CHAPTER#13 ELECTROSTATICS

CONCEPTUAL QUESTIONS

QUESTION#1

Rub plastic ruler with your hair. Place it near running water from tap. You see that thin stream is deflected, why?

Answer: This happens due to *electrostatic induction.*

When we rub plastic ruler with our hair, a charge is produced on it due to loss or gain of electrons. When this charged plastic ruler is placed near running water from tap, it induces opposite charge on it. An attractive force developed between them. Therefore, thin stream of water is deflected.

QUESTION#2

Two identical spheres have same masses. Then we charge both sphere oppositely charged. After charging, will there be both bodies have same masses or different masses? Explain.

Answer: No, their masses are not same after charging.

We know that bodies attain positive charge due to loss of electrons and negative charge due to gain of electrons. Before charging, the spheres have equal masses. But after charging, negatively charged body will be heavier due to addition of electrons and positively charged body will be lighter due to removal of electrons.

$$\text{Mass of electron} = m_E = 9.01 \times 10^{-31}\ \text{kg}$$

QUESTION#3

You take your car to service station to get it polished. After a while, you observe that your car attracts the dust. Why is dust attracted by the car?

Answer: This happens due to *electrostatic induction.*

After the car is polished, it becomes a charge body (either positive or negative). It induces opposite charge on the nearby dust due to electrostatic induction. That's why attractive force develops between the polished car and dust particles.

QUESTION#4

Take two oppositely charged rods, place them separately near small pieces of paper. Why do they both attract small pieces of paper? Is there any third type of charge on papers which attracts both positive and negative charges?

Answer: There is no third type of charge on the paper, in fact it happens due to *electrostatic induction.*

When charged rods are placed near small pieces of paper, they induce opposite charge on the pieces of paper due to electrostatic induction. That's why attractive force develops between the charged rods and small pieces of paper.

QUESTION#5

The force between two point charges is 10 N. If their charge is doubled and distance between them is reduced to half, what will be magnitude of force between them?

Answer: The force will now become 16 times i.e., 160 N.

$$F = k\frac{q_1 q_2}{r^2} = 10\ \text{N}$$

As charges have doubled and distance is reduced to half:

$$q_1' = 2q_1\ ,\ q_2' = 2q_2\ ,\ r' = \frac{r}{2}$$

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

$$F' = k\frac{(2q_1)(2q_2)}{\left(\frac{r}{2}\right)^2}$$

$$F' = k\frac{4(q_1)(q_2)}{\frac{r^2}{4}}$$

$$F' = 16\left[k\frac{q_1 q_2}{r^2}\right]$$

$$F' = 16[F]$$

$$F' = 16[10]$$

$$\boxed{F' = 160\ N}$$

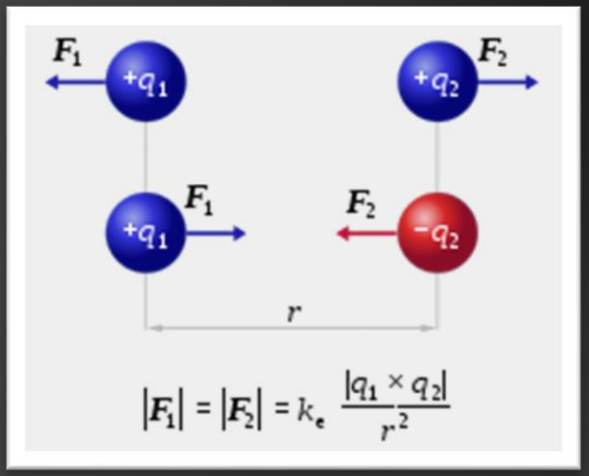
QUESTION#6

A 100 C charged body of mass 20 kg repels 1 C charged body of 10 g with a force of 2000 N. Will smaller charged body apply force same / smaller/ greater force?

Answer: Both bodies will apply same force on each other irrespective of charge and masses.

We know that Coulomb's force is a mutual force. If charge 1 applies force on charge 2 then as a reaction charge 2 applies equal force on charge 1 but in opposite direction by Newton's 3rd law of motion.

$$\vec{F}_{12} = -\vec{F}_{21}$$



QUESTION#7

Why is it dangerous for construction workers to hold long steel pole upright during lightning weather condition?

Answer: It is dangerous as lightning can travel long distances through steel, since steel is a conductor.

Lightning takes the path of least resistance. When the construction worker will be holding long steel pole upright, a path will be developed for the lightning current to pass through steel and then his body which may result in the death of worker. So, it is very dangerous to do so.

QUESTION#8

According to equation of capacitance of capacitor, capacitance is numerically equal to ratio between the charge store on one of its plates and potential difference between its plates. Does it value depend upon amount of charge and potential difference.

Answer: No, capacitance does not depend on Q and V.

Capacitance formula is given as: C = Q/V. But it does not depend on Q and V, since increase in Q will also increase V between plates, hence capacitance will remain constant.

Capacitance is a geometric quantity and it depends on:-

- area of plates
- distance between the plates
- medium between the plates

$$C = \frac{A\varepsilon}{d}$$

QUESTION#9

Do two capacitors of different plate area gain same or different amount of charge if connected with same e.m.f ?

Answer: Yes, they will gain different amount of charge.

Since plate areas of capacitors are different so their capacitance will also be different. Greater the area of plates, greater will be the capacitance.

$$C = \frac{A\varepsilon}{d} \quad \Rightarrow \quad C \propto A$$

And for same e.m.f or voltages, charge is directly proportional to capacitance:

$$Q = CV \quad \Rightarrow \quad Q \propto C$$

Hence capacitor having greater plate area will store more charge as compared to that capacitor which has smaller plate area.

QUESTION#10

A device has capacitance of 250 nC. You are asked to decrease its capacitance to 50 nC. How can you get it by connecting another capacitor with it?

Answer: I will connect capacitor of 62.5 nC in series with 250 nC to decrease capacitance to 50 nC.

In series combination of capacitors:-

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

Here, $C_{eq} = 50\ nC$, $C_1 = 250\ nC$

$$\frac{1}{50} = \frac{1}{250} + \frac{1}{C_2}$$

$$\frac{1}{50} - \frac{1}{250} = \frac{1}{C_2}$$

$$\frac{1}{C_2} = \frac{5-1}{250}$$

$$\frac{1}{C_2} = \frac{4}{250}$$

$$\frac{C_2}{1} = \frac{250}{4}$$

$$\boxed{C_2 = 62.5\ nC}$$