ELECTROMAGNETIC INDUCTION

LENZ'S LAW AND CONSERVATION OF ENERGY

LENZ" S LAW

LENZ'S LAW EXPLAINED IN DETAIL:

Lenz's Law is a fundamental principle in electromagnetism that describes the relationship between induced electromotive force (emf) and the change in magnetic flux. This law states that the effect of the induced emf is always such that it opposes the change in magnetic flux that gives rise to it. Let's delve deeper into the concept and its practical applications.

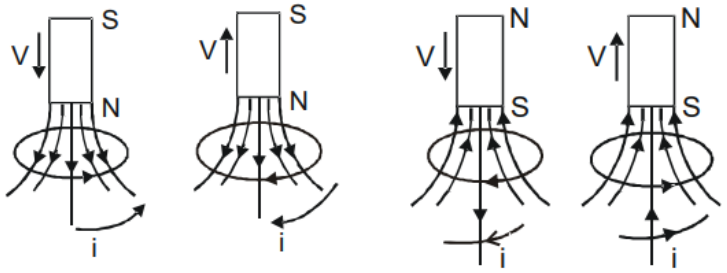


Illustration with a Magnet and a Loop:

In Figure (a & b), when a magnet approaches a conducting loop, the magnetic flux through the loop increases. As a result, an induced current is generated in the loop, creating an induced magnetic field (Bind) whose flux opposes the change. The direction of Bind is opposite to the external magnetic field (Bext) produced by the approaching magnet.

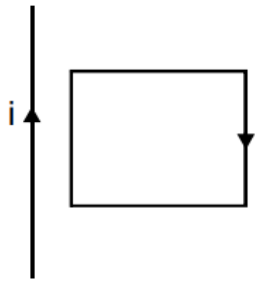
In Figure (c & d), as the magnet moves away from the loop, the magnetic flux through the loop decreases. To maintain the flux through the loop, the induced magnetic field (Bind) tries to keep it constant. The direction of Bind aligns with the external magnetic field (Bext) produced by the magnet. Lenz's law is intimately linked with the conservation of energy, as it ensures that work done to move a magnet near a conducting loop is transformed into electrical energy, inducing a current in the loop.

Determining Current Direction:

Another method to ascertain the direction of induced current inside a loop is by considering a conducting loop near a long, straight wire carrying a current (i). When the current in the wire increases continuously, it induces emf in the loop, resulting in an electric current. The right-hand thumb rule is applied to determine the direction of the current. It shows that the normal to the loop and the magnetic field at the loop's location are both directed into the plane of the diagram.

As a consequence, the integral of the dot product of magnetic field (B) and the differential area (dA) is positive when the current (i) increases, leading to an increase in magnetic flux (Φ). However,

since the magnitude of magnetic (ε) is negative. Consequently, the opposing the initial change in



flux (Φ) is positive and increasing, emf induced current is also negative, magnetic flux.

Brain Teaser:

Regarding two identical coaxial circular loops carrying equal currents in the same direction and approaching each other, Lenz's law predicts that as the loops get closer, the induced currents in each loop will oppose the approach. Therefore, the current in each loop will decrease as they approach each other. This phenomenon exemplifies Lenz's law in action, ensuring that induced currents always act to counter the change in magnetic conditions.