

Q1: Define an electric field and write its formula.

Answer:

An **electric field** is a region around a charged object where other charges experience a force. It is mathematically defined as:

$$E = F/Q$$

Where:

- E = Electric field (N/C)
 - F = Force on the test charge (N)
 - q = Test charge (C)
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Q2: What is the SI unit of the electric field?

Answer:

The SI unit of the electric field is **Newton per Coulomb (N/C)** or **Volt per meter (V/m)**.

Q3: Describe the direction of the electric field for positive and negative charges.

Answer:

- The **electric field due to a positive charge** radiates **outward**.
 - The **electric field due to a negative charge** points **inward**.
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Q4: What is the formula for the electric field due to a point charge?

Answer:

The electric field due to a point charge is given by:

$$E = KQ / r^2$$

Where:

- E = Electric field (N/C)
- K = Coulomb's constant ($9.0 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$)
- Q = Charge producing the field (C)
- r = Distance from the charge (m)

Section 2: Applications of Electric Field

Q5: How does a photocopier use the electric field to print images?

Answer:

A **photocopier** works using **static electricity** and electric fields:

1. **Charging:** A **drum** inside the photocopier is given a **uniform charge** using a **corona wire**.
2. **Exposure:** The image is projected onto the drum using light, and the charge is removed where the light hits (because light removes charge from the drum).
3. **Toner Application: Negatively charged toner particles** stick to the remaining charged areas of the drum.
4. **Transfer to Paper:** The **toner is transferred** to the paper using an **electric field**.
5. **Fusing:** The toner is **heated and pressed** onto the paper to make the image permanent.

Q6: How does a capacitive touch screen use the electric field?

Answer:

A **capacitive touch screen** detects touch using **electric fields**:

1. **Conductive Layer:** The screen is covered with a thin layer of **transparent conductors** (like indium tin oxide).
2. **Electric Field Generation:** When the screen is on, an **electric field** is present across the surface.
3. **Touch Detection:** When a finger (which conducts electricity) touches the screen, it **disrupts the field**, changing the capacitance.
4. **Signal Processing:** Sensors detect the change and send data to the processor to determine the exact touch location.

Q7: Why does a capacitive touchscreen not work with gloves?

Answer:

Gloves act as an **insulator** and **do not allow charge to flow**, so they prevent the electric field from being disturbed. Since capacitive screens rely on **conductive touch**, they do not work with gloves unless they are made of conductive material.

Q8: What are electric field lines? State their properties.

Answer:

Electric field lines are **imaginary lines** that represent the direction and strength of an electric field.

Properties:

1. **Originate from positive charges** and **terminate at negative charges**.
2. **Never intersect** each other.
3. **Closer lines indicate a stronger field**, while widely spaced lines indicate a weaker field.
4. **Always perpendicular** to the surface of a charged conductor.
5. **Field lines inside a conductor are zero** in electrostatic equilibrium.

Q9: What is the electric field inside a conductor? Why?

Answer:

The **electric field inside a conductor is zero** in electrostatic equilibrium. This happens because free electrons within the conductor move until the **internal field cancels out** any external influence.

Q10: Differentiate between uniform and non-uniform electric fields.

Answer:

Property	Uniform Electric Field	Non-Uniform Electric Field
Definition	Same magnitude & direction at every point	Varies in magnitude and/or direction
Example	Between two parallel plates in a capacitor	Around a point charge
Field Lines	Parallel and equally spaced	Unevenly spaced

Q11: What happens to the electric field strength when the distance from a charge is doubled?

Answer:

The electric field strength **reduces to one-fourth** of its original value.

Q12: Can an electric field exist without a charge?

Answer:

No, an electric field is created by charges. However, a **region in space may have an electric field** even if no charge is physically present at that point.

Q13: Why does a charged drum attract toner particles in a photocopier?

Answer:

The drum retains **static charges** in the form of an electrostatic image. Since the **toner has the opposite charge**, it is attracted to the charged areas and sticks to them.

Q14: What happens if a photocopier's drum loses its charge?

Answer:

If the drum loses its charge, the toner **will not stick properly**, and the image will be **faint or missing**.

Q15: What type of charge is given to the toner in a photocopier?

Answer:

The toner is given a **negative charge** so that it is attracted to the **positively charged** areas of the drum.

Q16: What is the role of capacitance in a capacitive touchscreen?

Answer:

Capacitance helps **store charge** at the surface. When a conductive object (like a finger) touches the screen, it **alters the capacitance**, allowing the device to detect touch.

Q17: Why does a capacitive screen not work with plastic or wood?

Answer:

Plastic and wood are **insulators**; they do not conduct electricity and therefore **do not disturb the electric field**, making them undetectable by the screen.

Q18: How does a capacitive touchscreen determine the exact touch position?

Answer:

A capacitive screen has **multiple sensors** that detect changes in the electric field at different points. The touch **disrupts** the field at a specific location, which is then **processed by software** to determine the exact position.

Q19: What happens if two like charges are placed close to each other?

Answer:

They **repel** each other because **like charges repel** due to the nature of the electric field.

Q20: Can a capacitor store charge indefinitely? Why or why not?

Answer:

No, a capacitor **loses charge over time** due to **leakage currents** and **dielectric breakdown**.

Q21: How does humidity affect the working of a photocopier?

Answer:

High humidity can cause **moisture to accumulate**, reducing static charge buildup, which may lead to **poor toner transfer and smudged prints**.

Q22: Why do some capacitive touchscreens support multi-touch?

Answer:

Multi-touch screens have **multiple capacitance sensors** that can detect changes at **multiple points** simultaneously.

