10.3 LENZ'S LAW

In Figs. 10.2 , 10.3, and 10.4, the directions of induced currents are shown in various experiments. The induced currents are in opposite directions when the magnetic flux is increasing and when the magnetic flux is decreasing. To obtain a rule for the direction of the induced current from these experiments, it is helpful to redraw the pictures so that magnetic field is perpendicular to the plane of the loop under study.

For instance, when we look at the loop in Fig. 10.2 from the side of the bar magnet, the magnetic field lines that pass through the loop are going-away from us. Therefore, we will draw this direction of the magnetic field as into-the-page direction with the back-of the arrow symbol as shown in Fig. 10.10.

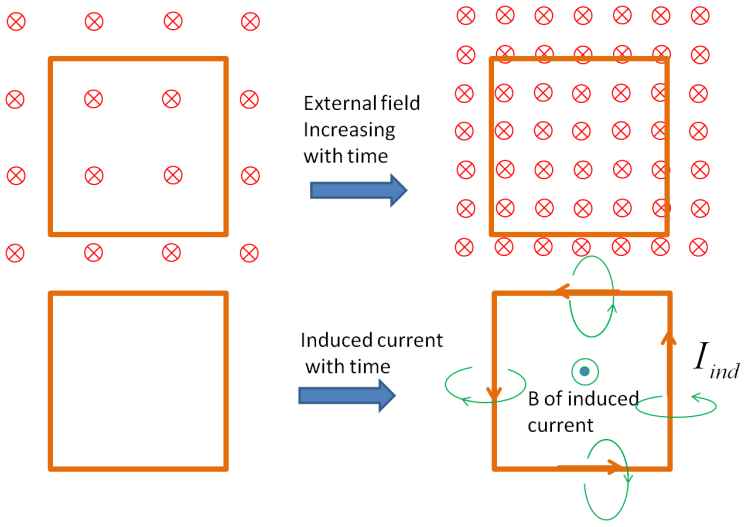

Figure 10.10: Faraday experiment on left side in Fig 10.2 is redrawn here in the plane of the loop as viewed from the side of the approaching magnet. As magnetic flux in the direction away from the observer increases, the induced current is in counter-clockwise direction. The symbol $\otimes$ stands for away or into-the page direction and $\odot$ for towards or out-of-page direction.

When the bar magnet approaches the loop, the magnetic flux increases, which is shown in the the figure as increase in the density of the magnetic field lines through the loop. Experiments show that in this situation, the induced current is counter-clockwise as shown in Fig. 10.10. The receding bar magnet leads to decrease of magnetic flux of the field which gives rise to the induced current in the clockwise direction as viewed from the side of the bar magnet.

When you examine the magnetic field of the induced current and

compare it with the direction of the external magnetic field, you notice that:

The magnetic flux of the magnetic field generated by the induced current always opposes the change in the magnetic flux of the external field through the area of the loop.

Thus, if the magnetic flux of the external magnetic field is increasing then the magnetic field of the induced current at points inside the loop will be in the opposite direction to the external magnetic field. If the magnetic flux in the loop is decreasing then the magnetic field from the induced current will be in the same direction as the external magnetic field.

The observation regarding the direction of the induced current and the character of the change in magnetic flux suggests that there is an inertia of the magnetic flux through any loop and the induced effect tends to oppose any change. This rule is called Lenz's law.

Lenz's Law: *An electric circuit opposes any change in the magnetic flux through the space of the circuit. If the magnetic flux changes, then a current will be induced in the circuit that will oppose the change in the magnetic flux by its own magnetic field.*