# NUMERICAL PROBLMES

13.1.1 The charge of how many negatively charged particles would be equal to $100\mu C$. Assume charge on one negative particle is $1.6\times10^{-19}C$?

**Solution:** Given that,

Total Charge $Q = 100\ \mu C = 100 \times 10^{-6} C$

Charge on an electron $e = 1.6 \times 10^{-19} C$

**To find:** No. of negatively charged particles $n = ?$

**Calculations:** Using the formula

$$Q = ne$$

Or $$n = \frac{Q}{e}$$

By putting the values

$$n = \frac{100\times10^{-6}C}{1.6\times10^{-19}C}$$

$$= \frac{10^{2}\times10^{-6}\times10^{19}}{1.6}$$

$$= \frac{10^{0} \times 10^{21}}{1.6}$$

$$= \frac{1}{1.6} \times 10^{15}$$

$$= \frac{1}{16} \times 10^{16} = 0.0625 \times 10^{16}$$

$$n = 6.25 \times 10^{13}$$ **Ans**

**13.1.2** Two point charges $q_1 = 10\mu C$ and $q_2 = 5\mu C$ are placed at a distance of 150 cm. What will be the Coulomb's force between them? Also find the direction of the force.

**Solution:** Given that

First point charge = $q_1 = 10\mu C = 10 \times 10^{-6} = 1 \times 10^{-5} C$

Second point charge = $q_2 = 5\ \mu C = 5 \times 10^{-6}\ C$

Distance r = 150 cm = $\frac{150cm}{100} = 1.5$ m

Proportionality constant = k = $9 \times 10^{9}\ Nm^2\ C^{-2}$

**To Find**

(i) Magnitude of Coulomb's force F = ?

(ii) Direction of Coulomb's force = ?

**Calculations:** According to Coulomb's law

$$F = k\frac{q_1 q_2}{r^2}$$

By putting the values

$$F = \frac{9 \times 10^{9} Nm^2 C^{-2} \times 1 \times 10^{-5} C \times 5 \times 10^{-6} C}{(1.5m)^2}$$

$$= \frac{9 \times 10^{9} Nm^2 \times 10^{-5} \times 5 \times 10^{-6}}{2.25m^2}$$

$$= \frac{45 \times 10^{-2} N}{2.25}$$

$$= \frac{45}{225} N$$

F = 0.2 N **Ans**

The direction of coulomb's force is direction of repulsion

13.1.3 The force of repulsion between two identical positive charges is 0.8 N, when the charges are 0.1 m part. Find the value of each charge.

**Solution:** Given that,

Force = F = 0.8 N

Distance between the charges r = 0.1 m

Proportionality constant = $k = 9 \times 10^9\ Nm^2C^{-2}$

**To Find:** Value of each charger = q = ?

**Calculations:** Using Coulomb's law

$$F = \frac{kq_1q_2}{r^2}$$

Since the charges are identical, therefore, $q_1 = q_2 = q$, thus

$$F = k\frac{q^2}{r^2}$$

Or $\quad F \times r^2 = 9 \times 10^9\ Nm^2\ C^{-2} \times q^2$

Or $\quad q^2 = \frac{F \times r^2}{9 \times 10^9\ Nm^2C^{-2}}$

By putting the values

$$q^2 = \frac{0.8N \times (0.1m)^2}{9 \times 10^9\ Nm^2\ C^{-2}}$$

$$= \frac{0.8 \times 0.01}{9 \times 10^9}\ C^2$$

$$= \frac{0.008}{9 \times 10^9}\ C^2$$

$$q = \sqrt{\frac{0.008 \times 10^{-9}}{9}}\ C$$

$$q = 9.4 \times 10^{-7}\ C \text{ Ans}$$

13.1.4 Two charges repel each other with a force of 0.1 N when they are 5cm apart. Find the forces between the same charges when they are 2 cm apart.

**Solution:** Given that,

Force F $= 0.1$ N

Distance between the charges r = 5 cm = $\frac{5}{100}$ m = 0.05 m

**To Find:** Forces between the charge when they are 2 cm or 0.02 m apart F = ?

**Calculations:** According to coulomb's law,

$$F = K\frac{q.q}{r^2}$$

By putting the values

$$0.1\ N = 9 \times Nm^2\ C^{-2} \times \frac{q.q}{(0.05m)^2}$$

Or $q_1q_2 = \frac{0.1\times(0.05)^2}{9\times10^9} C^2$

Now force between the charges

$$F = k\frac{q_1q_2}{r^2}$$

By putting the values

$$F = 9\times10^9\ Nm^2C^{-2} \times \frac{(0.1)\times(0.05)^2\ C^2}{9\times10^9} \times \frac{1}{(0.02m)^2}$$

$$= \frac{(0.1)\times(0.05)^2}{(0.02)^2} N$$

F = 0.62 N **Ans.**

**13.1.5** The potential lat a point in an electric field is $10^4$ V. If a charge of $+100\mu C$ is brought from infinity to this point. What would be the amount of work done on it?

**Solution:** Given that,

Electric potential V = $10^4$ V

Charge q = $+100\ \mu C = 100\times10^{-6}\ C = 1\times10^{-4}\ C$

**To Find**: Work done W = ?

**Calculations:** Using the formula

$$V = \frac{W}{q}$$

Or $W = qV$

By putting the values

$W = 10^{-4}\ C \times 10^4\ C$

W = 1J **Ans.**

**13.1.6** A point charge of +2C is transferred from a point at potential 100V to a point at potential 50V, what would be the energy supplied by the charge?

**Solution:** Given that,

Charge q = +2C

Potential at point A $V_A$ = 100 V

Potential at point B $V_B$ = 50 V

**To Find:** Energy supplied by the charge E = ?

**Calculations**

Using the formula

$$E = q(V_A - V_B)$$

By putting the values

E = 2C(100V – 50V)

E = 100 J **Ans.**

13.1.7 A capacitor holds 0.06 coulombs of charge when fully charged by a 9 volt battery. Calculate capacitance of the capacitor.

**Solution:** Given that,

Charge Q = 0.06 C

Voltage V = 9V

**To Find:** Capacitance C = ?

**Calculations:** Using the formula

$$Q = CV$$

Or $$C = \frac{Q}{V}$$

By putting the values

$$C = \frac{0.06C}{9v}$$

$$C = 6.67 \times 10^{-3} \text{ F}$$ **Ans.**

13.1.8 A capacitor holds 0.03 coulombs of charge when fully charged by a 6 volt battery. How much voltage would be required for it to hold 2 coulombs of charge?

**Solutions:** Given that

Charge = Q = 0.03 C

Voltage V = 6V

**To Find:** Voltage to hold 2C of charge V = ?

**Calculations:** Since

$$0.03\ C = 6V$$

Or $$1C = \frac{6V}{0.03}$$

Therefore,

$$2C = \frac{6V}{0.03} \times 2$$

$$= \frac{1200V}{3}$$

$$V = 400 \text{ V}$$ **Ans.**

13.1.9 Two capacitors of $6\mu F$ and $12\mu F$ are connected in series with 12V battery. Find the equivalent capacitance of the combination. Find the charge and potential difference across each capacitor.

**Solution:** Given that,

Capacitance = $C_1 = 6\ \mu F = 6 \times 10^{-6} F$

Capacitance = $C_2 = 12\ \mu F = 12 \times 10^{-6} F$

Voltage = $V = 12\ V$

**To Find**

(i) Equivalent capacitance $C_{eq} = ?$

(ii) Charge on each capacitor $Q = ?$

(iii) Potential difference across one capacitor $V_1 = ?$

Potential difference across second capacitor = $V_2 = ?$

**Calculations:** (i) Since the capacitors are connected in series, therefore, equivalent capacitance will be

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

By putting the values

$$\frac{1}{C_{eq}} = \frac{1}{6\mu F} + \frac{1}{12\mu F} = \frac{2+1}{\mu F}$$

$$\frac{1}{C_{eq}} = \frac{3}{12\mu F}$$

Or $$C_{eq} = \frac{12\mu F}{3}$$

$$C_{eq} = 4\mu F \text{ Ans.}$$

(ii) Since the capacitor are connected in series, therefore, charge on capacitor will be

$$Q = CV$$

Or $$Q = 4 \times 10^{-6}\ F \times 12V$$

$$Q = 48 \times 10^{-6}\ FV$$

$$Q = 48\ \mu C \text{ Ans.}$$

(iii) Potential difference across capacitor of capacitance $C_1$ will be

$$Q = C_1 V_1$$

Or $$V_1 = \frac{Q}{C_1}$$

Or $V_1 = \frac{48\mu C}{6\mu F} = 8V$ **Ans.**

Similarly, potential difference across capacitor of capacitance $C_2$ will be

$$Q = C_2V_2$$

Or $$V_2 = \frac{Q}{C_2}$$

Or $$V_2 = \frac{48\mu C}{12\mu F} = 4V$$ **Ans.**

13.1.10 Tow capacitors of capacitances $6\mu F$ and $12\mu F$ are connected in parallel with a 12V battery. Find the equivalent capacitance of the combination. Find the charge and the potential difference across each capacitor.

Solution: Given that,

Capacitance $= C_1 = 6\mu F$

Capacitance $= C_2 = 12\mu F$

Voltage $= V = 12V$

To Find

(i) Equivalent capacitance $C_{eq} = ?$

(ii) Charge on one capacitor $Q_1 = ?$

(iii) Charge on second capacitor $= Q_2 = ?$

(iv) Potential difference across each capacitor $V = ?$

Calculations: (i) Since the capacitors are connected in parallel, therefore, equivalent capacitance will be

$$C_{eq} = C_1 + C_2$$
$$= 6\mu F + 12\mu F$$
$$C_{eq} = 18\mu F$$ **Ans.**

(ii) Charge on capacitor $C_1$ will be

$$Q_1 = C_1V$$

Or $$Q_1 = 6\mu F \times 12V$$

$$Q_1 = 72\mu C$$ **Ans.**

(iii) Charge on capacitor $C_2$ will be

$$Q_2 = C_2V$$

$$Q_2 = 12\ \mu F \times 12\ V$$

$$Q_2 = 144\mu\ C$$ Ans.

(iv) Since the capacitors are connected in parallel, therefore, potential difference across each capacitor will be 12V.