# Electricity I

## Electric Charge and Field

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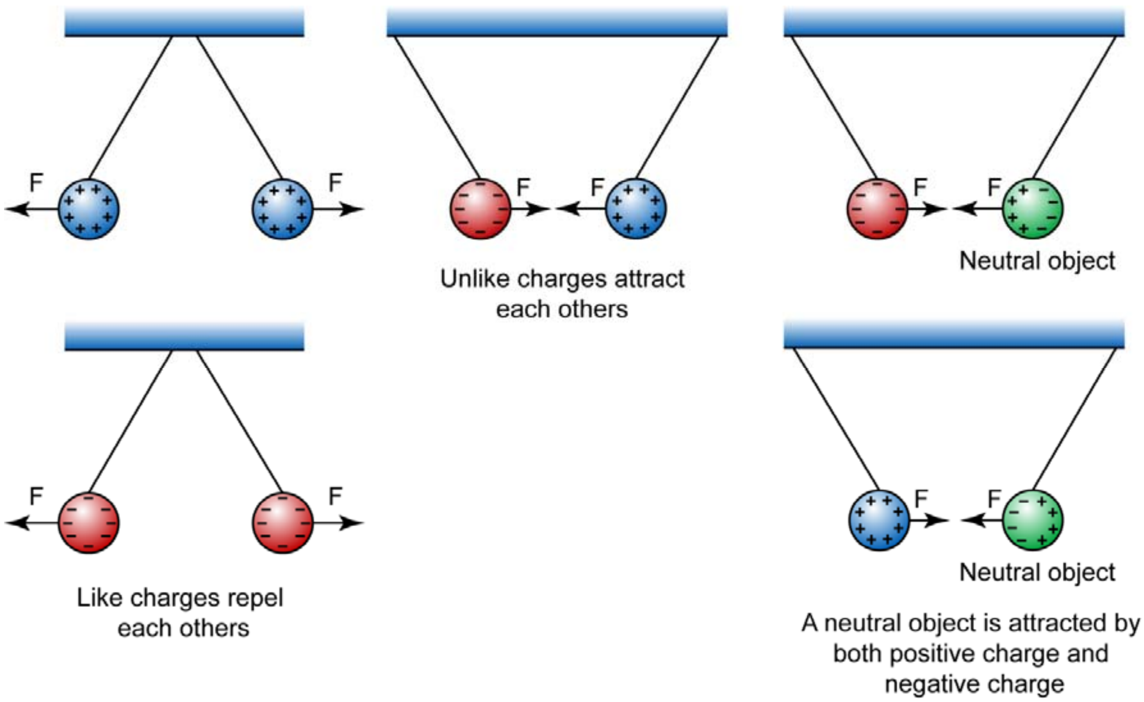



**Unit of Charge**
The SI unit of electric charge is Coulomb (C).

**Equation:**

**Sum of charge**

$$Q = ne$$

## Electric Charge

1. There are two kind of electric charge, namely the positive charge and the negative charge.
2. Like charge repel each other.
3. Unlike charge attract each other.
4. A neutral body can be attracted by another body which has either positive or negative charge.

5. The SI unit of electric charge is Coulomb (C).
   Example
   Charge of 1 electron = $-1.6 \times 10^{-19}$ C
   Charge of 1 proton = $+1.6 \times 10^{-19}$ C

### Charge and Relative Charge

| Particle | Relative charge | Charge |
|---|---|---|
| **Electron** | **-1** | $-1.6 \times 10^{-19}$ C |
| **Proton** | **+1** | $+1.6 \times 10^{-19}$ C |
| **Aluminium ion** | **+3** | $3 \times +1.6 \times 10^{-19}$ C |
| **Oxygen ion** | **-2** | $2 \times -1.6 \times 10^{-19}$ C |

### Sum of Charge

Sum of charge
= number of charge particles × charge of 1 particle

$$Q = ne$$

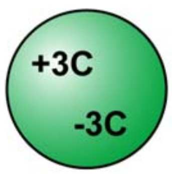
**Example 1**

Find the charge of 2.5 x $10^{-19}$ electrons. (Charge of 1 electron is -1.6 x $10^{-19}$C)

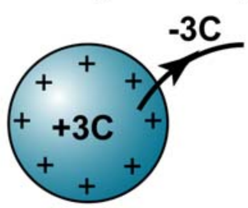
[-4C]

**Example 2**

How many protons are there in +2.5 Coulomb of charge?




A neutral object contain equal amount of positive and negative charge




If negative charge is removed from a neutral object, the object will become positively chearged.

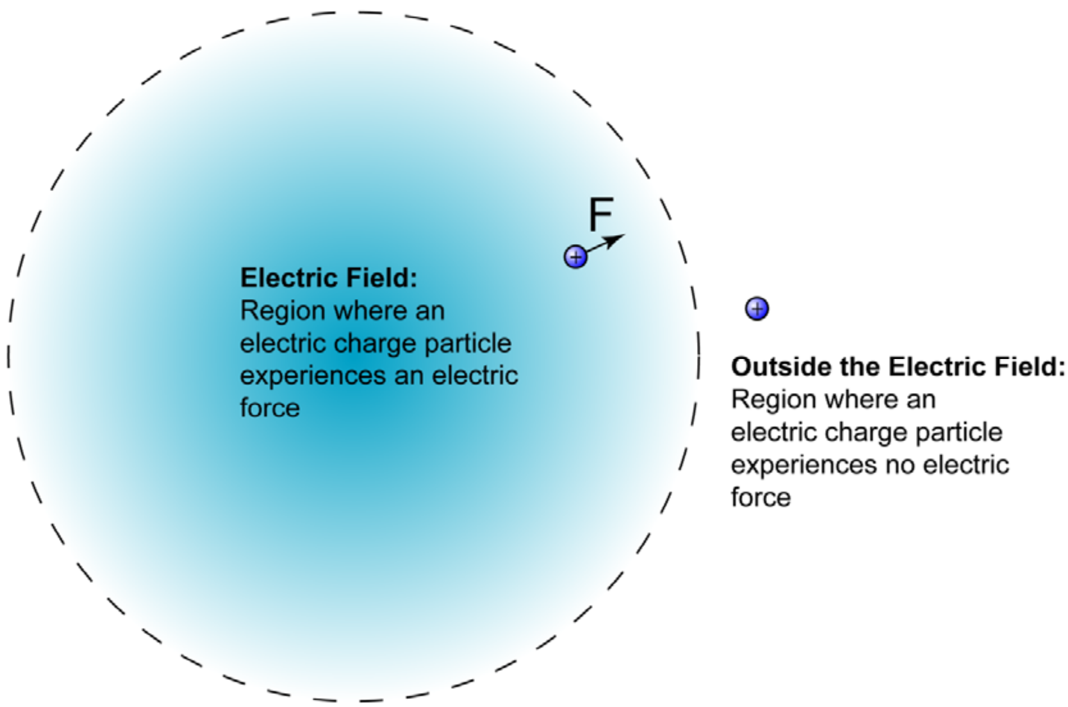
**Concept of Neutral**

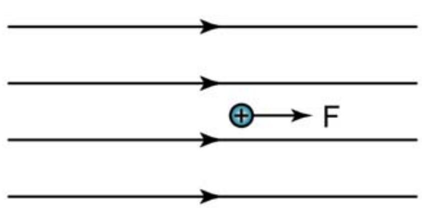
1. An object is neutral if the amount of positive charge is equal to the amount of negative charge.
2. When negative charge is removed from a neutral object, the object will come positively charged.

**Example 3**

$1.25\times10^{16}$ electrons are added into an object that carries +1C of charge. Calculate the nett charge of the object.

[+3C]

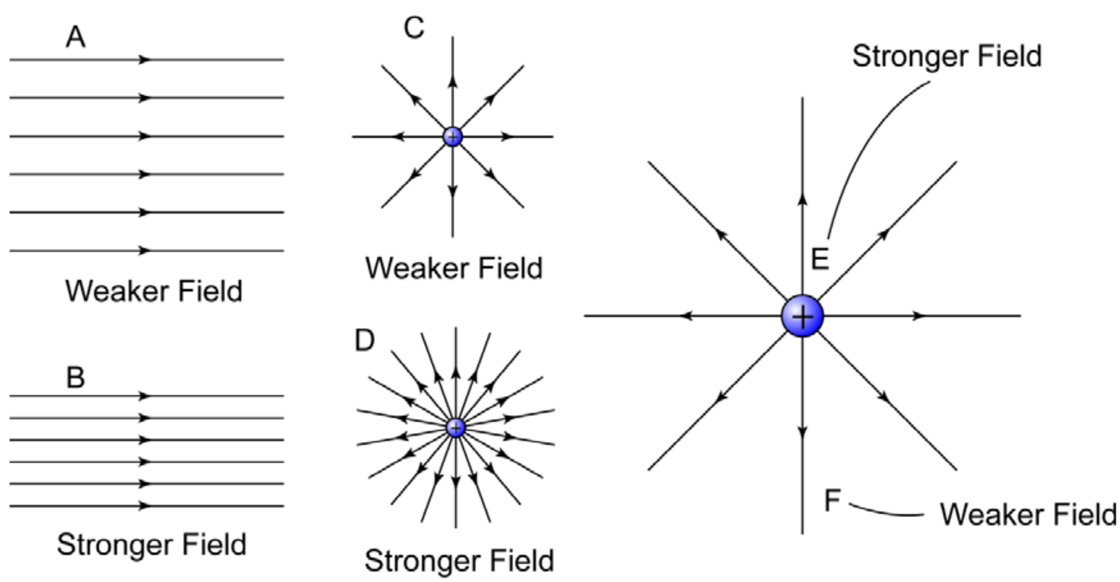


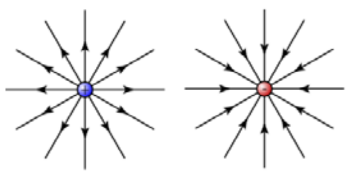




The direction of the field at a point is defined by the direction of the electric force exerted on a positive test charge placed at that point.

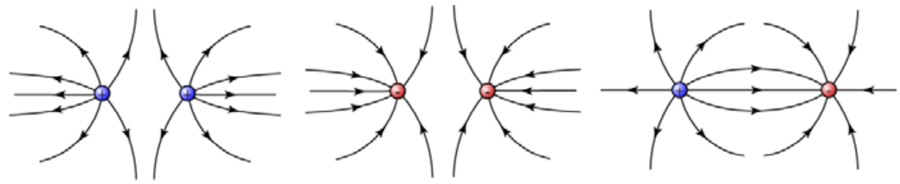
## Electric Field

1. An **electric field** is a region in which an electric charged particle experiences an electric force.
2. Electric field is represented by a number of lines with arrows, called **electric lines of force** or electric field lines.
3. The direction of the field at a point is defined by the direction of the electric force exerted on a positive test charge placed at that point.
4. The strength of the electric field is indicated by how close the field lines are to each other. The closer the field lines, the stronger the electric field in that region.
   Example

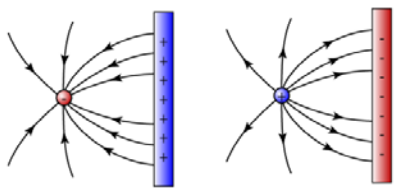




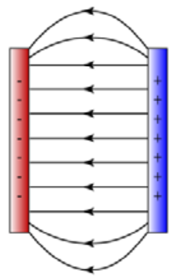
Field pattern of
a pointed electrode



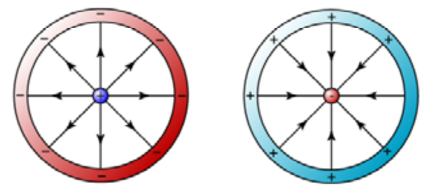
Field pattern of
two pointed electrodes



Field pattern of
a pointed electrode
and a plane electrode



Field pattern of
two plane electrodes



Field pattern of
a pointed electrode
and a ring electrode

5. The lines of force are directed **outwards for a positive** charge and **inwards for a negative** charge.
6. The electric line of force will never cross each other.
7. The figure shows a few examples of the field pattern that you need to know in the SPM syllabus.

**Direction of the field**
The direction of the field at a point is defined by the direction of the electric force exerted on a positive test charge placed at that point.

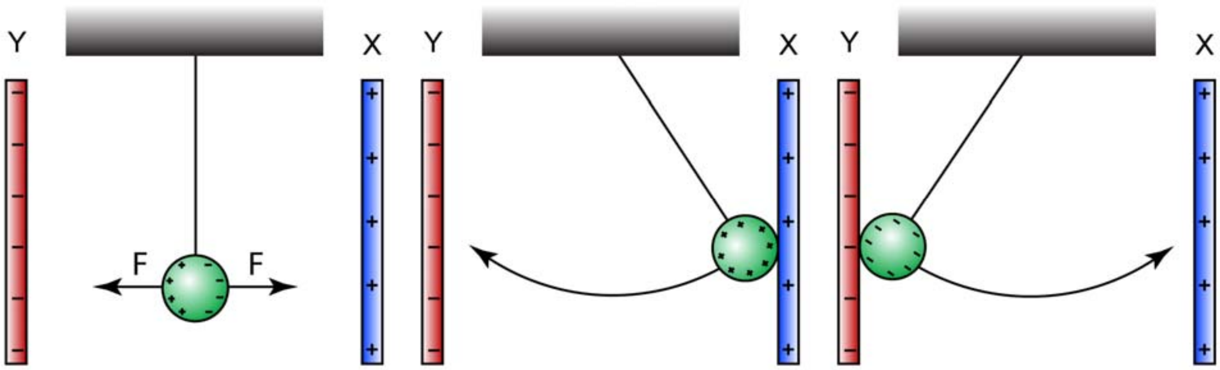
The lines of force are directed **outwards for a positive** charge and **inwards for a negative** charge.

The electric line of force will never cross each other.

## Effect of Electric Field

### Effect of Electric Field on a Ping Pong Ball Coated with Conducting Material

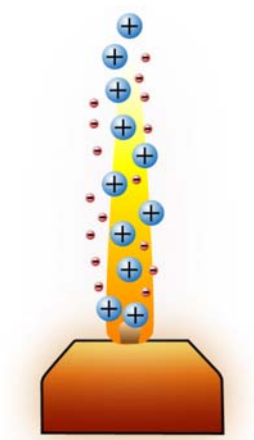
1. A ping ball coated with conducting material is hung by a nylon thread.
2. When the ping pong ball is placed in between 2 plates connected to a Extra High Tension (E.H.T.) power supply, opposite charges are induced on the surface of the ball. The ball will still remain stationary. This is because the force exert on the ball by the positive plate is equal to the force exerted on it by the negative plate.
3. If the ping pong ball is displaced to the right to touch the positive plate, it will then be charged with positive charge. Since like charges repel, the ball will be pushed towards the negative plate.
4. When the ping pong ball touches the negative plate, it will be charged with negative charge. Again, like charge repel, the ball will be pushed towards the positive plate. This process repeats again and again, causes the ping pong ball oscillates to and fro continuously between the two plates.



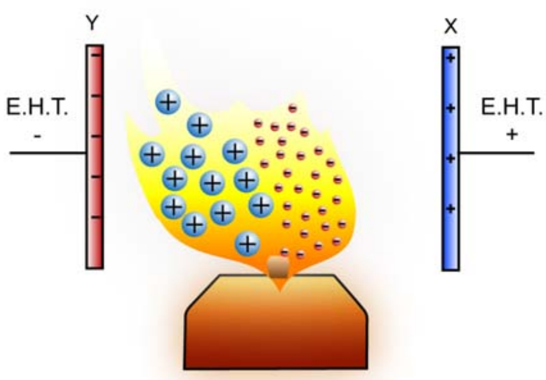

The ball will still remain stationary. This is because the force exert on the ball by the positive plate is equal to the force exerted on it by the negative plate.

If the ping pong ball is displaced to the right to touch the positive plate, it will then be charged with positive charge and will be pushed towards the negative plate.

When the ping pong ball touches the negative plate, it will be charged with negative charge and will be pushed towards the positive plate. This process repeats again and again, causes the ping pong ball oscillates to and fro continuously between the two plates.



The heat of the candle flame removes electrons from the air molecules around it, and therefore ionised the molecule.




If the candle is placed in between 2 plates connected to a Extra High Tension (E.H.T.) power supply, the positive ions will be attracted to the negative plate while the negative ions will be attracted to the positive plate.

## A Candle Flame in an Electric Field

1. Normally, with absent of wind, the flame of a candle is symmetry.
2. The heat of the candle flame removes electrons from the air molecules around it, and therefore ionised the molecule. As a result, the flame is surrounded by a large number of positive and negative ions.
3. If the candle is placed in between 2 plates connected to a Extra High Tension (E.H.T.) power supply, the positive ions will be attracted to the negative plate while the negative ions will be attracted to the positive plate.
4. The spreading of the flame is not symmetry. This is because the positive ions are much bigger than the negative ions; it will collide with the other air molecule and bring more air molecule towards the negative plate.

# Current and Potential Difference

## Current

1. An electric current $I$ is a measure of the rate of flow of electric charge Q through a given cross-section of a conductor.
2. In other words, current is the measure of how fast the charge flow through a cross section of a conductor.

Equation

$$\text{Current} = \frac{\text{The amount of charge flow}}{\text{Time taken}}$$

or

$$I = \frac{Q}{t}$$

**Current**
Current is the rate of flow of electric charge flow in conductor.

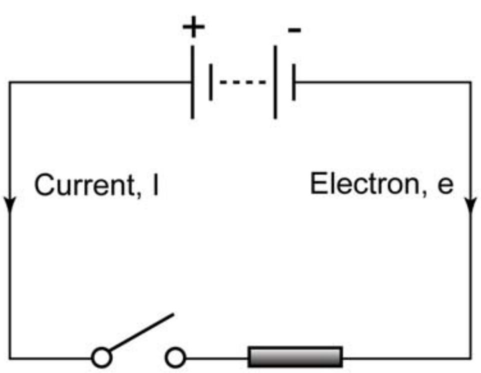
*Current*

$$I = \frac{Q}{t}$$

## Direction of Current

1. Conventionally, the direction of the electric current is taken to be the flow of positive charge.
2. The electron flow is in the opposite direction to that of the conventional current.
3. In a circuit, current flow from the positive terminal to the negative terminal.
4. In a circuit, electrons flow from the negative terminal to the positive terminal.

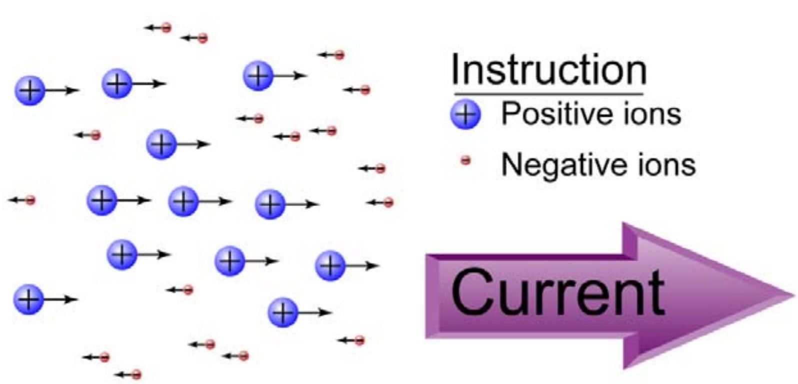
**Direction of Current**
In a circuit, current flow from the positive terminal to the negative terminal.




## Unit of Current

1. The SI unit for current is the ampere (A).
2. The current at a point is 1 ampere if 1 Coulomb of electric charge flows through that point in 1 second. Therefore, 1 A = 1C/s.

**Example 4**
If 30 C of electric charge flows past a point in a wire in 2 minutes, what is the current in the wire?



**Example 5**

Current of 0.5A flowed through a bulb. How many electrons had flowed through the bulb in 5 minute? (The charge of 1 electron is equal to $-1.6\times10^{-19}$ C)

## Potential and Potential Difference

1. The **electric potential** V at a point in an electric field is the work done to bring a unit ( 1 Coulomb) positive charge from **infinity to the point**.
2. The **potential difference** (p.d.) between two points is defined as the work done in moving 1 Coulomb of positive charge from 1 point in an electric field to another point.
3. In mathematics form

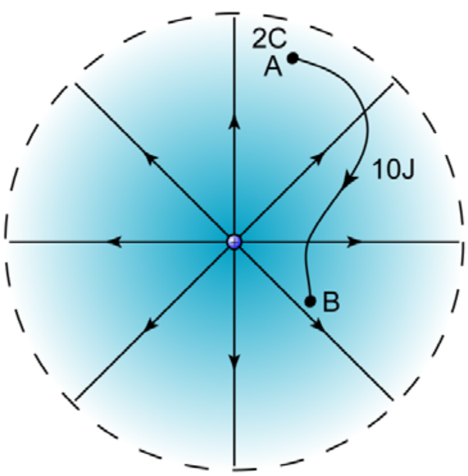
$$Potential\ Difference(V) = \frac{Work\ Done\ (W)}{Amount\ of\ Charge\ (Q)}$$

or

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

4. Example, the diagram on the left, if the work done to move a charge of 2C from point A to point is 10J, the potential difference between A and B,

$$V_{AB} = \frac{10J}{2C} = 5J/C = 5V$$




The potential difference between A and B is 5J/C or 5V.

**Example 6**

During an occasion of lightning, 200C of charge was transferred from the cloud to the surface of the earth and $1.25\times10^{10}$J of energy was produced. Find the potential difference between the cloud and the surface of the earth.