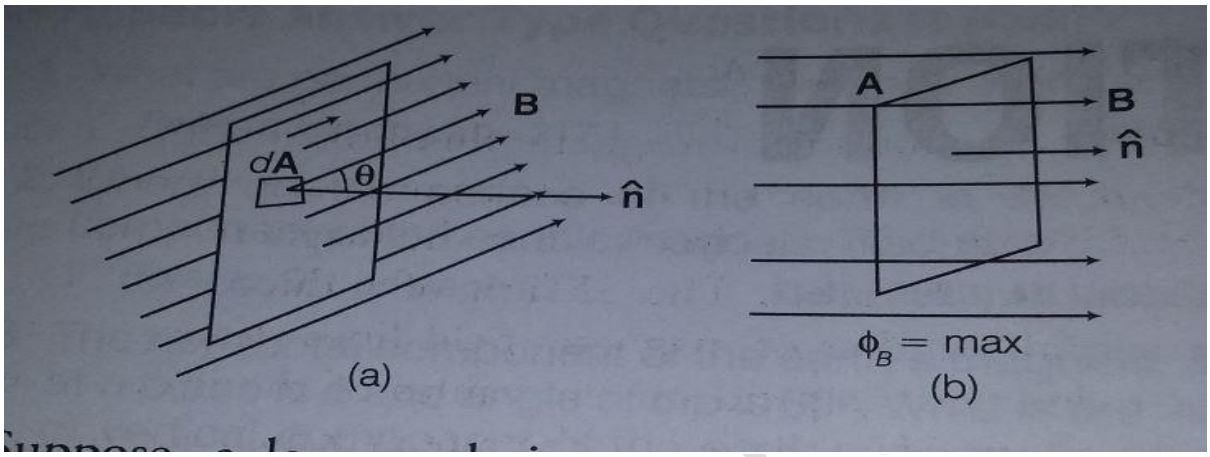
ELECTROMAGNETIC INDUCTION

Whenever the magnetic flux linked with an electric circuit changes, an emf is induced in the circuit. This phenomenon is called **electromagnetic induction**.

Magnetic flux



Magnetic flux is a measurement of the total magnetic field which passes through a given area. A field line passing through at a glancing angle will only contribute a small component of the field to the magnetic flux.

Flux Formula

Magnetic flux formula is given by:

$\phi_B = B.A = BA\cos\Theta$

Where,

Φ_B is the magnetic flux.

B is the magnetic field

A is the area

θ the angle at which the field lines pass through the given surface area

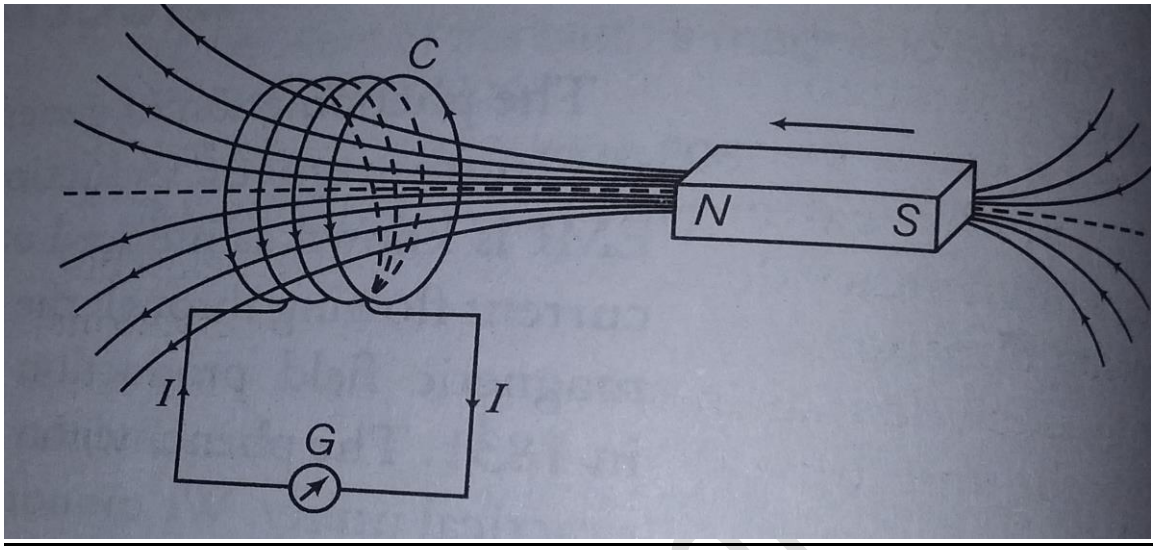
Magnetic Flux Unit

Magnetic flux is usually measured with a flux meter. The SI and CGS unit of magnetic flux is given below:

SI unit of magnetic flux is Weber (Wb).
The fundamental unit is Volt-seconds.
The CGS unit is Maxwell.

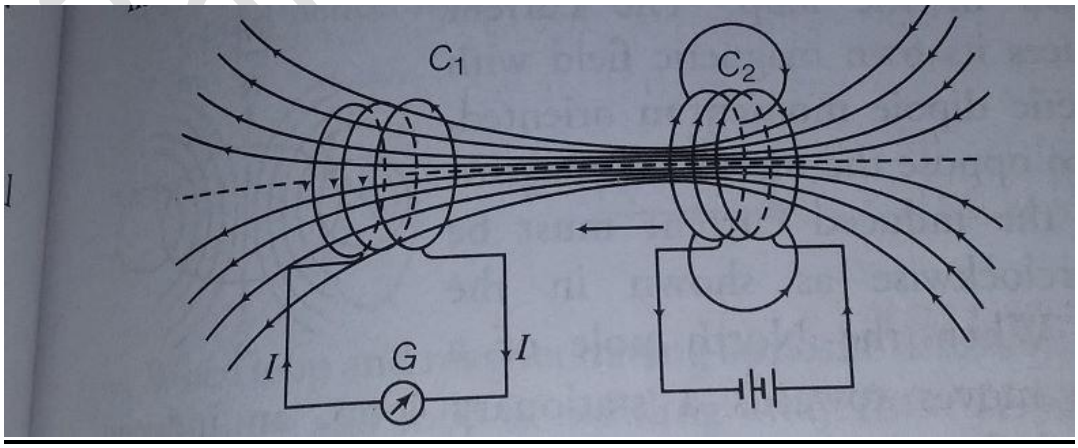
The Experiments of Faraday and Henry

Experiment 1



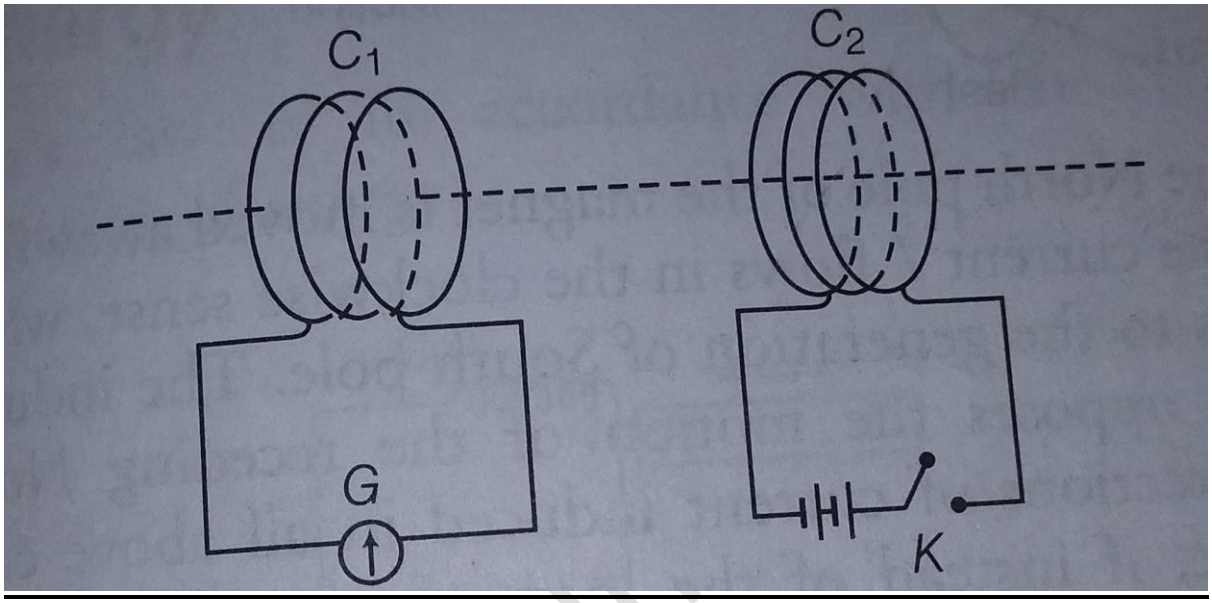
If North-pole of a bar magnet is pushed towards the coil, the pointer in the galvanometer deflects, indicating the presence of electric current in the coil. This deflection lasts as long as the bar magnet remains in motion.
The galvanometer doesn't show any deflection when the magnet is held at rest. When the magnet is pulled away from the coil, the galvanometer shows deflection in the opposite direction, which indicates reversal of the current's direction.
This shows that the relative motion between the magnet and the coil that is responsible for generation (induction) of electric current in the coil

Experiment 2



If the bar magnet is replaced by a second coil C_2 (as shown in figure given above) connected to a battery. The steady current in the coil C_2 produces a steady magnetic field. If coil C_2 is moved towards the coil C_1, then the galvanometer shows a deflection. This indicates that electric current is induced in coil C_1.
When C_2 is moved away, the galvanometer shows a deflection again, but this time in the opposite direction. The deflection will be observed as long as coil C_2 is in motion.

Third experiment



The galvanometer shows a momentary deflection when the tapping key K is pressed. The pointer in the galvanometer returns to zero immediately. If the key is held pressed continuously, there is no deflection in the galvanometer. When the key is released, a momentary deflection is observed again, but in the opposite direction. It is also observed that the deflection increases dramatically when an iron rod is inserted into the coils along their axis.

Faraday's Laws of Electromagnetic Induction

(i) Whenever the magnetic flux linked with a circuit changes, an induced emf is produced in it.

(ii) Changing the magnetic flux through a loop of wire induces a current. Faraday's law states that the emf induced in a wire is proportional to the rate of the flux through the loop. Mathematically,

$\mathcal{E} = -N \Delta\Phi / \Delta t.$

Where N is the number of loops, $\Delta\Phi$ is the change of flux in time, Δt. The minus sign indicates the polarity of the induced emf.