# DPP – 1 (Capacitor)

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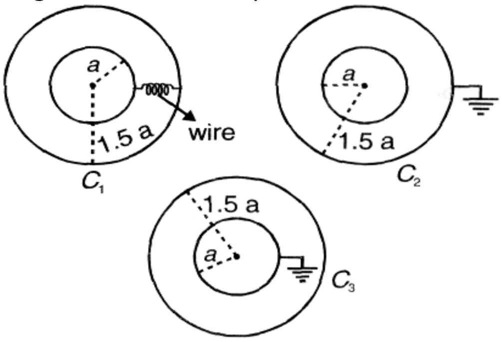
Q 1. Capacitance of following combination of spheres are $C_1$, $C_2$ & $C_3$

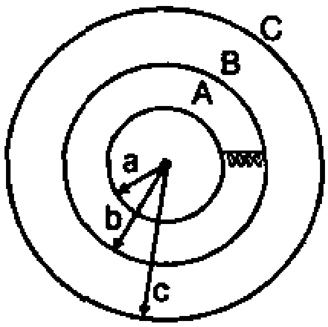



(a) $C_2 > C_1$ (b) $C_1 > C_3$
(c) $C_1 > C_2$ (d) $C_3 > C_2$

Q 2. Capacity of a spherical capacitor is $C_1$ when inner sphere is charged and outer sphere is earthed and $C_2$ when inner sphere is earthed and outer sphere is charged. Then $\frac{C_1}{C_2}$ is : (a = radius of inner sphere, b = radius of outer sphere)

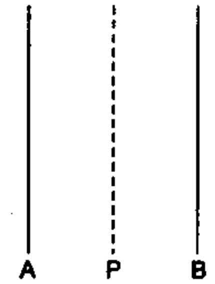
(a) 1 (b) $\frac{a}{b}$ (c) $\frac{b}{a}$ (d) $\frac{a+b}{a-b}$

Q 3. Three conducting spheres A, B and C are as shown in figure. The radii of the spheres are a, b and c respectively. A and B are connected by a conducting wire. The capacity of the system is between A and C is:




(a) $4\pi\varepsilon_0(a + b + c)$ (b) $4\pi\varepsilon_0\left(\frac{bc}{c-b}\right)$
(c) $4\pi\varepsilon_0\left(\frac{1}{a}+\frac{1}{b}+\frac{1}{c}\right)$ (d) $4\pi\varepsilon_0\left(\frac{abc}{ab+bc+ca}\right)$

Q 4. An air capacitor consists of two parallel plates A and B as shown in the figure. Plate A is given a charge Q and plate B is given a charge 3Q. P is the median plane of the capacitor. If $C_o$ is the capacitance of the capacitor, then:




(a) $V_P - V_A = \frac{Q}{4C_0}$ (b) $V_P - V_A = \frac{Q}{2C_0}$

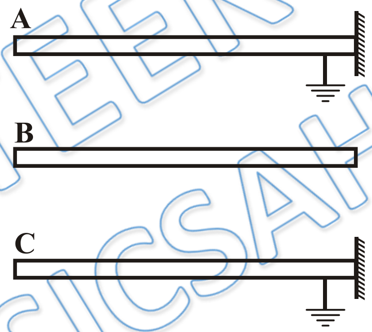
(c) $V_P - V_A = \frac{Q}{C_0}$ (d) $V_P - V_A = -\frac{Q}{4C_0}$

Q 5. A capacitor of capacitance C is charged to a potential difference V from a cell and then disconnected from it. A charge +Q is now given to its positive plate. The potential difference across the capacitor is now

(a) V (b) V + $\frac{Q}{C}$

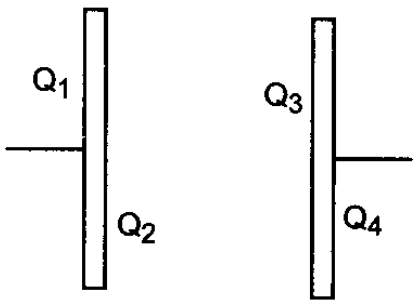
(c) V + $\frac{Q}{2C}$ (d) V - $\frac{Q}{C}$, if V < CV

Q 6. A, B and C are three large, parallel conducting plates, placed horizontally. A and C are rigidly fixed and earthed. B is given some charge. Under electrostatic and gravitational forces, B may be




(a) in equilibrium midway between A and C
(b) in equilibrium if it is closer to A than to C
(c) in equilibrium if it is closer to C than to A
(d) B can never be in stable equilibrium

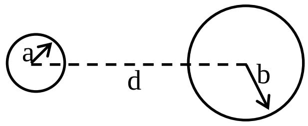
Q 7. In an isolated parallel-plate capacitor of capacitance C, the four surfaces have charges $Q_1$, $Q_2$, $Q_3$ and $Q_4$, as shown. The potential difference between the plates is




(a) $\frac{Q_1+Q_2}{C}$ (b) $\left|\frac{Q_2}{C}\right|$

(c) $\left|\frac{Q_3}{C}\right|$ (d) $\frac{1}{C}$ [($Q_1$+$Q_2$)-($Q_3$-$Q_4$)]

Q 8. Two metallic spheres of radii a and b are separated by a distance d as shown in figure. the capacity of the system is (assuming d is very large in comparison to a and b) –




(a) $4\pi\epsilon_0/(1/a + 1/b - 2/d)$
(b) $2\pi\epsilon_0/(1/a - 1/b + 1/d)$
(c) $4\pi\epsilon_0/(1/a + 1/b - 1/d)$
(d) $4\pi\epsilon_0(a + b)$

Q 9. Two thin long parallel conductor cylindrical wires of radius a have distance b between their axes. Their capacitance per unit length is

(a) $\frac{\pi\epsilon_0}{ln\left(\frac{b}{a}\right)}$ (b) $\frac{2\pi\epsilon_0}{ln\left(\frac{b}{a}\right)}$
(c) $\frac{4\pi\epsilon_0}{ln\left(\frac{b}{a}\right)}$ (d) $\frac{ab\pi\epsilon_0}{b-a}$

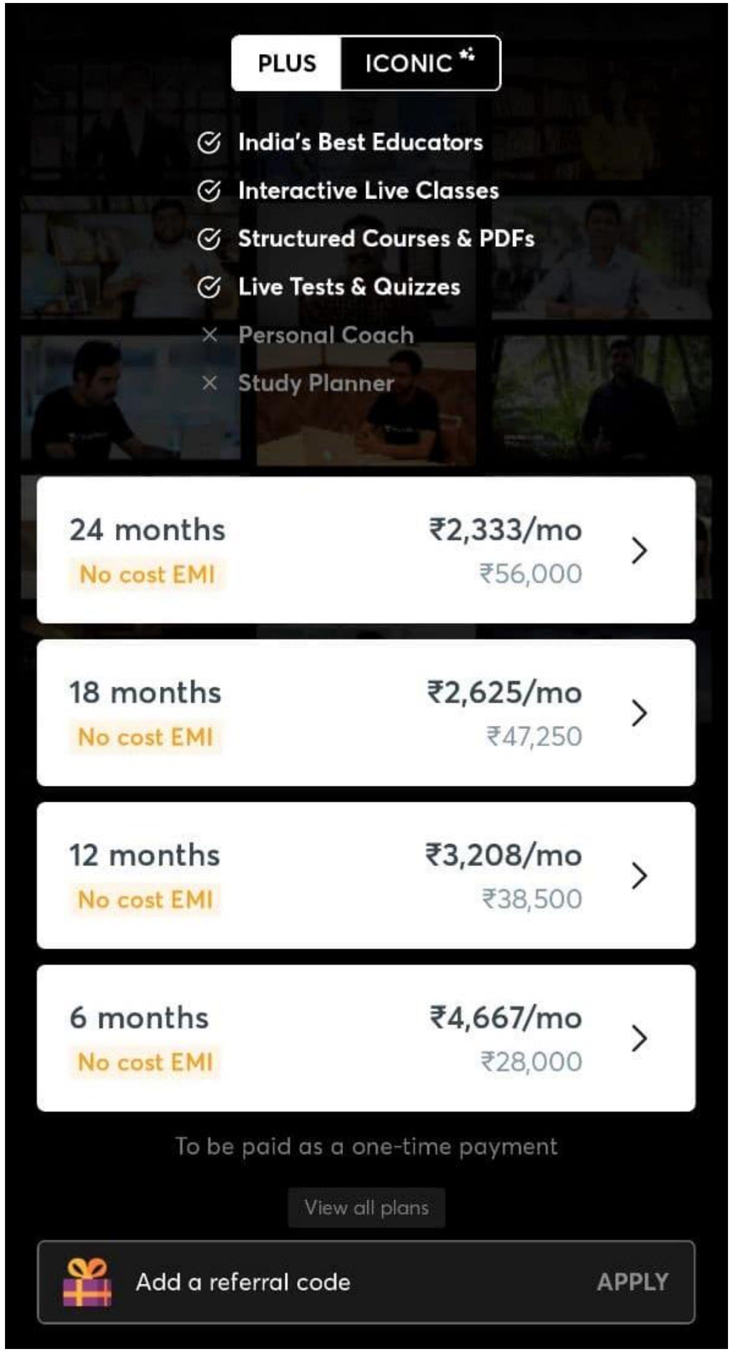
Q 10. If charge on positive plate of parallel plate capacitor is Q and electric field between plates is E, electrostatic force on positive plate will be
(a) QE
(b) QE/2
(c) QE/4
(d) QE/8

Q 11. Keeping potential difference between plates constant if we increase distance between parallel plate capacitor to two times ,electrostatic force between plates will become
(a)2 times of initial value
(b) 4 times of initial value
(c) 1/4 times of initial value
(d) ½ times of initial value



# Answer Key

| | | | | |
|---|---|---|---|---|
| Q.1 a, d | Q.2 b | Q.3 b | Q.4 b | Q.5 c |
| Q.6 b, d | Q.7 b, c | Q.8 a | Q.9 a | Q.10 b |
| Q.11 c | | | | |

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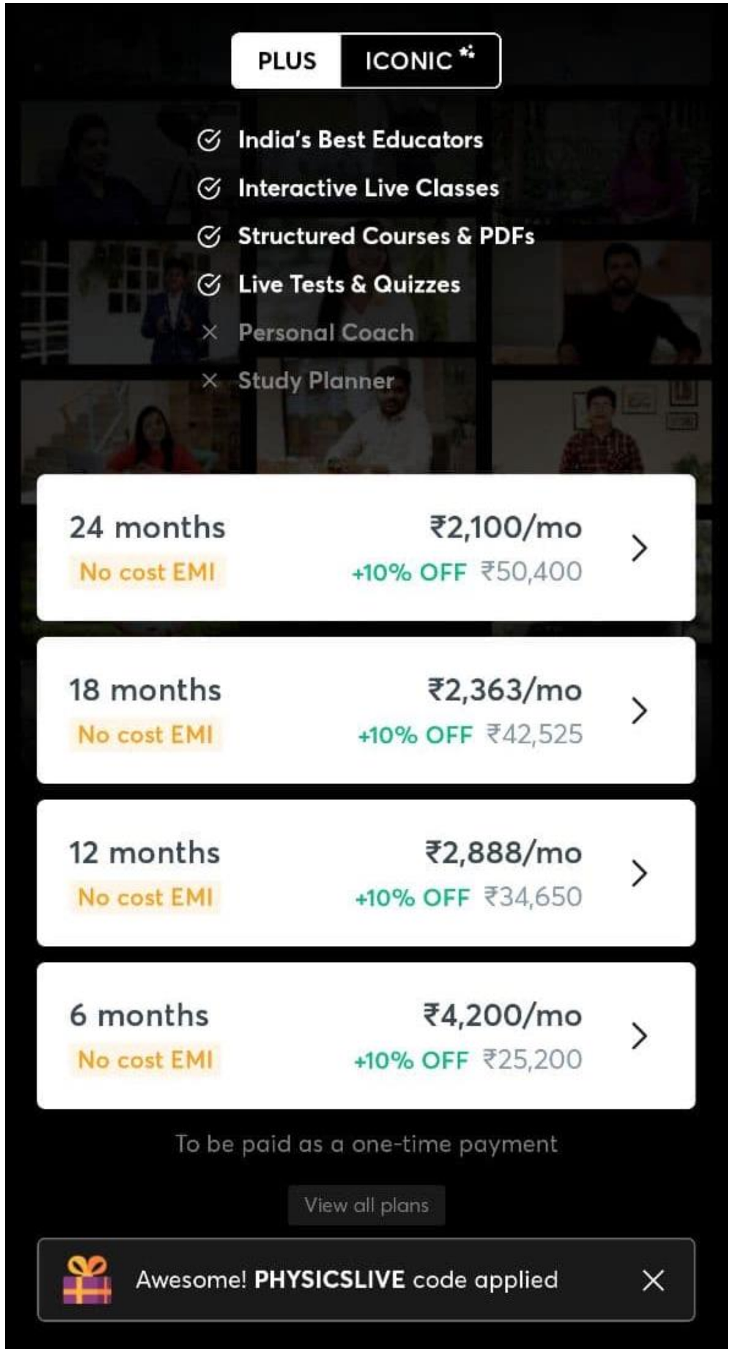


# Written Solution

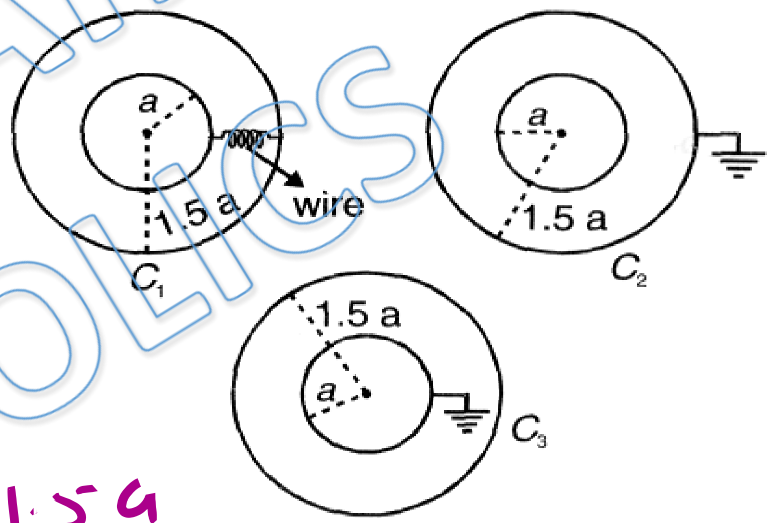
## DPP- 1 Capacitor : Capacitance of different types of capacitors, Force between plates of Parallel Plate capacitor

**By Physicsaholics Team**

(Q.1) Capacitance of following combination of spheres are $C_1$, $C_2$ & $C_3$

In $C_1$ There will be no charge on inner sphere. $C_1 = 4\pi\epsilon_0 R = 4\pi\epsilon_0 \times 1.5a$

$= 6\pi\epsilon_0 a$




(a) $C_2 > C_1$ ✓
(b) $C_1 > C_3$
(c) $C_1 > C_2$
(d) $C_3 > C_2$ ✓

$$C_2 = \frac{4\pi\epsilon_0 ab}{b-a} = \frac{4\pi\epsilon_0 \times a \times 1.5a}{.5a} = 6\pi\epsilon_0 a$$

$$C_3 = \frac{4\pi\epsilon_0 b^2}{b-a} = \frac{4\pi\epsilon_0 \times 1.5 \times 1.5a}{.5a} = 18\pi\epsilon_0 a$$

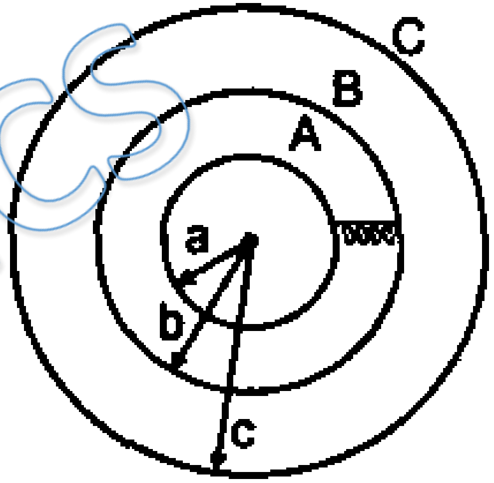
(Q.2) Capacity of a spherical capacitor is $C_1$ when inner sphere is charged and outer sphere is earthed and $C_2$ when inner sphere is earthed and outer sphere is charged. Then $\frac{C_1}{C_2}$ is : (a = radius of inner sphere, b = radius of outer sphere)

(a) 1 (b) $\frac{a}{b}$ (c) $\frac{b}{a}$ (d) $\frac{a+b}{a-b}$

$$C_1 = \frac{4\pi\epsilon_0 ab}{b-a}, \quad C_2 = \frac{4\pi\epsilon_0 b^2}{b-a}$$

$$\frac{C_1}{C_2} = \frac{a}{b}$$

(Q.3) Three conducting spheres A, B and C are as shown in figure. The radii of the spheres are a, b and c respectively. A and B are connected by a conducting wire. The capacity of the system is between A and C is:




There will be no charge on A.
Capacitance between A & C is

(a) $4\pi\varepsilon_0(a + b + c)$ (b) $4\pi\varepsilon_0\left(\frac{bc}{c-b}\right)$

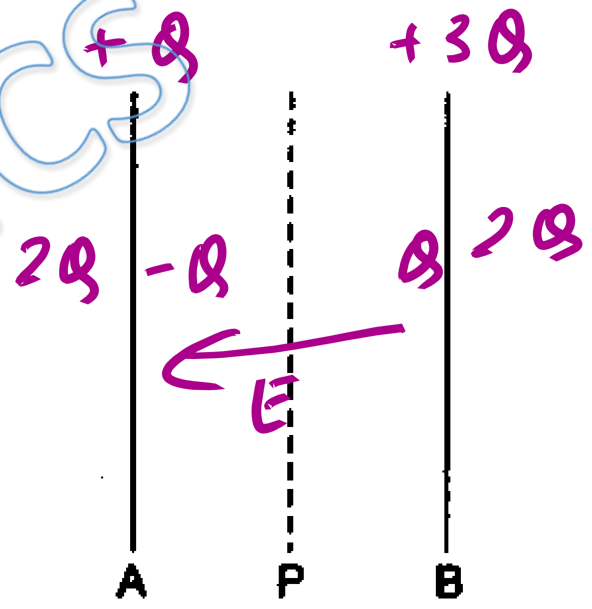
(c) $4\pi\varepsilon_0\left(\frac{1}{a}+\frac{1}{b}+\frac{1}{c}\right)$ (d) $4\pi\varepsilon_0\left(\frac{abc}{ab+bc+ca}\right)$

equal to Capacitance between B & C

$$= \frac{4\pi\varepsilon_0 bc}{c-b}$$

(Q.4) An air capacitor consists of two parallel plates A and B as shown in the figure. Plate A is given a charge Q and plate B is given a charge 3Q. P is the median plane of the capacitor. If $C_o$ is the capacitance of the capacitor, then:

$V_B > V_P > V_A$




(a) $V_P - V_A = \frac{Q}{4C_0}$

(b) $V_P - V_A = \frac{Q}{2C_0}$

(c) $V_P - V_A = \frac{Q}{C_0}$

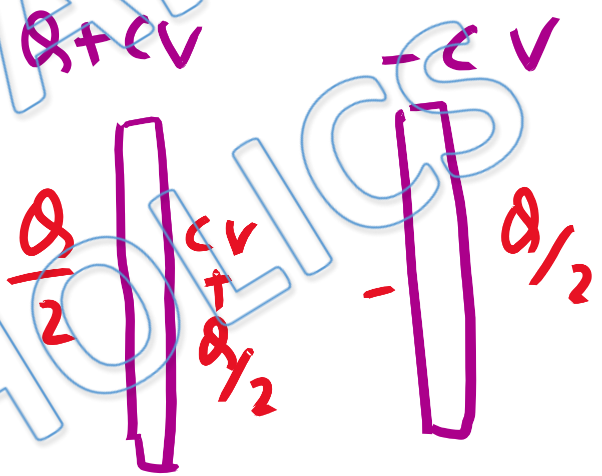
(d) $V_P - V_A = -\frac{Q}{4C_0}$

$V_B - V_A = \frac{Q}{C_0}$

$V_P - V_A = \frac{1}{2}(V_B - V_A) = \frac{Q}{2\epsilon_0}$

(Q.5) A capacitor of capacitance C is charged to a potential difference V from a cell and then disconnected from it. A charge +Q is now given to its positive plate. The potential difference across the capacitor is now

Only facing surfaces behave as capacitor.




(a) V

(b) $V + \frac{Q}{C}$

(c) $V + \frac{Q}{2C}$ ✓

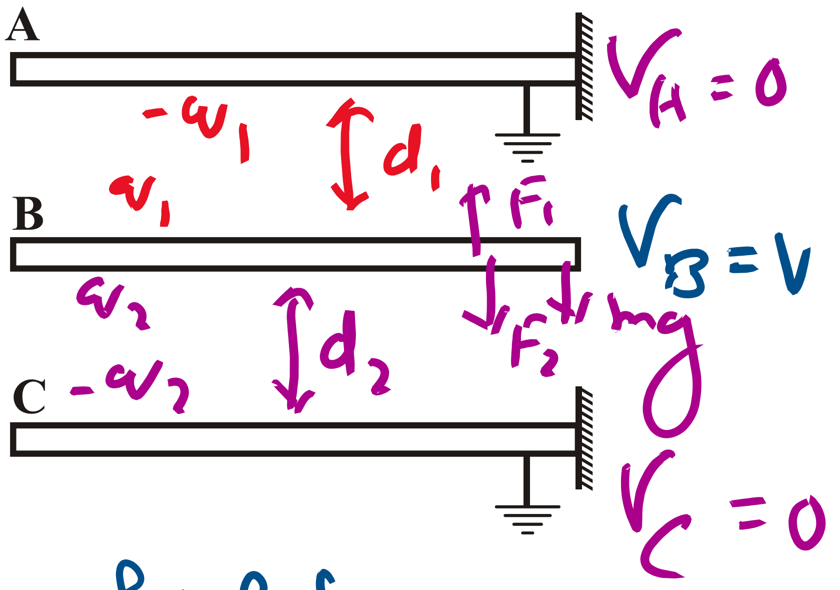
(d) $V - \frac{Q}{C}$, if $V < CV$

Potential difference $= \frac{CV + Q/2}{C}$

$= V + Q/2C$

(Q.6) A, B and C are three large, parallel conducting plates, placed horizontally. A and C are rigidly fixed and earthed. B is given some charge. Under electrostatic and gravitational forces, B may be

$\Delta V_{AB} = \Delta V_{CB} = V$




(a) in equilibrium midway between A and C
(b) in equilibrium if it is closer to A than to C
(c) in equilibrium if it is closer to C than to A
(d) B can never be in stable equilibrium

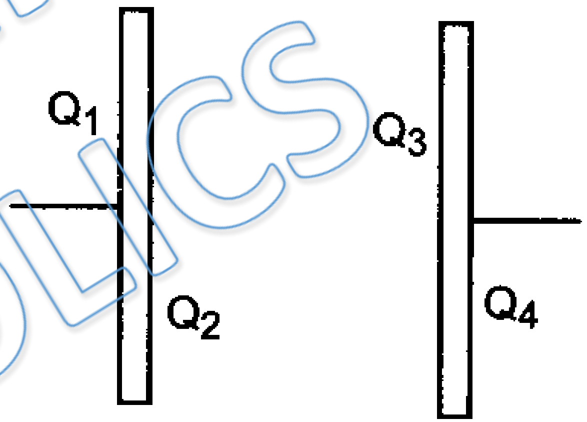
$q = CV = \frac{A\epsilon_0}{d} V \Rightarrow$ low $d$, high $q$; high force.

for equilibrium $F_1 > F_2 \Rightarrow d_1 < d_2$

$\Rightarrow$ B is closer to A.

(Q.7) In an isolated parallel-plate capacitor of capacitance C, the four surfaces have charges $Q_1$, $Q_2$, $Q_3$ and $Q_4$, as shown. The potential difference between the plates is

$Q_1 = Q_4$ & $Q_2 = -Q_3$




(a) $\frac{Q_1+Q_2}{C}$

(b) $\left|\frac{Q_2}{C}\right|$ ✓

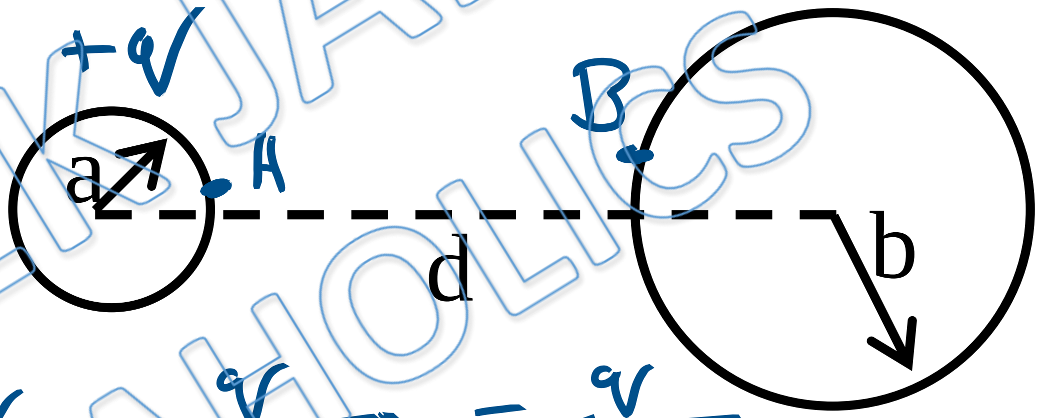
(c) $\left|\frac{Q_3}{C}\right|$ ✓

(d) $\frac{1}{C}[(Q_1+Q_2)-(Q_3-Q_4)]$

Since only inner surfaces behave as capacitor

$V = \left|\frac{Q_2}{C}\right| = \left|\frac{Q_3}{C}\right|$

(Q.8) Two metallic spheres of radii a and b are separated by a distance d as shown in figure. the capacity of the system is (assuming d is very large in comparison to a and b) -




✓ (a) $4\pi \in_0/(1/a + 1/b - 2/d)$

(b) $2\pi \in_0/(1/a - 1/b + 1/d)$

(c) $4\pi \in_0/(1/a + 1/b - 1/d)$

(d) $4\pi \in_0(a + b)$

$$V_A = \frac{q}{4\pi\epsilon_0 a} - \frac{q}{4\pi\epsilon_0 d}$$

$$V_B = \frac{-q}{4\pi\epsilon_0 b} + \frac{q}{4\pi\epsilon_0 d}$$

$$V = V_A - V_B = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{a} + \frac{1}{b} - \frac{2}{d}\right)$$

$$C = 4\pi\epsilon_0 \Big/ \frac{1}{a} + \frac{1}{b} - \frac{2}{d}$$

(Q.9) Two thin long parallel conductor cylindrical wires of radius a have distance b between their axes. Their capacitance per unit length is

$\lambda = q/l$

field due to +ve wire only

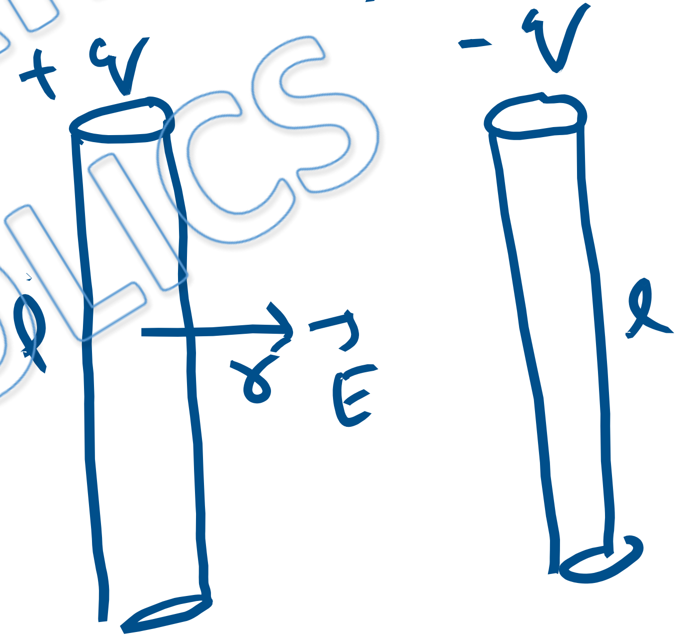
$E = \frac{2K\lambda}{r}$

(a) $\frac{\pi\epsilon_0}{ln\left(\frac{b}{a}\right)}$ ✓

(b) $\frac{2\pi\epsilon_0}{ln\left(\frac{b}{a}\right)}$

(c) $\frac{4\pi\epsilon_0}{ln\left(\frac{b}{a}\right)}$

(d) $\frac{ab\pi\epsilon_0}{b-a}$




ΔV due to +ve wire only

$= \int_a^b \frac{2K\lambda}{r} dr$

$= \frac{2K\lambda}{r} ln(b/a)$

Total P.D $= \frac{4Kq}{lr} ln(b/a) \Rightarrow C = \frac{lr}{4\pi \, ln(b/a)}$

(Q.10) If charge on positive plate of parallel plate capacitor is Q and electric field between plates is E, electrostatic force on positive plate will be

(a) QE

(b) QE/2

(c) QE/4

(d) QE/8

$$E = \frac{Q}{A\epsilon_0}$$

$$F = \frac{Q^2}{2A\epsilon_0} = Q\left(\frac{Q}{2A\epsilon_0}\right)$$

$$= \frac{QE}{2}$$

(Q.11) Keeping potential difference between plates constant if we increase distance between parallel plate capacitor to two times ,electrostatic force between plates will become

(a) 2 times of initial value

(b) 4 times of initial value

(c) 1/4 times of initial value

(d) ½ times of initial value

$q = CV = \frac{A\epsilon_0}{d} V$

$d \rightarrow 2$ times, $q \rightarrow \frac{1}{2}$ times.

$F \propto q^2$, $q \rightarrow \frac{1}{2}$ times, $F \rightarrow \frac{1}{4}$ times.

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Chalo Niklo