

Magnetism

10-05

Lenz's Law, Generators/Motors, Electromagnetic
Radiation

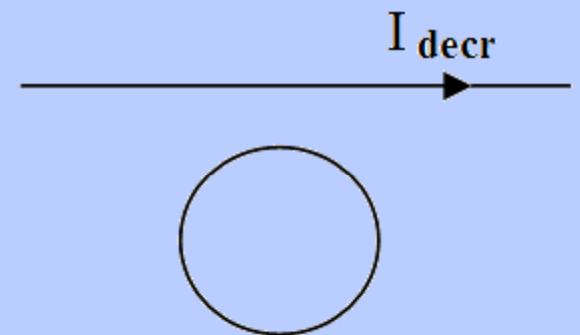
Lenz's Law

- If the magnetic field within a loop (circuit) changes, current will flow to create (induce) a magnetic field to oppose that change
- Simpler: Nature likes the magnetic field the way it is; if you try to change it, nature will fight you!
- Everything electrical you ever owned and pretty much all the technology you love is based on this!

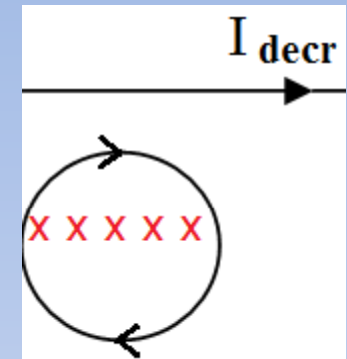
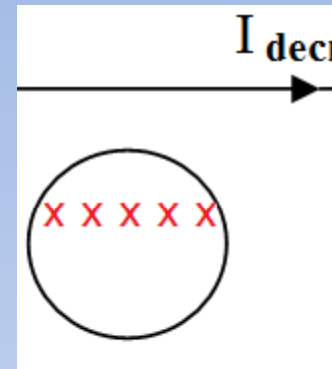
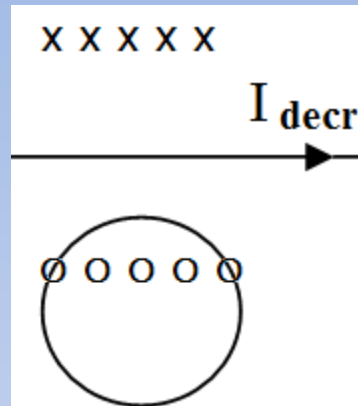
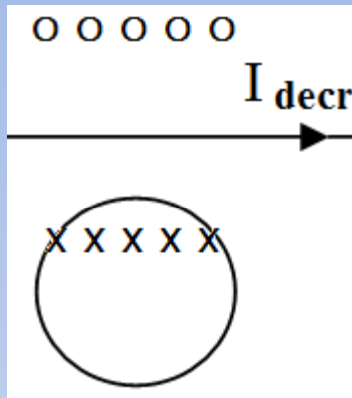
Lenz's Law – loop problems

- Divide logic into four steps:
 1. Show magnetic field due to current
 2. Show CHANGE in magnetic field due to CHANGE in current
 3. Show OPPOSING change in loop (Lenz)
 4. Show current that nature produce to oppose change
- Practice Example 1: Current in a wire near a loop is decreasing as shown below. Will a clock-wise or counter clock-wise current be induced in the loop? (CW)

*Solution on next slide, but try it yourself!
Sketch the set up on the right and do the four steps above and see if you can figure it on your own!*



Lenz's Law – Example Solved



Show magnetic field due to current

Simple right hand rule: Align thumb with I , fingers come out of paper above wire, into paper below wire.

Show CHANGE in magnetic field due to CHANGE in current

Since current is DECREASING, change in magnetic field is opposite of field's current direction

Show OPPOSING change in loop (Lenz)

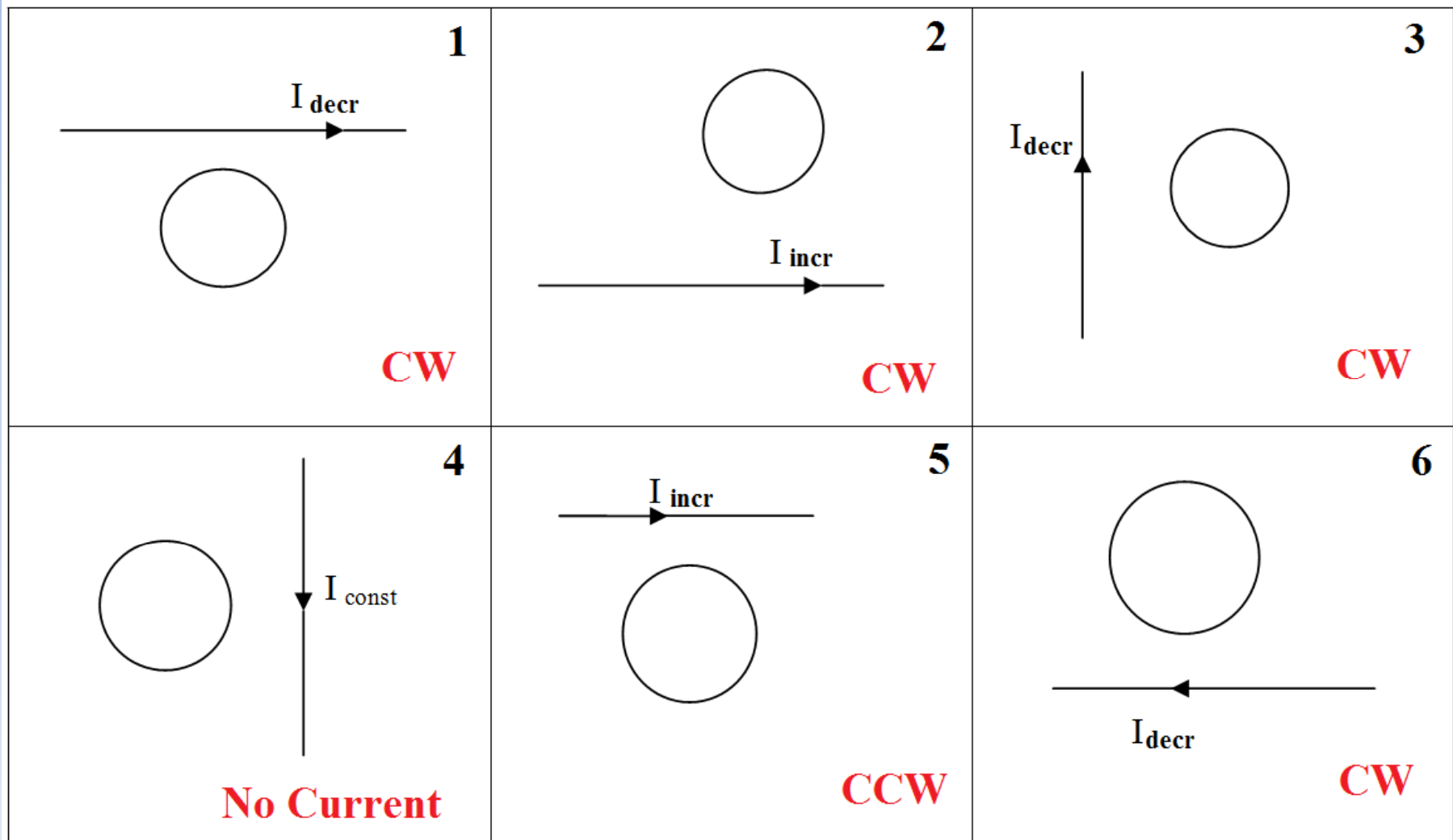
Nature doesn't like this CHANGE and produces WITHIN the loop a magnetic field that opposes the CHANGE

Show current that nature produce to oppose change

To produce this opposing magnetic field, use simple right hand rule to find which way nature induces current to flow (CW)

Lenz's Law – More loop practice

- Need more practice? (one is a repeat)



Generators and motors

- Know they are opposites in function, but work on same principle
 - Generators take mechanical energy and output current (electrical energy)
 - Motors take current and output mechanical energy
- Lenz's law predicts this
 - Since nature opposes change, you have to input mechanical work to make a change
 - You turn a crank (or waterfall, etc. turns a paddle wheel) and your mechanical work gets turned into electrical energy

Generators and motors

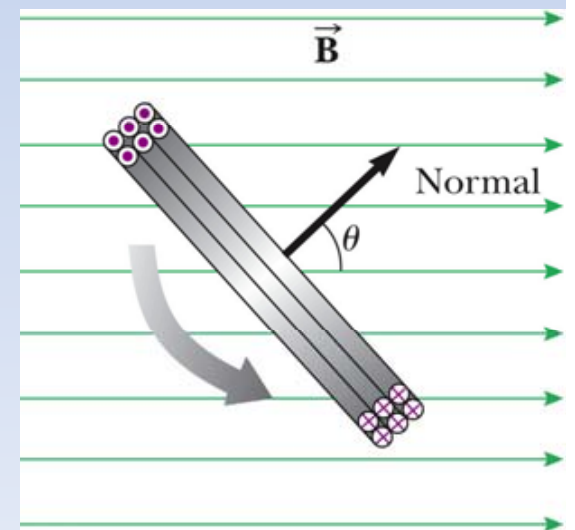
- Key idea to notice from Faraday's law

$$N \Delta(BA)$$

$$\varepsilon = \frac{\quad}{\Delta t} \quad (\text{remember EMF means voltage})$$

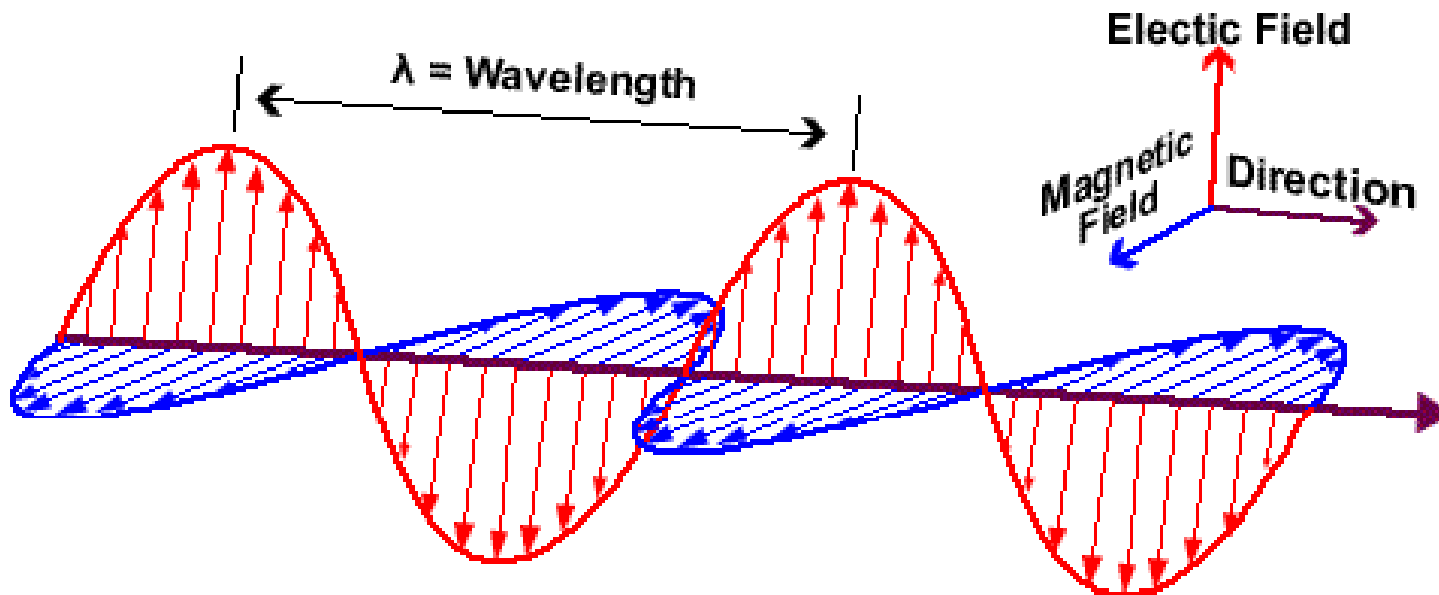
- Notice BA changes, nature rebels & makes current (produces voltage)
- Spinning a loop changes A of BA, AREA
- Changed BA means voila, you force current flow
- N is the number of loops (coils)
- See the CCW loop at right?
- See how less B passes through loop?
- Visit generator link and watch it!
- See why motors/generators use magnets?

http://www.walter-fendt.de/ph14e/generator_e.htm



What light really is

- Say a lot of energy causes an electron to vibrate, like you get iron red hot
- The vibrating electric field is a changing electric field, which induces a magnetic field
- The magnetic field is changes and created (induces) a changing electric field
- If this light wave is the lowest frequency we can see, our red cones are stimulated and we see it's red hot!



What light really is

- Light is merely changing electric fields inducing changing magnetic fields, etc.
- Any vibrating electrically charged particle can make it, but electrons are usually handy
- Remember when we said you'd have to understand magnetism to understand electromagnetic radiation? See why?

