JEE NEET PHYSICS QA

A 10 μC charge is divided into two parts and placed at 1 cm distance so that the repulsive force between them is maximum. The charges of the two parts are :

(a) 9 μC, 1 μC (b) 5 μC, 5 μC
(c) 7 μC, 3 μC (d) 8 μC, 2 μC

Ans. (b) : Let one part of the charge be q and other part of the charge is (10 – q) separated at distance 1cm.
From coulombs law-
Electrostatic force between them-

$$F = \frac{kq(10-q)}{r^2}$$

For maximum force, $\frac{dF}{dq} = 0$

$$\frac{dF}{dq} = 0$$

$$\frac{k(10-2q)}{(1)^2} = 0$$

$$10 - 2q = 0$$

$$q = \frac{10}{2}$$

$$q = 5\ \mu C$$

So, other charge = 10 – q
= 10 – 5
= 5μC

Hence, force between them is maximum if the two parts have equal charge of 5μC.

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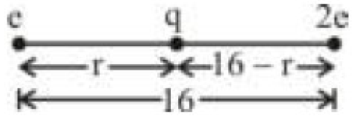
Two particles of charges + e and + 2e are at 16 cm away from each other. Where should another charge q be placed between them, so that the system remains in equilibrium?

(a) 24 cm from + e (b) 12.23 cm from + e
(c) 80 cm from + e (d) 6.63 cm from + e

Ans. (d) :



For the condition of equilibrium –

Force on q due to e = force on q due to 2e

$$\frac{1}{4\pi\varepsilon_o}\cdot\frac{eq}{r^2} = \frac{1}{4\pi\varepsilon_o}\frac{2e\cdot q}{(16-r)^2}$$

$$\frac{1}{r^2} = \frac{2}{(16-r)^2}$$

$$16 - r = \sqrt{2}\,r$$

$$r = \frac{16}{1+\sqrt{2}} = 6.63\,\text{cm}$$

r = 6.63 cm from +e

The distance between charges 5×10^{-11} C and -2.7×10^{-11} C is 0.2 m. The distance at which is third charge should be placed in order that it will not experience any force along the line joining the two charges is

(a) 0.44 m (b) 0.65 m

(c) 0.556 m (d) 0.350 m

Ans. (c) : Given, $Q_1 = 5\times10^{-11}$C, $Q_2 = -2.7\times10^{-11}$C

Let distance of A is x m from Q_2 having charge q

Force acting on point A due to Q_1

$$F_1 = k\frac{qQ_1}{(0.2+x)^2} \quad \text{...(i)}$$

Force acting on point A due to Q_2

$$F_2 = k\frac{qQ_2}{x^2} \quad \text{....(ii)}$$

$\because$ $F_1 = F_2$

$$k\frac{qQ_1}{(0.2+x)^2} = \frac{kqQ_2}{x^2}$$

$$\frac{Q_1}{(0.2+x)^2} = \frac{Q_2}{x^2}$$

$$\frac{5\times10^{-11}}{(0.2+x)^2}=\frac{2.7\times10^{-11}}{x^2}$$

$$\frac{50}{27}=\frac{(0.2+x)^2}{x^2}$$

$$\frac{0.2+x}{x}=1.36$$

$$0.2 = 0.36x$$

$$x = 0.556 \text{ m}$$

The specific charge of an electron is

(a) 1.76×10^{11} C kg^{-1} (b) 1.6×10^{-19} C kg^{-1}

(c) 9.1×10^{-31} C kg^{-1} (d) 1.76×10^{11} C kg^{-1}

Ans. (a) : We know,

Specific charge of an electron = $\frac{\text{Charge}}{\text{Mass}}$

So, $$\frac{e}{m_e}=\frac{1.6\times10^{-19}\text{C}}{9.1\times10^{-31}\text{kg}}$$

$$\frac{e}{m_e}=1.76\times10^{11}\text{C/kg}$$

A circular coil of radius 10 cm and 50 turns is rotated about its vertical diameter with an angular speed of 20 rad/s in a uniform horizontal magnetic field of magnitude 7×10^{-2} T. If the closed loop of resistance of the coil is 20Ω. The maximum value of current in the coil is

(a) 0.08 A (b) 0.06 A

(c) 0.15 A (d) 0.11 A

Ans. (d) : Given,

$r = 10 \text{ cm} = 10\times10^{-2}$ m

N = 50 turns

$\omega = 20$ rad /sec

$B = 7\times10^{-2}$ T

R = 20Ω

Maximum induced emf

$$\varepsilon = NBA\omega$$

$$\varepsilon = 50\times7\times10^{-2}\,[\pi\times(10\times10^{-2})^2]\times20$$

$$\varepsilon = 70\,(\pi\times10^{-2})$$

∴ Maximum induced current (I) = $\frac{\varepsilon}{R}=\frac{70\pi\times10^{-2}}{20}$

$$I = 0.11 \text{ A}$$

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A big circular coil of 1000 turns and average radius 10 m is rotating about its horizontal diameter at 2 rad s^{-1}. If the vertical component of earth's magnetic field at that place is 2×10^{-5} T and electrical resistance of the coil is 12.56 Ω, then the maximum induced current in the coil will be

(a) 1 A (b) 2 A
(c) 0.25 A (d) 1.5 A

Ans. (a) : Given,
Number of turns (N) = 1000
Radius of coil (r) = 10m
Earth's magnetic field (B) = 2×10^{-5} T
Induced emf is given as
$\varepsilon_{max} = NBA\omega$
Maximum induced current is

$$I_{max} = \frac{E_{max}}{R} = \frac{NBA\omega}{R}$$

$$I_{max} = \frac{1000\times2\times10^{-5}\times\pi\times(10^2)\times2}{12.56}$$

$I_{max} = 1A$

A square loop of side 1 m and resistance 1 Ω is placed in a magnetic field of 0.5T. If the plane of loop is perpendicular to the direction of magnetic field, the magnetic flux through the loop is

(a) 1 weber (b) Zero weber
(c) 2 weber (d) 0.5 weber

Ans. (d) : Given,
Magnetic field (B) = 0.5 T
Length (L) = $1m^2$
Angle between $\overline{B}$ and $\overline{A}$ is zero

$\phi = B.A.\cos\phi$

$\phi = B\times(L)^2\times\cos0°$
$= 0.5\times(1)^2\times1$
$= 0.5$Weber

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The charge flowing in a conductor changes with time as $Q(t) = \alpha t - \beta t^2 + \gamma t^3$. Where α, β and γ are constants. Minimum value of current is:

(a) $\alpha - \frac{\gamma^2}{3\beta}$ (b) $\beta - \frac{\alpha^2}{3\gamma}$

(c) $\alpha - \frac{\beta^2}{3\gamma}$ (d) $\alpha - \frac{3\beta^2}{\gamma}$

Ans. (c) : We know that,

$$i = \frac{Q}{t}$$

$$i = \frac{dQ}{dt} = \alpha - 2\beta t + 3\gamma t^2$$

Now, $di/dt = -2\beta + 6\gamma t$

$di/dt = 0$

$-2\beta + 6\gamma t = 0$

$$-2\beta = -6\gamma t \Rightarrow t = \frac{2\beta}{6\gamma} = \frac{\beta}{3\gamma}$$

$t = \beta/3\gamma$

And, $d^2i/dt^2 = 6\gamma$

$$\therefore \quad i_{min} = \alpha - 2\beta\left(\frac{\beta}{3\gamma}\right) + 3\gamma\left(\frac{\beta}{3\gamma}\right)^2 = \alpha - \frac{2\beta^2}{3\gamma} + \frac{\beta^2}{3\gamma}$$

$$i_{min} = \alpha - \frac{\beta^2}{3\gamma}$$

A current of 0.6 A is drawn by an electric bulb for 10 minutes. Which one of the following is the amount of electric charge that flows through the circuit?

(a) 6 C (b) 0·6 C

(c) 360 C (d) 36 C

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Ans. (c) : Given, I = 0.6 A, t = 10 minutes = 600 s

We know that,

Charge, $Q = I.t$

$Q = 0.6 \times 10 \times 60$

$Q = 360$ C