UNIT 13

ELECTROSTATICS

After studying this unit, the students will be able to:

- **a.** Describe simple experiments to show the production and detection of electric charge.
- **b.** Describe experiment to show electrostatic charging by induction.
- **c.** State that there are positive and negative charges.
- **d.** Describe the construction and working principle of electroscope.
- **e.** State and explain Coulomb's law.
- **f.** Solve problems on electrostatic charges by using Coulomb's law.
- **g.** Define electric field and electric field intensity.
- **h.** Sketch the electric field lines for an isolated +ve and -ve point charges.
- **i.** Describe the concept of electrostatic potential.
- **j.** Define the unit "volt".
- **k.** Describe potential difference as energy transfer per unit charge.
- **l.** Describe one situation in which static electricity is dangerous and the precautions taken to ensure that static electricity is discharged safely.
- **m.** Describe that the capacitor is charge storing device.
- **n.** Define capacitance and its unit.
- **o.** Derive the formula for the effective capacitance of a number of capacitors connected in series and in parallel.
- **p.** Apply the formula for the effective capacitance of a number of capacitors connected in series and in parallel to solve related problems.

Q.1 Define an electric charge. How electric charges can be produced?

Answer

Electric charge:

Definition:

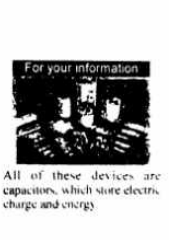
"Charge is a basic property of a material body due to which it attracts or repels another object."

1) Friction produces two different types of charges on different materials (such as glass and plastic).

2) Like charges always repel each other.

3) Unlike charges always attract each other.

4) Repulsion is the sure test of charge on a body.



All of these devices are capacitors, which store electric charge and energy

Production of electric charges:

I) If a plastic comb is run through the hair and then brought near small pieces of paper, the comb attracts them as shown in fig. 13.1.

2) Amber, when rubbed with silk, attracts the small pieces of paper.

This property of attraction or repulsion between substances is due to the electric charges they acquire during rubbing.

Electric charge can also be produced by rubbing a neutral body with another neutral body as shown in the activities below.

Activity 1:

Take a plastic rod. Rub it with fur and suspend it horizontally by a silk thread as shown in the fig 13.2.

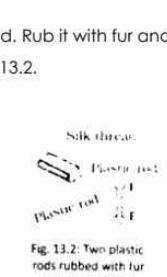


Fig. 13.2: Two plastic rods rubbed with fur repel each other

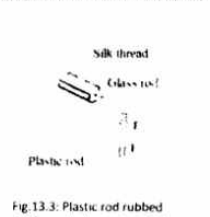


Fig 13.3: Plastic rod rubbed with fur and glass rod rubbed with silk attract each other

Now take another plastic rod and rub it with fur and bring it near to the suspended rod. We will observe that both the rods will repel each other.

It means during the rubbing both the rods were charged.

Activity 2:

Take a glass rod and rub it with silk and suspend it horizontally. When we bring the plastic, rod rubbed with fur near to the suspended glass rod, we observe that both the rods attract each other as shown in the fig. 13.3.

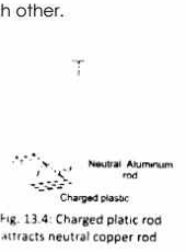


Fig. 13.4: Charged platic rod attracts neutral copper rod

Conclusion:

1) In the first activity, both rods are of plastic and both of them have been rubbed with fur. Therefore, we assume that charge of both rods would be of the same kind.

2) In the second activity rods are unlike and their attraction imply that charge on the two rods are not of the same kind but of opposite nature.

These opposite charges are conventionally called positive and negative charge. During the process of rubbing negative charge is transferred from one object to another object.

Q.2 Define electrostatic induction. Write the method of charging bodies by electrostatic induction?

Answer

Electrostatic induction:

Definition:

In the presence of a charged body, an insulated conductor develops positive charge at one end and negative charge at the other end. This process is called the electrostatic induction.

Activity 1:

Electrostatic induction is another method of charging a body and is described below.

i) Consider a metallic sphere placed on an insulated stand as shown in the fig. 13.5 (a). The sphere is neutral as it carries equal number of positive and negative charges. Now bring a negatively charged rubber rod near the conducting sphere. As shown in the fig. 13.5 (b). left part of the sphere that is close to the rod becomes positively charged while the right part that is away from the rod becomes negatively charged.

Negative charge in the rod repels the negative charge of the sphere and shifts it to the opposite region of the sphere that is away from the rod. Thus, there is excess of positive charge in the region of sphere close to the rod while there is excess of negative charge in the region of the sphere away from the rod. But as a whole the sphere is still neutral, since no charge has been added or subtracted.

ii) Now if we remove the rod away from the sphere, the charge again will spread uniformly on the whole surface of the sphere.

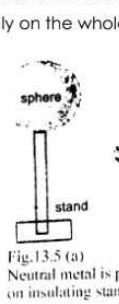


Fig.13.5 (a) Neutral metal is placed on insulating stand

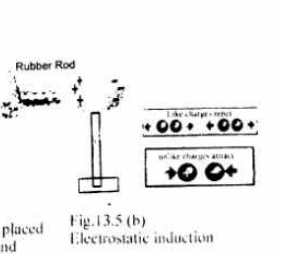


Fig.13.5 (b) Electrostatic induction

iii) Now earth the sphere through a conducting wire in the presence of the rod as shown in the figure 13.6 (a).

The negative charge will flow to the earth and leaves the sphere with net positive charge. Now if we first break the earth connection and then remove the rod from the sphere it will get positive charge permanently.

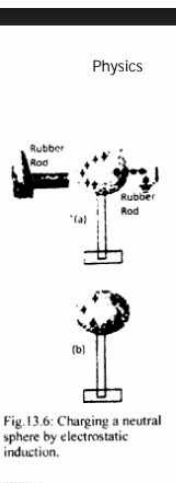


Fig.13.6: Charging a neutral sphere by electrostatic induction.

Method lo charge bodies through electrostatic induction:

i) Bring two metal spheres A and B and place them on an insulating stand as shown in the fig. 13.7 (a)

ii) Now bring a positively charged rod near sphere A as shown in fig. 13.7 (b). Rod will attract negative charge towards it and repel positive charge away from it. Negative charge will be developed on the left surface of the sphere A which is close to the rod. While positive charge will be developed on the right surface of the sphere B.

iii) Now separate the spheres by a small distance while the rod is still near the sphere A. The two spheres will be oppositely charged and attract each other as shown in the fig. 13.7 (c).

iv) Remove the rod. The charges on spheres rearrange themselves shown in the fig. 13.7(d).

v) Now separate the spheres by a large distance. The charges are uniformly distributed over the surfaces of the spheres as shown in fig.

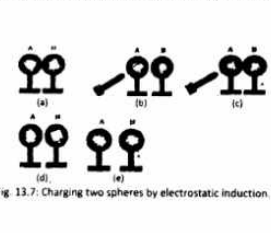


Fig. 13.7: Charging two spheres by electrostatic induction

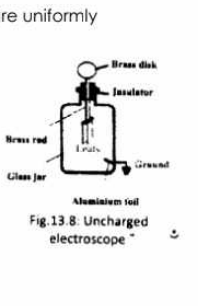


Fig 13.8: Uncharged electroscope

13.7(e). In this process, an equal and opposite charge will be developed on each metal sphere. This is charging by induction.

Q.3 Write in detail the construction and uses of electroscope?

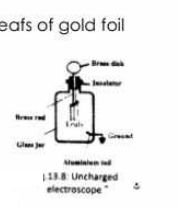
Answer

Electroscope: (Construction):

A gold leaf electroscope is sensitive instrument for detecting charges.

It consists of a brass rod with a brass disk at the top and two thin leafs of gold foil hanging at the bottom as shown in fig 13.8.

The rod passes through an insulator that keeps the rod in place and also retains the charges. Charges can move freely from the disk to the leafs through the rod.



13.8 Uncharged electroscope

A thin aluminum is attached on the lower portion of the inside of the jar. Usually, the aluminum foil is grounded by connecting a copper wire. This protects the leafs from the external electrical disturbances.

Working:

1) Detecting the presence of charge:

In order to detect the presence of charge on anybody, bring the body near the disk of an uncharged electroscope. If the body is neutral there will be no deflection of the leafs as shown in fig. 13.9 (a).

But if the body is positively or negatively charged. The leafs of the electroscope diverge.

For example, if the body is negatively charged then due to electrostatic induction positive charge will appear on the disk while negative charge will appear on the leafs as shown in fig. 13.9 (b).

The leafs of electroscope repel each other and diverge because each leaf gets similar charge. The divergence of leafs will depend on the amount of charge.

2) Detecting the type of charge:

For the detection of type of charge, electroscope is first charged either positively or negatively. Suppose the electroscope is positively charged as explained before.

Now in order to detect the type of charge on a body, bring the charged body near the disk of the positively charged electroscope.

If the divergence of the leafs increases, the body carries positive charge as shown in the figure 13.11 (a).

On the other hand, if the divergence decreases, the body has negative charge as shown in the figure 13.11 (b).

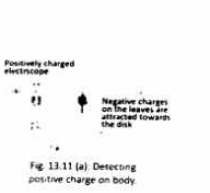

Positively charged electroscope
Negative charges on the leaves are attracted towards the disk

Fig. 13.11 (a): Detecting positive charge on body

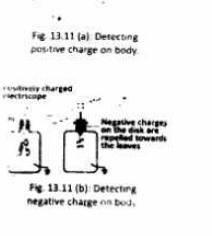

Positively charged electroscope
Negative charges on the disk are repelled towards the leaves

Fig. 13.11 (b): Detecting negative charge on body

3) Identifying conductors and insulators:

Electroscope can also be used to distinguish between insulators and conductors. Touch the disk of a charged electroscope with material under test. If the leafs collapse from their diverged position the body would be a good conductor.

If there is no change in the divergence of the leaves, it will show that the body under test is an insulator.

Q.4 How an electroscope be charged by electrostatic induction and conduction as well?

Answer

Charging the electroscope by electrostatic induction:

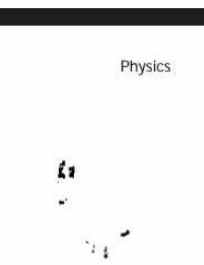
Electroscope can be charged by the process of electrostatic induction. In order to produce positive charge of the electroscope, bring a negatively charged body near the disk of the electroscope as shown in the figure 13.10 (a).

Positive charge will appear on the disk of the electroscope while negative charge will shift to the leafs.

Now connect the disk of electroscope to the earthed aluminum foil by a conducting w ire as shown in the fig. 13.10 (b). Charge of the leafs will flow to the earth 'through the wire.

Now if we first break the earth connection and then remove the rod the electroscope will be left with positive charge.

Similarly, electroscope can be charged negatively with the help of a positively charged rod.



13.10 (a) Charging the electroscope positively

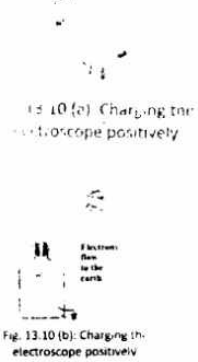


Fig. 13.10 (b): Charging the electroscope positively

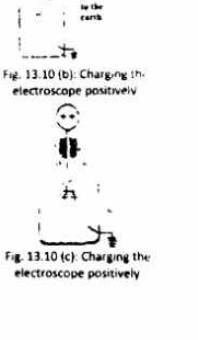


Fig. 13.10 (c): Charging the electroscope positively

Charging of electroscope by conduction:

Electroscope can also be charged by the process of conduction. Touch a negatively charged rod with the disk of a neutral electroscope. Negative charge from the rod will transfer to the electroscope and will cause its leafs to diverge:

Q.5 State coulomb's law. Derive the expression of electrostatic force?

Answer

Coulomb's law: (statement):

The force of attraction or repulsion between two-point charges is directly proportional to the product of the quantity of charges and inversely proportional to the square of the distance between them.

Explanation:

A French scientist Charles Coulomb in 1785 experimentally established this fundamental law of electric force between two stationary charged particles.

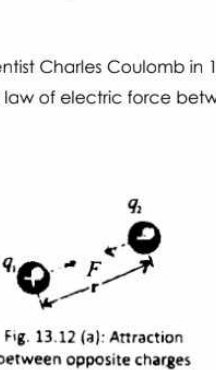


Fig. 13.12 (a): Attraction between opposite charges

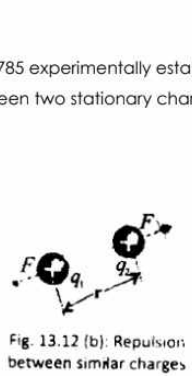


Fig. 13.12 (b): Repulsion between similar charges

Suppose two charges q_1 and q_2 are separated at a distance r. The electric force between these two charges is given as:

$$F \propto q_1 q_2 ....(1)$$

And $$F \propto \frac{1}{r^2} ....(2)$$

Combinig equation (1) & (2), we get,

$$F \propto \frac{q_1 q_2}{r^2}$$

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

The above equation is known as "Coulomb's law".

Where 'F' is the force between the two charges and is called the coulomb force, qi and q2 are the quantities of two charges separated by a- distance 'r'. 'k' is the constant of proportion given by,

$$k = \frac{1}{4}\pi E_o$$

The value of 'k' depends upon the medium between the charges and the system of units in which F, q and r are measured, ϵ_o' is the permittivity of free space.

Now if the medium between the two charges is air then the value of 'k' in SI units will be 9×10^9 Nm^2 C^{-2}.

Q.6 What is meant by electric field and electric intensity?

Answer

Electric field:

"The electric field is a region around a charge in which it exerts electrostatic force on another charge."

According to coulomb's law if a unit positive charge 'q_o' is brought near a charge q placed is space, the charge 'go' will experience a force. The value of this force would depend upon the distance between the two charges.

For your information
In SI, the unit of charge is coulomb (C). It is equal to the charge of 6.25×10^{19} electrons. This is very big unit. Usually charge is measured in micro coulomb. One micro coulomb is equal to 10^{6}C.

If the charge 'q_o' is moved away from 'q' this force would decrease till at a certain distance the force would practically reduce to zero. Now the charge 'q' is out of the influence of charge 'q'.

Electric field intensity:

"The strength of electric field at any point in space is known as electric field intensity."

In order to find the value of electric intensity at a point in the field, the charge '+q', we place a test charge 'q_o' at that point as shown in the fig 13.13.

If F is the force acting on the test charge 'go', the electric field intensity would be given by:

$$E = \frac{F}{q_o} ....(1)$$

Thus, the electric field intensity at any point is defined as, the force acting on a unit positive charge placed at that point.

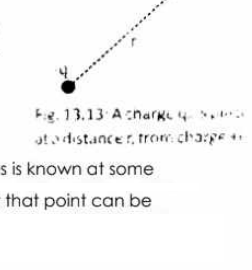


Fig. 13.13: A charge q_o at a distance r from charge +q

SI units of electric intensity is NC^{-1}.

If the electric field due to a given arrangement of charges is known at some point, the force on any particle with charge 'q' placed at that point can be calculated by using the formula:

$$F = qE..........(2)$$

1) Electric intensity being a force is a vector quantity.

2) Its direction is the same as that of the force acting on the positive test charge.

Q.7 What are electric field lines? How field lines are related to the electric field intensity?

Answer

Electric field lines:

"The direction of electric field intensity in an electric field can also be represented by drawing lines. These lines are known as electric lines of force."

These lines were introduced by Michael faraday.

The field lines are imaginary lines around a field charge with an arrow head indicating the direction of force.

Field lines always move away from positive charge but toward negative charge. The spacing between the field lines shows the strength of electric field as shown

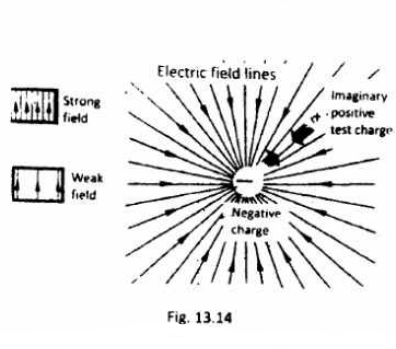


Fig. 13.14

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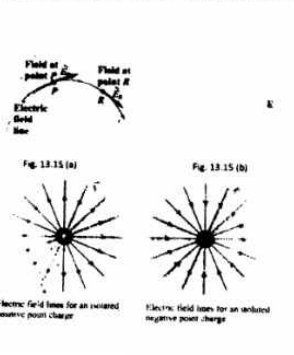
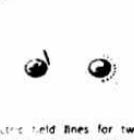
Relation between field lines and electric field intensity:

Field lines are related to the electric field intensity in any region of space in the following way.

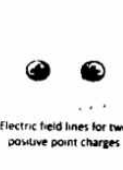

Field at point A
Field at point B
Electric field line
Fig. 13.15 (a)
Fig. 13.15 (b)
Electric field lines for an isolated positive point charge
Electric field lines for an isolated negative point charge

1) The electric field intensity is tangent to the electric field lines at each point as shown in fig. 13.15 (a).

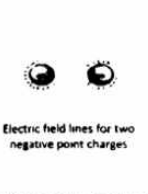
2) The number of lines per unit area through a surface perpendicular to the lines is proportional to the electric field strength in a given region as shown in fig. 13.15 (b).



Electric field lines for two equal and unequal point charges



Electric field lines for two positive point charges



Electric field lines for two negative point charges

3) Electric field is strong when the field lines are close together and weak when the lines are far apart.

4) No two lines cross each.

5) Electric field lines for an isolated positive and negative point charges are shown in the figure above.

Q.8 Define potential difference between two points? Show that potential difference can be described as energy transfer per unit charge between the two points?

Answer

Electrostatic Potential:

"Electric potential at a point in an electric field is equal to the amount of work done in bringing a unit positive charge from infinity to that point".

Do you know?
The volt is named after the Italian physicist Alessandro Volta (1745-1827), who developed the first practical electric battery, known as a voltaic pile. Because potential difference is measured in units of volts, it is sometimes referred to as voltage.

If 'W' is the work done in moving the unit positive charge from infinity to a certain point in the field, the electric potential V at this point would be given by:

$$V = \frac{W}{q} ....(1)$$

It implies that electric potential is measured relative to some reference point and like potential energy we can measure only the change in potential between two points.

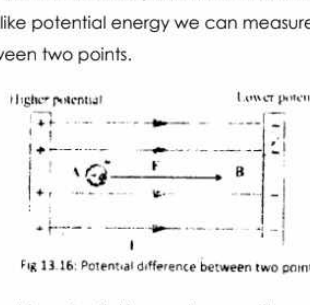


Fig 13.16: Potential difference between two points

1) Electric potential is a scalar quantity.

2) Its SI unit is volt which is equal to JC^{-1}.

Volt:

If one Joule of work is done against the electric field in bringing one coulomb positive charge from infinity to a point in the electric field then the postritual at that point will be one volt, or

If the potential energy of one coulomb of charge at a point in the electric field is one Joule, the potential of that point will be one volt.

Electric potential difference:

A body in gravitational field always tends to move from a point of higher potential energy to a point of lower potential energy. Similarly, when a charge is released in an electric field, it moves from a point of higher potential say 'A' to a point of lower potential say 'B', as shown in the fig 13.16.

If the potential of A is 'V_a' and that of point B is 'V_b', the potential energy of the charge at these points will be qV_a and qV_b respectively.

The change in potential energy of the charge when it moves from point A to B will be equal to qV_a - qV_b. This energy is utilized in some useful work. Thus:

Energy supplied by the charge = q (V_a - V_b)

If 'q' is equal to one unit, then the potential difference between two points becomes equal to the energy, supplied by the charge. Thus, we define potential difference between two points as:

The energy supplied by a unit charge as it moves from one point to the other in the direction of the field."

If a positive charge is transferred from a point of lower potential to a point of higher potential i.e. against the field direction, energy would have to be supplied to it.

When we release a negative charge in an electric field, its behavior will be opposite to that of positive charge. Amore useful unit for the electrical energy is electron volt (ev).

Q.9 Describe capacitor as an energy storing device. What do you mean by capacitance of a capacitor? Define units of capacitance?

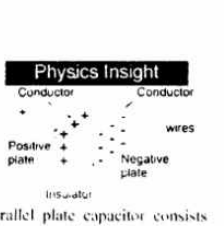
Answer

Capacitor:

A device consisting of two metal plates used for storing charge is called a capacitor, or parallel plate capacitor.

Explanation:

A capacitor consists of two thin metal plates, parallel to each other separated by a very small distance as shown in the figure 13.17.



Parallel plate capacitor consists of two metal plates separated with an insulator. The presence of charge Q on plate A induces a -Q charge on the inner surface of plate B.

The medium between the two plates is air or a sheet of some insulator. This medium is known as "dielectric."

If + Q amount of charge is given to plate A of a parallel plate capacitor, due to electrostatic induction, it would induce — Q charge on the inner surface of the plate B and +Q on its outer surface. The lines of force between the plates 13.17 (b).

Fig. 13.17 (a): Parallel plate capacitor

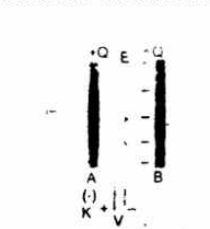


Fig. 13.17 (b): Plates of capacitor connected with battery

There exists a force of attraction between the charge + Q stored on the plate A and the charge - Q induced on the inner surface of plate B. Due to this force of attraction, the charges are bound within the plates and remain stored for long periods.

Energy Stored in a Capacitor
Capacitor stores energy in an electric field between two plates in the form of electrostatic potential energy.

Due to presence of charges on the plates, a potential difference 'V' is developed across them which is directly proportional to the charge 'Q' deposited on the plate A.

i.e. $Q \propto V$

or. $Q = CV$

Capacitance of a capacitor:

In the expression Q = CV, 'C' is the constant of proportionality called the capacitance of the capacitor and is defined as. "the ability of the capacitor to store charge."

It is given by the ratio of charge and the electric potential as:

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

Physics insight
A voltage across a devise, such as capacitor, has the same meaning as the potential difference across the device. For instance, if we suppose that the voltage across a capacitor is 12V, it also means that the potential difference between its plates is 12 V.

The unit of capacitance is "Farad".

Farad:

If one coulomb of charge given to the plates of a capacitor produces a potential difference of one volt between the plates of the capacitor then its capacitance would be one Farad.

It's a large unit usually we use smaller units i.e. μF and PF.

Q.10 Derive a formula for the effective capacitance for a parallel combination of a number of capacitors?

Answer

Capacitors in parallel:

In this method the left plate of each capacitor is connected to the positive terminal of the battery by a conducting wire. In the same way the right plate of each capacitor is connected to the negative terminal of the battery as shown in the fig. 13.18.

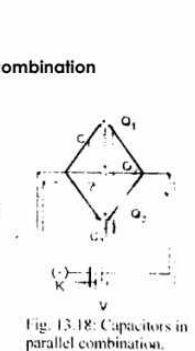


Fig. 13.18: Capacitors in parallel combination.

This type of combination has the following characteristics.

1) Each capacitor connected to a battery of voltage V has the same potential difference V across it. i.e.

$$V = V_1 = V_2 = V_3$$

2) The charge developed across the plates of each capacitor will be different due to different value of capacitances.

3) The total charge 'Q' supplied by the battery is divided among the various capacitors. Hence:

$$Q = Q_1 + Q_2 + Q_3$$

Or $$Q = C_1V + C_2V + C_3V$$

Or $$Q = V(C_1 + C_2 + C_3)$$

Or $$\frac{Q}{V} = C_1 + C_2 + C_3$$

4) Thus, we can replace the parallel combination of capacitors with one equivalent capacitor having capacitance such that,

$$C_{eq} = C_1 + C_2 + C_3$$

In the case of 'n' capacitors connected in parallel, the equivalent capacitance is given by;

$$C_{eq} = C_1 + C_2 + C_3 + \quad + C_{n+} ....C_n$$

5) The equivalent capacitance of a parallel combination of capacitors is greater than any of the individual capacitances

For your information
Three factors affect the ability of a capacitor to store charge.
1. Size of capacitor plates.
2. Distance between the Plates.
3. Type of insulator Between the plates.

Q.11 Derive a formula for the effective capacitance for a series combination of a number of capacitors?

Answer

Capacitors in series:

In this method the capacitors are connected side by side i.e. the right plate of one capacitor is connected to the left plate of the next capacitor as shown in the figure 13.20.

This type of combination has the following characteristics.

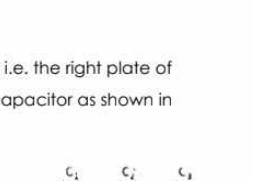


Fig. 13.20: capacitors in series combination.

1) Each capacitor has same charge across it. If the battery supplies + Q charge to the left plate of the capacitor C_1. Due to induction — Q charge is induced on its right plate and + Q charge on the left plate of the capacitor C_2 i.e.

$$Q_1 = Q_2 = Q_3 = Q$$

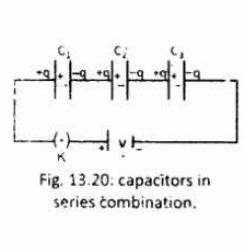


Fig. 13.21

2) The potential difference across each capacitor is different due to different values of capacitances.

3) The voltage of the battery has been divided among the various capacitors. Hence:

$$V = V_1 + V_2 + V_3$$

$$= \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$

$$= Q\left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right]$$

Or $$\frac{V}{Q} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

4) Thus we can replace series combination of capacitors with one equivalent capacitor having capacitance C_{eq}ie..:

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

5) In the case of n capacitors connected in series, we have:

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ... + \frac{1}{C_n}$$

Q.12 Discuss different types of capacitors?

Answer

Types of capacitors:

1) Parallel plate capacitors:

Parallel plate capacitors are not commonly used in most devices because in order to store enough charge their size must be large which is not desirable.

A parallel plate capacitor has a dielectric between its plates and is made of a flexible material that can be rolled into the shape of cylinder. In this way we can increase the area of each plate while the capacitor can fit into a small space.

Some other types of capacitors use chemical reactions to store charge, like tiny batteries.

2) Paper capacitor:

Paper capacitor is an example of fixed capacitor as shown in the fig. 13.22.

The paper capacitor has a cylindrical shape. Usually an oiled or greased paper or a thin plastic sheet is used as a dielectric between two aluminum foils. The paper or

Fig. 13.22: Paper capacitor

plastic sheet is firmly rolled in the form of a cylinder and is then enclosed into a plastic case.

3)Mica capacitor:

In these capacitors, mica is used as dielectric between the two metal plates. For convenience and safety purposes, it is enclosed in a plastic case or in a case of some insulator. Wires attached to plates project out of the case for making connections as shown in fig. 13.23.

Fig. 13.23: Mica capacitor

If the capacitance is to be increased, large number of plates is piled up, one over the other with layers of dielectric in between and alternative plates are connected with each other.

4) Variable capacitors:

In variable type of capacitors some arrangement is made to change the area of the plates facing each other as shown in the figure 13.24.

It is generally a combination of many capacitors with air as dielectric. It consists of two sets of plates. One set remains fixed while the other set can rotate so the distance between the plates does not change and they do not touch each other. The common area of the plates of the two sets which faces each other, determines the value of capacitance. Thus, the capacitance of the capacitor can be increased or decreased by turning the rotatable plates in or out of the space between the static plates. Such capacitors are usually used for tuning in radio sets.

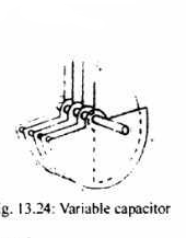
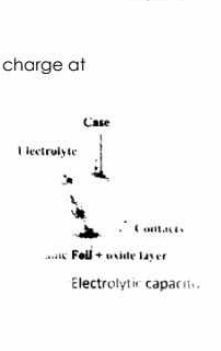


Fig. 13.24: Variable capacitor

5) Electrolytic capacitor:

An electrolytic capacitor is often used to store large amounts of charge at relatively 16W voltages as shown in the fig. 13.25.

It consists of a metal foil in contact with an electrolyte a solution that conducts charge by virtue of the motion of the ions contained in it. When a voltage is applied between the foil and the electrolyte, a thin layer of metal oxide (an insulator) is formed on the foil, and this layer serves as the dielectric. Enormous capacitances can be attained because the dielectric layer is very thin.



Electrolytic capacitor

Q.13 Briefly write the uses of capacitors?

Answer

Uses of capacitors:

Capacitors have wide range of applications in different electrical and electronic circuits. For example:

1) They are used for tuning transmitters, receivers and transistor radios. They are also used for table fans, ceiling fans, exhaust fans, fan motors in air conditioners, coolers, motors, washing machines and many other appliances for their smooth working.

2) Capacitors are also used in electronic circuits of computers etc..

3) Capacitors can be used to differentiate between high frequency and low frequency signals which make them useful in electronic circuits. For example, capacitors are used in resonant circuits that tune radios to particular frequencies. Such circuits are called filter circuits.

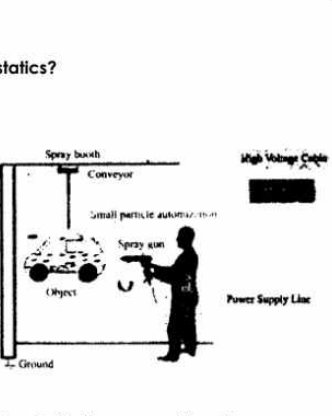
4) Ceramic capacitors are generally superior to other types and therefore can be used in vast ranges of applications.

Q.14 Discuss the applications of electrostatics?

Answer

Applications of electrostatics:

I) Electrostatic air cleaner:



An electrostatic air cleaner used in homes to relieve the discomfort of allergy sufferers. Air mixed with dust and pollen enters the device across a positively charged mesh screen.

The air borne particles become positively charged when they make contact with the screen. Then they pass through a second negatively charged mesh screen.

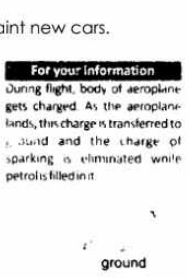
The electrostatic force of attraction between the positively charged particles in the air and the negatively charged screen causes the particles to precipitate out on the surface of the screen. Through this process we can removes a very high percentage of contaminants from the air stream.

2) Spray painting:

Automobile manufacturers use static electricity to paint new cars.

The body of car is charged and then the paint is given the opposite charge by charging the nozzle of the sprayer as shown in the figure.

For your information
During flight, body of aeroplane gets charged. As the aeroplane lands, the charge is transferred to ground and the charge of sparking is eliminated while petrol is filled in it



Due to mutual repulsion, charge particles coming out of the nozzle form a fine mist and are evenly distributed on the surface of the object.

The charged paint particles are attracted to the car and stick to the body, just like a charged balloon sticks to a wall. Once the paint dries, it sticks much better to the car and is smoother because it is uniformly distributed. This is a very effective, efficient and economical way of painting automobiles on large scale.

Q.15 What are hazards of static electricity?

Answer

Some hazards of static electricity

I) Lightening:

The phenomenon of lightening occurs due to a large quantity of electric charge which builds up in the heavy thunder clouds. The thunder clouds are charged by friction between the water molecules in the thunder-clouds and the air molecules. When the charge on the thunder clouds is sufficiently high it can produce positive and negative

charges in the air.

The huge amount of negative charge is discharged to the highest object on the ground and can harm them.

This explains why it is very dangerous to swim in the open sea, play in an open field or hide under a tree during a thunderstorm.

Physics of Field Lines

Some animals produce electric fields to detect nearby objects that affect the field.

To prevent lightening from damaging tall buildings, lightening conductors are used. The purpose of the lightening conductor is to provide a steady discharge path for the large amount of negative charge in the air to flow from the top of the building to the earth.

In this way, the chances of lightening damage due to minimized.

2) Fires or explosions:

Static electricity is a major cause of fires and explosions at many places. A fire or an explosion may occur due to excessive build-up of electric charges produced by friction. Static electricity can be generated by the friction of the gasoline being pumped into a vehicle or container. It can also be produced when we get out of the car or remove an article of clothing. Static charges are dangerous. If static charges are allowed to discharge through the areas where there is petrol vapor a fire can occur. The results are frightening and may be devastating.

Portable oil containers can build up a static electric charge during transport. Consequently, when the container is not placed on the ground for filling, its static electricity could be discharged and result in a fire when filling begins. Containers should be placed on the ground during filling and the nozzle should be kept in contact with the container. Containers should not to be filled while inside a vehicle.

Dangers of Static Electricity

Static electricity can spark a fire or explosions. Care must be taken to avoid sparks when putting fuel in cars or aircraft. Spark may be produced due to friction between the fuel and the pipe. This can cause a serious explosion. The spark can be avoided if the pipe nozzle is made to conduct by connecting an earthing strap to it. The earthing strap connects the pipe to the ground.

MULTIPLE CHOICE QUESTIONS

Choose the correct answer from the following choices:

i) A positive electric charge:

a) attract other positive charge **b)** repels other positive charge

c) attracts a neutral charge **d)** repels a neutral charge

ii) An object gains excess negative charge after being rubbed against another object, which is:

a) neutral **b)** negatively charged

c) positively charged **d)** either a, b or c

iii) Two uncharged objects A and B are rubbed against each other. When object B is placed near a negatively charged object C, the two objects repel each other. Which of these statements is true about object A?

a) remains uncharged **b)** becomes positively charged

c) becomes negatively charged **d)** unpredictable

iv) When you rub a. plastic rod against your hair several times and put it near some bits of paper, the pieces of papers are attracted towards it. What does this observation indicate?

a) the rod and the paper areoppositely charged

b) the rod acquires a positive charge

c) the rod and the paper have the same charge

d) the rod acquires a negative charge

v) According to Coulomb's law, what happens to the attraction of two oppositely charged objects as their distance of separation increases?

a) increase **b)** decrease

c) remains unchanged **d)** cannot be determined

vi) The Coulomb's 'law is valid for the charges which are:

a) moving and point charges **b)** moving and non-point charges

c) stationery and point charges **d)** stationary and large size charges

vii) A positive and a negative charge are initially 4 cm apart. When they are moved closer together so that they are now only lcm apart, the force between them is:

a) 4 times smaller than before **b)** 4 times larger than before

c) 8 times larger than before **d)** 16 time larger than before

viii) Five joules of work are needed to shift 10 C of charge from one place to another. The potential difference between the places is:

a) 0.5V **b)** 2V

c) 5V **d)** 10 V

ix) Two charged spheres are separated by 2mm. Which of the following would produce the greatest attractive force?

a) + l q and +4q **b)** - l q and --4q

c) + 2q and + 2q **d)** + 2q and - 2q

x) Electric field lines

a) always cross each other

b) never cross each other

c) cross each other in the region of strong field

d) cross each other in the region of weak field

xi) Capacitance is defined as

a) VC **b)** Q/V

c) QV **d)** V/Q

ANSWERS

i) b **ii)** a **iii)** b **iv)** d

v) b **vi)** c **vii)** d **viii)** a

ix) d **x)** b **xi)** b

REVIEW QUESTIONS

13.1 How can you show by simple experiments that there are two types of electric charges?

13.2 What is the method of charging bodies by electrostatic induction?

13.3 How does electrostatic induction differ from charging by friction?

Answer

In electrostatic induction, the charged and uncharged bodies have no physical touch even then due to electrostatic field uncharged body can get charged where as in charging by friction, both the bodies have physical touch in the form of rubbing.

13.4 What is gold leaf electroscope? Discuss its working principle with a labeled diagram.

13.5 Suppose you have a glass rod which becomes positively charged when you rub it with wool. Describe how would you charge the electroscope (i) negatively (ii) positively.

13.6 With the help of electroscope how you can find presence of charge on a body?

13.7 Describe how you would determine the nature of the charge on a body by using electroscope?

13.8 Explain Coulomb's law of electrostatic and write its mathematical form. 13.9 What is meant by electric field and electric intensity?

13.10 Is electric intensity a vector Quantity? What will be its direction?

Answer

Yes, electric intensity is a vector quantity.

Its direction is along the direction of electrostatic force.

13.11 Find the electric intensity due to a point charge q.

13.12 How would you define potential difference between two points? Define its unit.

13.13 Show that potential difference can be described as energy transfer per unit charge between the two points.

13.14 Describe capacitor as an energy storing device?

13.15 What do you mean by the capacitance of a capacitor? Define units of capacitance.

13.16 Derive the formula for the effective capacitance for a series combination of a number of capacitors.

13.17 Discuss different types of capacitors.

13.18 What is difference between variable and fixed type capacitor? 13.19 Enlist some uses of capacitors.

13.20 Discuss. one application of static electricity.

13.21 What are hazards of static electricity'?

['Note: rue answers of all the review questions are given in the topics"]

CONCEPTUAL QUESTIONS

13.1 An electrified rod attracts pieces of paper. After a while these pieces fly awav. Why?

Answer

Initially due to electrostatic induction the pieces of paper get charged and attracted by the electrified rod but after sometime the temporarily charged pieces of paper get neutralized due to which these pieces fly away.

13.2 How much negative charge has been removed from a positively charged electroscope if it has a charge 07.5×10^{-11} C?

Answer

The same 7.5×10^{-11}C negative charge is removed.

13.3 In what direction will a positively charged particle move in an electric field?

Answer

The electric field lines are supposed to he directed from positive to negative charge. So, when a positive charge is placed in such electric field, it will move away from the field.

or

A positive charge always moves along the direction of the field.

13.4 Does each capacitor carry equal charge in series combination? Explain.

Answer

Yes, in series combination each capacitor carries equal charge due to electrostatic induction. One type of charge at one plate will induce the same quantity of opposite charge on the other plate.

13.5 Each capacitor in parallel combination has equal potential difference between its two plates. Justify the statement.

Answer

As the capacitors are not connected in parallel to each other but also with the battery as well. So, in parallel circuit same potential is developed in all electrical components as that of battery therefore each two plates in parallel combination of capacitors will have same potential.

13.6 Is the presence of charge necessary for the existence of electrostatic potential?

Answer

Yes. Electrostatic potential is produced in an electric field and electric field is produced due to a charge; therefore, the presence of charge is necessary for the existence of electrostatic potential.

13.7 Rubber tires get charged from friction with the road. What is the polarity of the charge?

Answer

Rubber tires get negative charge due to rubbing with the road.

13.8 Perhaps you have seen a gasoline truck trailing a metal chain beneath it. What purpose does the chain serve?

Answer

A metallic chain can be seen hanging from the rear side of a gasoline truck. This chain rolls on the road as the tanker moves. Due to friction with air the body of tanker gets charged and tinny spark can cause a havoc. This charge is continuously being transferred to ground through the metallic chain. Thus, the danger of spark is eliminated.

13.9 If a high-voltage power line fell across your car while you were in the car, why should you not come out of the car?

Answer

If a high-voltage power line fell across the car while the person is in the car, the supply is actually grounded while passing through the body of the car and when the person will try to come out of the car, electrification may happen through the person to get grounded which is hazardous for the person.

13.10 Explain why, a glass rod can be charged by rubbing when held by hand but an iron rod cannot be charged by rubbing, if held by hand?

Answer

Glass rod is an insulator which can hold the charges for comparatively more time, whereas iron rod is a good conductor of charge so the charge produced due to rubbing may be grounded through the hand go iron rod cannot hold the charges for more time.

OBJECTIVE TYPE SHORT QUESTIONS

Q. Give short Answers.

1. Why comb acquire negative charge on rubbing with dry hair?

Answer

Comb acquires negative charge when rubbed with dry hair because on rubbing a comb with dry hair. Valence electrons of the hair appear on comb making it negatively charged. Since the number of electrons on the hair has decreased, the hair will become positively charged.

2. Why glass rod becomes positively charged when rubbed with silk?

Answer

When a glass rod is rubbed with silk, glass rod becomes positively charged because valence electrons will move from glass towards silk, creating a deficiency of electrons on it. Hence glass rod becomes positively charged.

3. Differentiate between insulators and conductors.

Answer

Insulators:

- Insulators are the substances through which electric charge do not flow easily.

- Such substances do not have free electrons to transport charge from one point to another.

Examples:

Glass, rubber, plastic etc..

Conductors

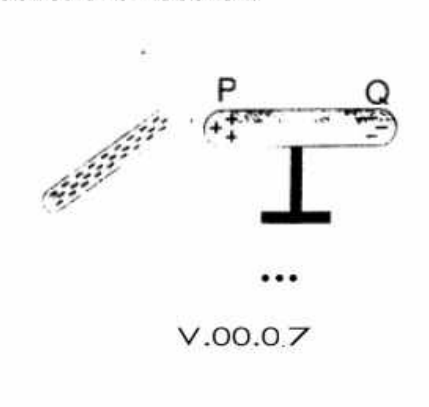
- Substances through which electric charge can flow easily are called conductors.
- Conductors have free electrons, which are responsible to transport charge from one end to another end through them.
- Examples:

  Copper, silver, iron, mercury etc..

4. What is meant by electrostatic induction?

Answer

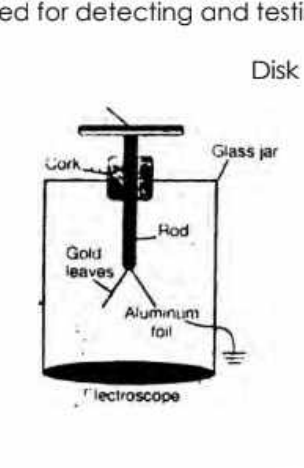
The phenomenon in which a charged body produces an, opposite charge at one end and a like charge at the other end of an insulated conductor is known as electrostatic induction.



5. Define gold leaf electroscope. Draw its diagram.

Answer

It is an instrument used for detecting and testing the nature of charge on body.



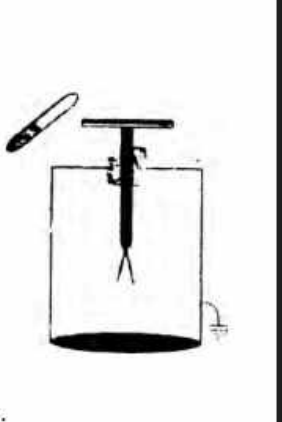
6. By using an electroscope, how we can find the presence of charge on a body?

Answer

In order to detect the presence of charge on a body, bring the charged body near the disc of an uncharged electroscope. If the body is charged, the leafs of the electroscope will diverge otherwise they would remain in their normal position.

7. By using an electroscope. How we can find the nature of the charge present on a body?

Answer



- In order to detect the nature of the charge on a charge body, the electroscope will have to be first charged either with positive charge or with negative charge.
- If the divergence of the leafs increases, then body has the same kind of charge as oil the electroscope.
- If the divergence of the leafs decreases, then charge on the body is opposite to the kind present on the electroscope.

8. By using an electroscope, how we can find whether a body is insulator or a conductor?

Answer

- Touch the disc of a charged electroscope with body under test.
- If the leafs collapse from their diverged position then the body will be a conductor.
- If there is no change in the divergence of the leafs. It means that the body is an insulator.
- A gradual collapse will indicate that the body is not a good conductor.

9. Write some applications of electroscope.

Answer

Gold leaf electroscope is used to:

- Detect the presence of charge.
- Test the nature of charge.
- Distinguish between insulator and conductor.

10. State Coulomb's law.

Answer

The force between two-point charges is directly proportional to the product of charges and inversely proportional to the square of the distance between them.

$$F=\frac{1}{4\pi \in_o}\frac{q_1q_2}{r^2}$$

11. What is the unit of charge?

Answer

In S.I system. the unit of charge is Coulomb.

It is equal to the charge of 6.25 x 10^{18} electrons.

12. What is the effect of medium on the Coulomb's force?

Answer

The Coulomb's force in the presence of dielectric is given by

$$F=\frac{1}{4\pi \in_o}\frac{q_1q_2}{r^2}$$

The dielectric reduces the electrostatic force by a factor €$_r$. The value of relative permittivity $\in_r$ is different for different dielectrics.

13. What is meant by electric field?

Answer

The electric field of a charge is a region or space surrounding it, in which a charge can feel its electrostatic effect in the form of a force.

OR

The region or space around a charge in which another charge can feel its electrostatic effect, in the form of a force, is called electric field of that charge.

14. Define electric intensity.

Answer

The strength of the electric field at any point is known as electric intensity.

OR

The electric intensity at any point is defined as the force acting on a unit positive charge placed at that point.

Mathematically, $E=\frac{F}{q}$

15. What is the unit of electric intensity?

Answer

The unit of electric intensity is NC^{-1} (Newton per coulomb).

16. What a charge produces in the space surrounding it?

Answer

A charge produces an electric field in the space surrounding it.

17. Give the direction of electric intensity?

Answer

Direction of electric intensity

Electric intensity is sector quantity and its direction are found as:

- In case of positive charge, the direction of electric intensity is same as that of force acting on it.
- In case of free charge. it will move in the direction of electric intensity.
- In case of negative charge. The force on it will be opposite to the direction of electric intensity.

18. Prove that 1 e V = 1.6 x 10^{-19}J

Answer

Charge on an electron = e = 1.6 x 10^{-19} coulomb

Potential difference between two points V = 1 volt.

$$1eV=1.6\times10^{-19}1coulomb\times\frac{1Joule}{1coulomb}$$

$$1eV=1.6\times10^{-19}J$$

$$1eV=1.6\times10^{-19}J$$

19. Write the differences between gravitational force and electrostatic force.

Answer

Following are the differences between them.

- The gravitational force is very weak as compared to electrostatic force.
- The electrostatic force could be attractive or repulsive, while the gravitational forces is only attractive.
- The electrostatic force is medium dependent and can be shielded while gravitational force lacks this property.

20. Define electric field lines of force.

Answer

The direction of electric intensity in an electric field can be indicated by drawing lines, are known as electric lines of force.

21. Write the properties of electric field lines of force.

Answer

1) Electric field lines start from positive charge and end on negative charge.
2) The tangent to a field line at any point gives the direction of the electric field at that point.
3) The lines are closer where the field is strong.
4) The lines are farther apart where the field is weak.
5) No two lines cross each other.

22. How can you show that the Coulomb's force on a charged object is independent of its mass?

Answer

The relation for Coulomb's force is

$$F=\frac{1q_1q_2}{4\pi \in_o r^2}$$

This equation shows that the electrostatic force between two charged objects is independent of their masses.

23. If the distance between two charged bodies is doubled, what is the effect on the force between them?

Answer

The relation for Coulomb's force is

$$F=\frac{1q_1q_2}{4\pi \in_o r^2}$$

This relation shows that force between, two charged bodies is inversely proportional to the square of the distance between them. So, if the distance is doubled then the force will reduce to one-fourth.

24. Define electric potential.

Answer

Electric potential at a point is defined as the potential energy of a unit positive charge placed at that point which is equal to the of work done in bringing a unit positive charge from infinity to that point.

Mathematically.

25. What is the S.I unit of electric potential? Define it.

Answer

Potential is a scalar quantity. Its S.I unit is known as Volt.

"If the potential energy of one coulomb positive charge at a point is one joule, the potential of that point would be one volt."

26. What is meant by the potential difference between two points?

Answer

The potential difference between two points can be defined as the energy supplied by a unit positive charge as it moves from one point to another.

27. Which phenomenon is used for separating of smoke from chimneys?

Answer

Electrostatic phenomenon is used for separation of smoke and other particles from the gases coming out of the chimneys of various factories.

28. What are advantages of painting by electrostatic?

Answer

Some advantages of painting by electrostatic are:

- This method is very effective, efficient and cheap.
- This method needs less paint as compared to other methods.
- This method is widely used to paint refrigerators, metallic furniture and other articles.

29. What is an electron volt?

Answer

An electron volt is a unit of energy. It is defined as:

"The amount of energy gained or lost by an electron as it passes through a potential difference of one volt."

I eV = 1.6 x 10^{-19}J

30. Write the similarities between electrostatic fierce and gravitational force.

Answer

- Both the forces are conservative forces.
- Both forces vary inversely with the square of the distances between two-point charges or two masses.
- The gravitational force between two masses is similar to the electric force between two charges.

31. How many methods are used for connecting capacitors?

Answer

Generally, two methods are used for connecting capacitors.

- Parallel combination of capacitors.
- Series combination of capacitors.

32. Is Coulomb's electrostatic interaction consistent with Newton's third law of motion?

Answer

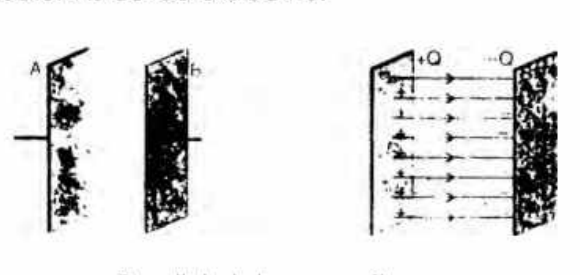
Yes, the Forces exerted by two charges are equal and opposite. It means that this law obeys Newton's third law of motion.

33. Define capacitor.

Answer

A capacitor is a device that can store charge.,

The simplest kind of capacitor is a parallel plate capacitor. It consists of two thin metal plates, parallel to each other with a small separation between them. The medium between the two plates is either air or some insulator. This medium is called dielectric.



Parallel plate capacitance

34. Define unit of capacitance.

Answer

The S.I unit of capacitance is called farad.

The capacitance of a capacitor is one farad if a charge of one coulomb given to one of the plates of a parallel plate capacitor, produces a potential difference of one wit between them.

1F = 1C / 1V

35. On what factors the capacitance of a capacitor depends?

Answer

The capacitance of a capacitor depends upon the following factors:

- Area of plates
- Distance between the plates
- Nature ot the medium

36. Write some characteristics of parallel combination of capacitors.

Answer

- The potential difference across each capacitor is the same.
- The charge storage on each capacitor is different.
- Capacitors arc connected in parallel to increase the value capacitance.

37. Find the equivalent capacitance in case of parallel combination?

Answer

If n-capacitors are combined in parallel the equivalent capacitance of the combination is given by

$C_e = C_1 + C_2 + C_3$ …………… $+ C_n$

Generally, capacitors are connected in parallel to increase the value of capacitance.

38. Write some characteristics of series combination of capacitors.

Answer

- The potential difference across each capacitor is different.
- The charge on each capacitor would be same.
- Capacitors are connected in parallel to decrease the value capacitance.

39. Find the equivalent capacitance in case of parallel combination?

Answer

If n-capacitors are combined in parallel, the equivalent capacitance of the combination is given by:

$1 / C_e = 1 / C_1 + 1 / C_2 + 1 / C_3$ ……… $+ 1 / C_n$

This shows that when capacitors are connected in series, their equivalent capacitance decreases.

40. Define capacitance.

Answer

The ability of a capacitor to store charge is called the capacitance of a capacitor.

41. What happens to the capacitance in case of the presence of any medium between the plates of the capacitor?

Answer

When any medium is placed between the plates of the capacitor. its capacitance increases.

42. A paper capacitor is a fixed capacitor. Explain?

Answer

A fixed capacitor is that whose capacitance is fixed and cannot be changed. It is generally made of Aluminum foil with greased paper or plastic sheet as insulator between them.

43. What are types of the capacitors?

Answer

There two types of capacitors:

- Those capacitors whose capacitance is fixed are called fixed capacitors.

- Those capacitors whose capacitance can, be changed are called variable capacitors.

44. How the capacitance of a capacitor can be changed?

Answer

The capacitance of capacitors can be changed:

- By changing the separation between the plates of a capacitor.
- By changing the area of plates of a capacitor.
- By changing the dielectric material.

45. Can there be a potential difference between two conductors that carrying like charges of the same magnitude?

Answer

Yes, there can be potential difference between two charged conductors that carry like charges of the same magnitude, if they are some distance apart on a line.

46. Electric lines of force never cross. Why?

Answer

Electric lines of force nerve cross each other because electric intensity being a vector quantity has only one direction at any given point.

47. How many kinds of electric charge?

Answer

There are two kinds of electric charge:

- Positive charge.
- Negative charge.

48. Give some properties of charges.

Answer

- Like charges repel each other.
- Unlike charges attract each other.
- Electric lines of force start from +ive charge.
- Electric lines of force end on —ive charge.

49. Give some applications of capacitors.

Answer

Capacitors of all shapes and sizes are important element in various electrical appliances.

- Some capacitors are used to tune radio circuits.
- Some are used to store energy.

50. How an aero plane acquires a charge as it flies through air and how danger of spark is eliminated?

Answer

During flight, body of an aeroplane gets charged. Their tyres are of some conducting materials. As the aeroplane lands, this charge is easily transferred to ground and the danger of sparking is eliminated while the petrol is filled in it.

OBJECTIVE TYPE QUESTIONS & ANSWERS

Q1. Each question is followed by four options encircle the correct option.

1) The maximum potential energy of a vibrating mass attached to a spring is at:
a. Equilibrium position b. Extreme position
c. Between equilibrium and extreme position d. All of them

2) The product of frequency 'and time period is equal to:
a. 1/∞ b. b. I
c. 0 d. 1/0

3) If the mass of bob of a simple pendulum is doubled, its period:
a. is doubled b. becomes four times
c. remains the same d. none of the above

4) If the length of a simple pendulum is halved its time period T will become:
a) T/2 b) $T/\sqrt{2}$
c) $\sqrt{2}T$ d) 2T

5) In terms of wave length (λ), the distance between two neighboring nodes or antinodes Is:
a) λ b) λ /2
c) λ/4 d) 2 λ

6) Which of the following waves is not electromagnetic?
a. X-rays b. radio waves
c. light waves d. water waves

7) Which is the correct formula to find the frequency?
a. f=T b. f=1/t
c. $T=2\pi\sqrt{L}/f$ d. $T=2\pi\sqrt{M}/f$

8) Hertz is the unit of:
a. frequency b. wavelength
c. mass d. acceleration

9) Which Is not the characteristic of simple harmonic motion of a body?
a. It always vibrates about its position of equilibrium
b. Its acceleration Is always directed towards its mean position
c. its velocity is minimum at mean position
d. its velocity IS maximum at its mean position

10) The Waves in which the particles of the medium vibrate perpendicular to the direction of motion of waves are called:
a. electromagnetic waves b. transverse waves
c. compressional waves d. longitudinal waves

11) Energy can be transferred from one place to another:
a. through matter b. through waves
c. both of them d. none of these

12) The apparatus used to study the properties of waves is:
a. ripple tank ' b. water tank
c. electric bulb d. galvanometer

13) Which is concerned with bending of waves around corners?
a. reflection b. refraction
c. diffraction d. none of above

14) The up and down motion of hand produces waves in string known as:
a. Longitudinal waves b. compressional waves
c. transverse waves d. stationary wave:

15) Which is not correct?
a. the number of loops on string depends upon the frequency of up and down motion of hand.
b. string makes single loop at the lowest frequency
c. the fundamental frequency is called second harmonics
d. the fundamental frequency is called first harmonics

16) Which is not the true statement?
a. water waves exhibit phenomenon of refraction
b. speed of water waves depends on the depth of water
c. speed of light is more in air than in glass
d. bending of waves from their incident path is called amplitude

17) Which is not a correct equation
a. λ=VT b. V= λ /T
c. T= λ /V d. V= λ T

18) Find the equation in which spr...g constant has been used:
a. $k=f_e/x$ b. a= f /m
c. $T=2\pi\sqrt{\mu g}$ d. $f=1/T$

19) When where will the bob have maximum kinetic energy?
a. at its mean position b. at its extreme position
c. when the bob is stationary d. none of the above

20) .The sound waves in air are:
a. longitudinal b. radio
c. stationary d. none of the above

21) The 8.1. unit of spring constants K is:
a. Nm^2 b. Nm^{-2}
c. Nm^{-1} d.Nm

22) In S.E.M. the acceleration of the vibrating body is directly proportional to the:
a. distance b. displacement
c. amplitude d. velocity

23) The motion which repeats itself in equal intervals of time is called:
a. rotatory motion b. circular motion
c. angular motion d. vibratory motion

24) A force of 20N, produces an extension of 10 cm in an elastic spring. Then the value of spring constant is:
a. 200 Nm^{-1} b. 2Nm^{-1}
c. 20 Nm^{-1} d. none of these

25) The number of vibrations completed in one second is called:
a. time period b. frequency
c. amplitude d. wavelength

26) One complete round trip of an object about mean position is called:
a. amplitude b. frequency
c. Vibration d. time period

27) In an elastic spring, SHM is produced due to:
a. K.E of spring b. weight of spring
c. mass of spring d. restoring force

28) The time period of the simple pendulum does not depend upon:
a. mass of object b. length of string
c. value of g d. tension in string

29) The time period of the spring depends upon:
a. length of spring b. mass of object
c. value of g d. none of these

30). At which place, the motion of simple pendulum becomes faster?
a. Lahore b. Quetta
c. Murree d. Karachi

31) How many times the' value of "g" on 'moon surface is less than the value of g on earth's surface?
a. 1/6 b. 2
c.4 d. 6

32) The waves which do not require a medium for their propagation are known as:
a. mechanical waves b. electromagnetic waves
c. matter waves d. transverse, waves

33) Which of the following is not electromagnetic wave?
a. ultraviolet b. Microwave
c. water wave d. radio wave

34) The speea of electromagnetic wave is:
a. 3.0×10^8 ms^{-1} b. 332 ms^{-1}
c. 600 m/s d. zero

35) The acceleration of a vibrating body is maximum at:
a. when v is maximum b. mean position
c. extreme position d. both a and b

36) At mean position, a vibrating object has maximum:
a. acceleration b. velocity
c. time period d. displacement

37) The time period of a spring executing S.H.M. is equal '0:
a. $\frac{1}{2\pi}\sqrt{\frac{m}{k}}$ b. $2\pi\sqrt{\frac{k}{m}}$ c. $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ d. $2\pi\sqrt{\frac{m}{k}}$

38) By increasing the load in the spring, the time period of spring:
a. Increases b. decreases
c. remains unchanged d. becomes zero

39) The time period of a simple pendulum is equal to:
a. $2\pi\sqrt{\frac{g}{\ell}}$ b. $\frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$ c. $2\pi\sqrt{\frac{\ell}{g}}$ d. $\frac{1}{2\pi}\sqrt{\frac{\ell}{g}}$

40) The time period of simple pendulum is independent of:
a. length b. mass
c. value of g d. acceleration

41) Which of the following have maximum wavelength?
a. gamma rays b. visible light
c. microwaves d. radio waves

42) Which of the following have maximum frequency?
a. gamma rays b. radio waves
c. x-rays d. microwaves

43) Ripple tank is used to:
a. firing bomb b. to study waves
c. swimming d. none of these '

44) Bending of waves from their incident path is called:
a. reflection b. diffraction
c. refraction d. interference

45) According to the law of reflection:
a. sin i=sin y b. <i=<y
c. n=1/sinc d. <y≠<i

46) The radio transmission can be heard in such areas where the waves cannot reach directly due to:
a. reflection b. refraction
c. interference d. diffraction

47) When two identical waves travelling in opposite direction along the same line combine to form:
a. interference b. diffraction
c. stationary waved d. none of these '

48) Bending of waves around obstacles is called:
a. diffraction b. interference;
c. reflection d. refraction

49) The equation of wave speed is:
a. $f= c\lambda$ b. λ=fv
c. v=fλ d. v=f/λ

50) The units of frequency are:
a. Hertz b. S^{-1}
c. cycles per second d. all of them

ANSWERS

No	ANS	No	ANS	NO	ANS	NO	ANS
1	b	**2**	b	**3**	c	**4**	b
5	b	**6**	d	**7**	b	**8**	a
9	c	**10**	b	**11**	c	**12**	a
13	c	**14**	d	**15**	c	**16**	d
17	d	**18**	a	**19**	a	**20**	a
21	c	**22**	b	**23**	d	**24**	a
25	b	**26**	c	**27**	d	**28**	a