = Q/2$

$$-2Q = \text{const}$$

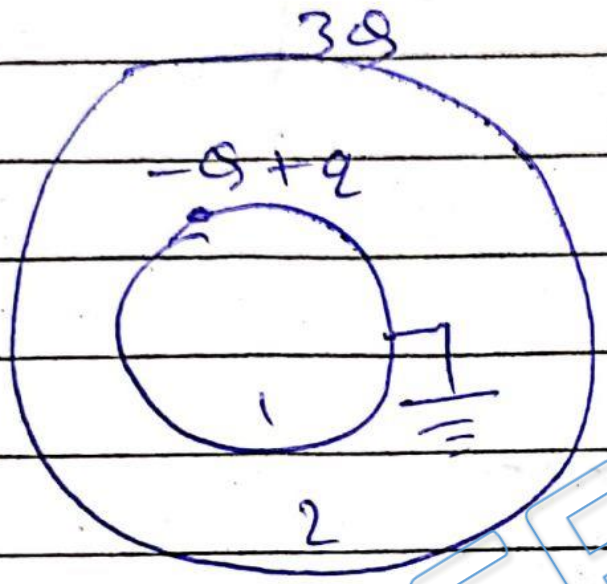
$$5Q + Q/2 = \frac{11Q}{2}$$

$$-3Q/2 + 5Q = \frac{7Q}{2}$$



Ans. b

Solution: 10



$$V_1 = \frac{K(-Q+q)}{R} + \frac{K3Q}{2R} = 0$$

~~$-Q + 2q + 3 = 0$~~

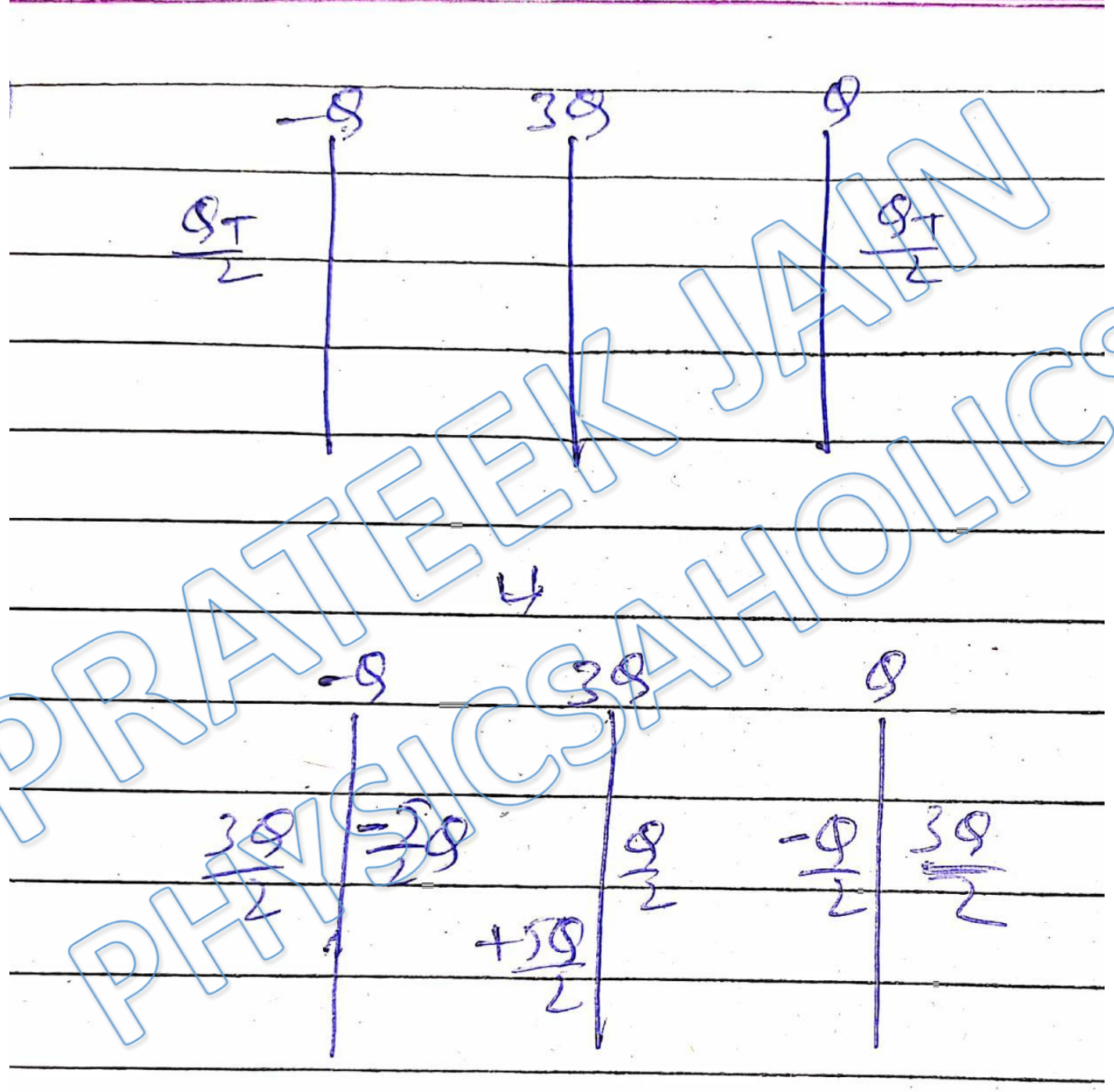
$$V_1 = -Q + q + \frac{3Q}{2} = 0$$

$$\boxed{q = -Q/2}$$

Hence charge flows into the earth $= \frac{Q}{2}$

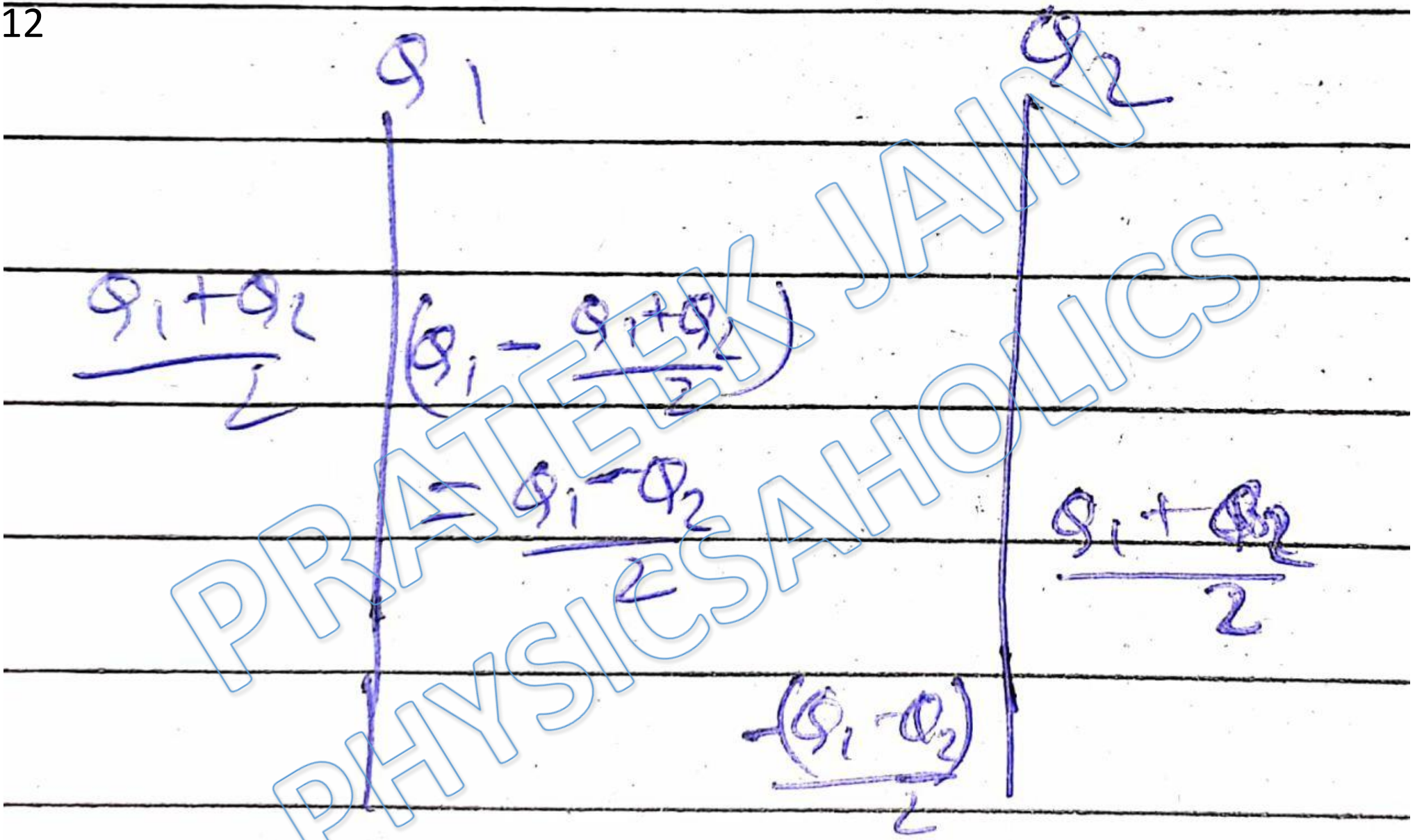
Ans. c

Solution: 11



Ans. a

Solution: 12

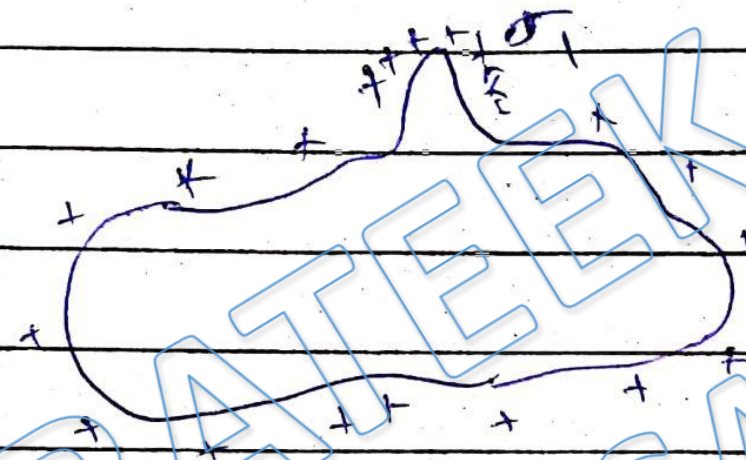


Ans. d

Solution: 13

$\sigma \propto \frac{1}{r}$

r = radius of curvature.



$\sigma_1 > \sigma_2$

$\therefore$ high at sharp and less at flat portion

Ans. b

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