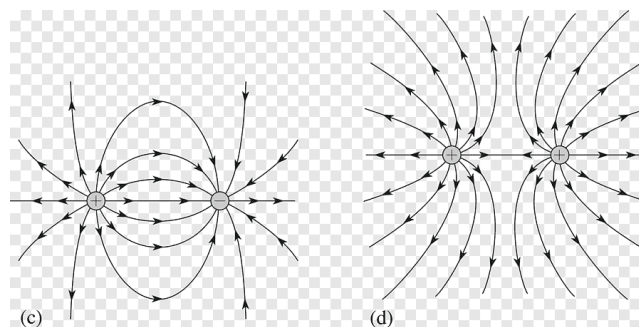


# Electric Field – Definition & Related Phenomena(Theory)

- Definition: An electric field is a region around a charged object where other charged objects experience a force. It is represented by the symbol  $E$  and is defined as the force per unit charge:  $E = F / q$

where  $F$  is the force acting on a test charge  $q$ .

- Units: The SI unit of the electric field is Newton per Coulomb (N/C) or Volt per meter (V/m).
- Direction: The direction of the electric field is away from positive charges and towards negative charges.
- Key Equations:
  - For a point charge:  $E = (kQ)/r^2$  where  $k$  is Coulomb's constant.
  - For a uniform field:  $E = V/d$  where  $V$  is voltage and  $d$  is distance.



[png-clipart-point-electric-field-field-line-electric-charge-three-dimensional-effect-angle-white.png](#)  
(900x446)

## Extended Concepts

### *Pyroelectricity(Heat/Cool):*

- Definition: Certain materials generate an electric charge when heated or cooled due to asymmetric crystal structures.
- How It Works: When temperature changes, the internal structure of the material shifts, causing charge separation and voltage generation.
- Example: Infrared sensors in motion detectors, thermal cameras, energy harvesting applications.
- Applications: Fire detection systems, energy harvesting, medical imaging.
- Key Material: Tourmaline, Lithium Tantalate ( $\text{LiTaO}_3$ ), Gallium Nitride ( $\text{GaN}$ ), Barium Titanate ( $\text{BaTiO}_3$ ).

### Piezoelectricity(Pressure):

- Definition: Some crystals generate an electric charge when mechanically stressed.
- How It Works: When pressure is applied, the structure deforms, shifting charge centers and generating voltage.
- Example: Quartz watches (mechanical pressure → electricity), electric lighters, ultrasound machines.
- Applications: Sonar systems, pressure sensors, medical ultrasound, microphones, energy harvesting.
- Key Materials: Quartz, PZT (Lead Zirconate Titanate), Rochelle salt, PVDF (Polyvinylidene fluoride), Barium Titanate.

### Triboelectricity(Friction):

- Definition: Electric charge generated by friction between different materials.
- How It Works: When two materials come into contact and separate, electrons transfer, leading to charge imbalance.
- Example: Rubbing a balloon on hair, static electricity in clothes, lightning formation in storms.
- Applications: Energy harvesting, anti-static coatings, touch sensors, electrostatic painting.
- Key Materials: Glass, rubber, silk, fur, amber, Teflon, nylon.

### *Electret Materials:*

- Definition: Materials that maintain a permanent electric charge or dipole moment.
- How It Works: Similar to dielectrics but with a quasi-permanent internal charge polarization.
- Example: Used in microphones, electrostatic air filters, copy machines, MEMS sensors.
- Applications: Long-lasting electrostatic charge storage, sensors, biomedical implants, high-efficiency filters.
- Key Material: Teflon-based materials, polymer electrets (polypropylene, PVDF), silicon dioxide coatings.

### Ferroelectricity

- Definition: Materials that exhibit spontaneous electric polarization, which can be reversed by an external electric field.

- **How It Works:** Unlike ordinary dielectrics, ferroelectric materials have a switchable permanent dipole moment due to asymmetric lattice structure.
- **Example:** Used in non-volatile memory (FeRAM), capacitors, sonar devices, high-precision actuators.
- **Applications:** Non-volatile data storage, piezoelectric actuators, energy-efficient capacitors, tunable RF devices.
- **Key Material:** Barium Titanate ( $\text{BaTiO}_3$ ), Lead Zirconate Titanate (PZT), Strontium Bismuth Tantalate (SBT).

### 3. Real-Life Applications & Examples

Concept	Real-Life Example
Electric Field	Charged balloon attracting small paper bits
Pyroelectricity	Infrared sensors in burglar alarms, energy harvesting from temperature changes
Piezoelectricity	Quartz watches, lighter ignition, medical ultrasound, sonar technology
Triboelectricity	Static shocks when touching a door handle, energy harvesting from walking
Electret Effect	Condenser microphones in smartphones, electrostatic air filters
Ferroelectricity	FeRAM memory in smart cards, tunable capacitors in wireless communications

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*"Knowledge Should Be Shared  
Only With The One  
Who Knows Its True Worth!  
Not Everyone Deserves It"  
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