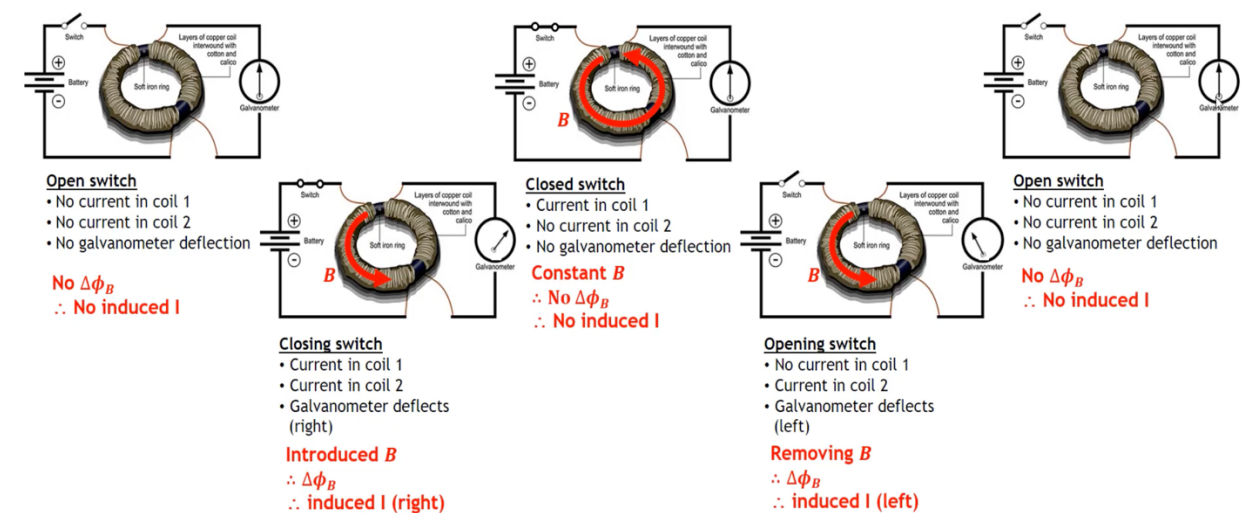
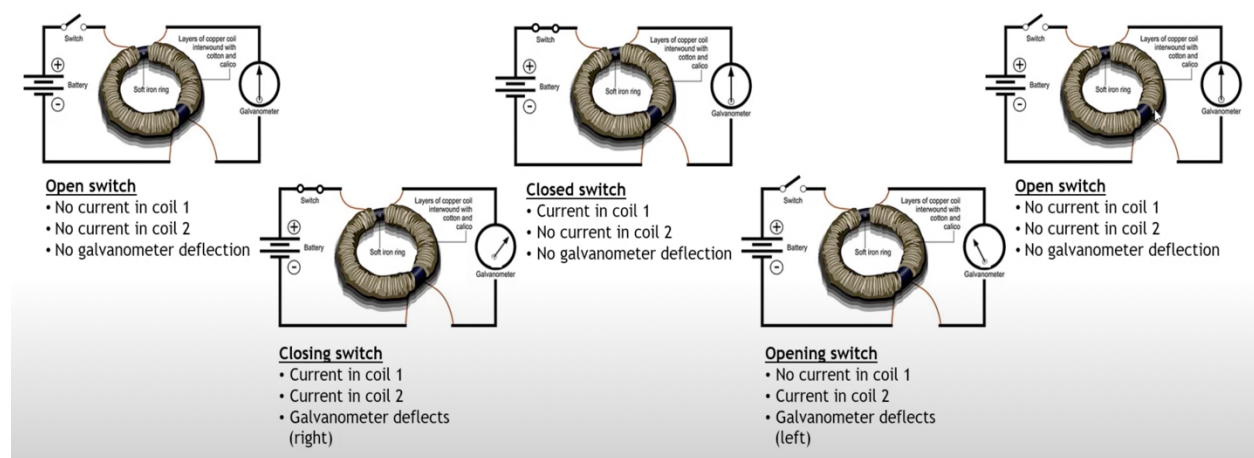


Faraday's Law: A changing magnetic field can induce a current in a wire.

- The law of electromagnetic induction states that a change in the magnetic field in the region of a conductor induces a voltage in the conductor, causing an induced electric current in the conductor
- Faraday's ring is a device that demonstrates electromagnetic induction. A current in the primary coil creates a magnetic field in the ring. the magnetic field in the ring then induces a current in the secondary coil.
- The amount of induced electric current can be increase by coiling the conductor, increasing the number of loops, increasing the rate of change of the magnetic field, or increasing the strength of the magnetic field.

<https://www.youtube.com/watch?v=fJ07KulXr9s&t=127s>



Lenz's Law: The current induced by the electromagnetic induction, is in such a direction that it opposes that produced it.

<https://phet.colorado.edu/sims/cheerpj/faraday/latest/faraday.html?simulation=faraday>

Named after Emil Lenz, Lenz's law depends on the principle of conservation of energy and Newton's third law. It is the most convenient method to determine the direction of the induced current. It states that the direction of an induced current is always such as to oppose the change in the circuit or the magnetic field that produces it.

Lenz's Law is reflected in the formula of Faraday's law. Here the negative sign is contributed by Lenz's law. The expression is:

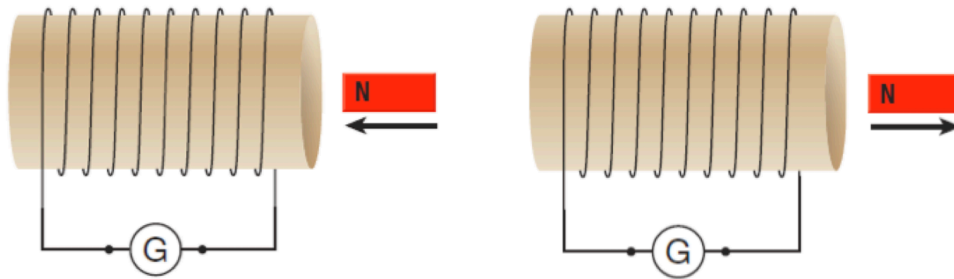
$$Emf = -N \left(\frac{\Delta\phi}{\Delta t} \right)$$

Where Emf is the induced voltage (also known as electromotive force).

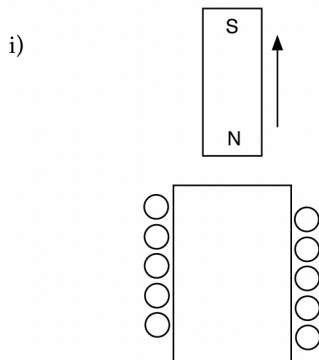
N is the number of loops.

$\Delta\phi$ Change in magnetic flux.

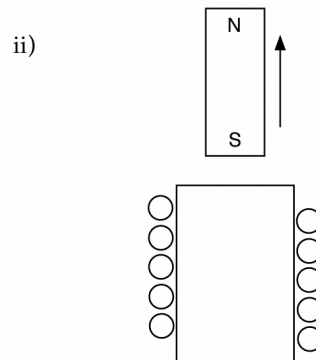
Δt Change in time.



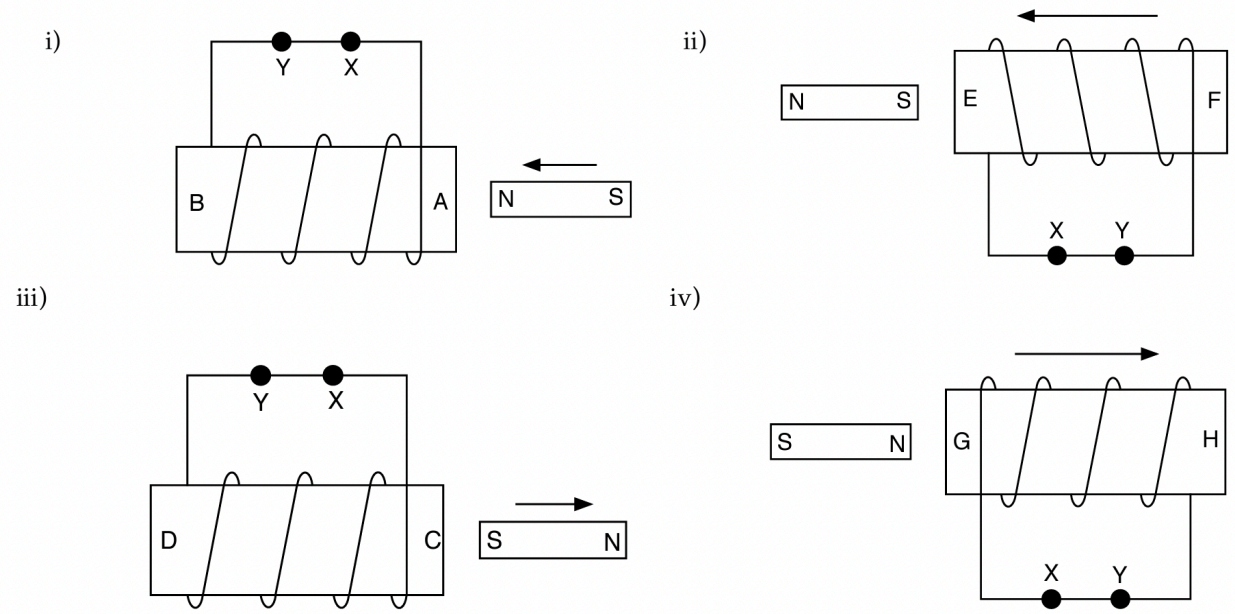
1. For the following two diagrams, indicate the N and S poles of the coil, and the direction of the induced current:



⊙ or ⊗ ?



2. For each of the inducing actions in the diagrams below, predict:
 a) which of the poles formed on the helix is the north pole.
 b) the direction of the induced current (i.e. from X to Y, or from Y to X).



1. These are loops being put into or pulled out of a magnetic field. Lenz's law says that the current induced flows in a direction so as to oppose the change in flux. So if flux **goes away**, you **replace** it, and if flux **increases**, you **oppose** it. Remember, that CW (clockwise) current creates flux into the page inside a loop. (Rt-hand rule for magnets and loops), and ACW (anti-clockwise) current creates flux out of the page inside a loop.

(cw) B: x	(cw) B:	(acw) B: x	(acw) B:
(acw) B:	(acw) B: x	(cw) B:	(cw) B:
(acw) B: x	(cw) B: x	(acw) B:	(cw) B:

2. The first two are loops where we change magnetic field. Lenz's law says that the current induced flows in a direction so as to oppose the change in flux. So if flux **decreases**, you **replace** it, and if flux **increases**, you **oppose** it. Remember, that CW current creates flux into the page. (Rt-hand rule for magnets and loops), and ACW current creates flux out of the page. The second two have to do with the current induced in a solenoid (or coil) flowing in such a way as to also oppose the motion of the magnet. (i.e. the work the magnet does becomes electrical energy) So as the magnet approaches, the current will flow in the coil in such a way as to make the coil a magnet that either **repels an incoming** magnet, or **attracts a receding** magnet.

<p>B decreases (acw)</p> <p>B:</p>	<p>B increases (acw)</p> <p>B</p>	<p>The magnet moves as shown. Which way does the current flow on the front of the coil? (↑)</p>	<p>The magnet moves as shown. Which way does the current flow on the front of the coil? (↓)</p>
<p>B increases (cw)</p> <p>B:</p>	<p>B increases (acw)</p> <p>B</p>	<p>The magnet moves as shown. Which way does the current flow on the front of the coil? (↑)</p>	<p>The magnet moves as shown. Which way does the current flow on the front of the coil? (↑)</p>
<p>B increases (acw)</p> <p>B</p>	<p>B decreases (acw)</p> <p>B:</p>	<p>The magnet moves as shown. Which way does the current flow on the front of the coil? (↑)</p>	<p>The magnet moves as shown. Which way does the current flow on the front of the coil? (↓)</p>

3. For the first two, the loops with no arrow are in the magnetic field of a wire, so use the wire right hand rule to figure out the direction of that field. For the second two, current in the loop with no arrow is responding to the B-field created by the arrowed loop. Inner and outer work pretty much the same way. Lenz's law says that the current induced flows in a direction so as to oppose the change in flux. So if flux **goes away**, you **replace** it, and if flux **increases**, you **oppose** it. Remember, that CW current creates flux into the page, and ACW current creates flux out of the page.

<p>Current decreases (acw)</p> <p>I</p>	<p>Current increases (cw)</p> <p>I</p>	<p>Current in outer loop increases (acw)</p>	<p>Current in inner loop decreases (acw)</p>
<p>Current decreases (acw)</p> <p>I</p>	<p>Current increases (acw)</p> <p>I</p>	<p>Current in inner loop increases (cw)</p>	<p>Current in outer loop decreases (acw)</p>