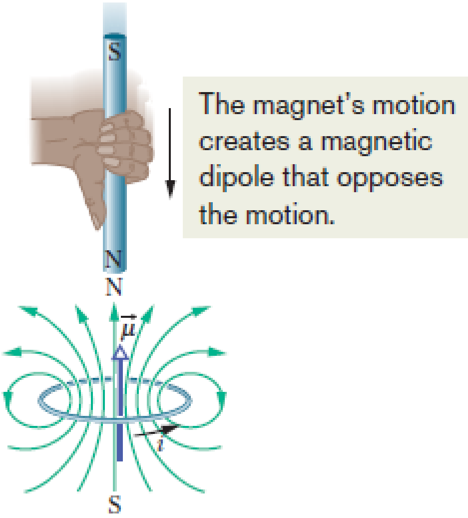
Lenz's Law

Soon after Faraday proposed his law of induction, Heinrich Friedrich Lenz devised a rule for determining the direction of an induced current in a loop:

An induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current.

Furthermore, the direction of an induced emf is that of the induced current. The key word in Lenz's law is "opposition." Let's apply the law to the motion of the north pole toward the conducting loop in Fig.



1. *Opposition to Pole Movement.* The approach of the magnet's north pole in Fig. increases the magnetic flux through the loop and thereby induces a current in the loop. We know that the loop then acts as a magnetic dipole with a south pole and a north pole, and that its magnetic dipole moment *u* is directed from south to north. To *oppose* the magnetic flux increase being caused by the approaching magnet, the loop's north pole (and thus) must face *toward* the approaching north pole so as to repel it (Fig). Then the curled – straight right-hand rule for *u* tells us that the current induced in the loop must be counter clockwise in Fig. If we next pull the magnet away from the loop, a current will again be induced in the loop. Now, however, the loop will have a south pole facing the retreating north pole of the magnet, so as to oppose the retreat. Thus, the induced current will be clockwise.

2. *Opposition to Flux Change.* In Fig., with the magnet initially distant, no magnetic flux passes through the loop. As the north pole of the magnet then nears the loop with its magnetic field B directed *downward*, the flux through the loop increases. To oppose this increase in flux, the induced current *i* must set up its own field B_{ind} directed *upward* inside the loop.

Heads Up. The flux of always opposes the *change* in the flux of , but is not always opposite . For example, if we next pull the magnet away from the loop in Fig., the magnet's flux B is still downward through the loop, but it is now decreasing.