Physical Sciences 3

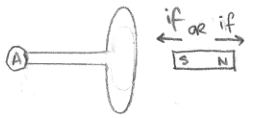
Lectures 13, 14 and 15 – April 2, 2008 – Induction, Waves, Ray Model of Light, and Polarization

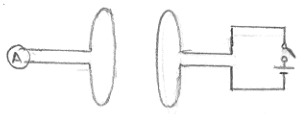
Reading for Understanding: Chapter 28, Chapter 29, Chapter 15, Chapter 32

INDUCTION

a changing magnetic field can create an electric current; this is called an induced current.

- holds true when a magnet approaches a current carrying wire.
- holds true if there are two current carrying wires and 1 "wire" is able to be switched on/off





- the induced emf caused by a changing $\vec{B}$ is proportional to dB/dt in loop. the faster the Δ in $\vec{B}$, the greater the induction
- Depends on the relative motion of the wire/magnet:
  - * distance between magnet/wire decreasing = magnetic flux increasing
  - * distance between magnet/wire increasing = magnetic flux decreasing

where magnetic flux $\Phi_B = \int \vec{B} \cdot d\vec{A}$ in general ($\vec{B}$: magnetic $\vec{B}$; A: area of loop)

if $\vec{B}$ uniform $\Phi_B = BA\cos\theta$ (Φ_B: total # of lines of $\vec{B}$ passing through the loop of A)

use this in

LENZ'S LAW

Lenz's law is used to determine the direction of the electric current induced in a loop due to a Δ in Φ_B.

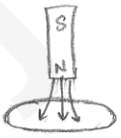
"induced current creates $\vec{B}$ field that opposes the change in the magnetic flux"

IF

a) the magnetic flux is increasing, the magnetic field due to the induced current is in the opposite direction

b) the magnetic flux is decreasing, the magnetic field due to the induced current, is in the same direction.

DIRECTION OF $\vec{B}$ FIELD - INDUCED

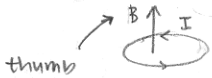


① Find the direction of the $\vec{B}$ field caused by the magnet ($\downarrow \vec{B}$)

② determine increasing Φ_B or decreasing Φ_B ($\uparrow \Phi_B$ b/c magnet approaching wire)

③ determine direction of induced current/field in wire (want opposite, $\uparrow \vec{B}$)

④ RIGHT HAND RULE (Rings)



thumb points in direction of $\vec{B}$; curl fingers around ring in direction of current

∴ want counterclockwise induced current to give $\uparrow \vec{B}$

⑤ Force on magnet due to wire

like putting two north poles next to each other, the N end is repelled by induced $\vec{B}$ ($\uparrow F$)

so induced $\vec{B}$ will attract S end. ($\downarrow F$)

AC Generators - a conductor loop rotates in $\vec{B}$ uniform

$B_\perp = B_0 \sin\omega t$ $\quad f = \omega/2\pi = 60$ Hz commercial in US.

AC Transformers - two coils around Fe core

- 1st coil: N_1, driven by AC volt
- 2nd coil: N_2, drives R
- ↙ increase voltage

$V_{in} \propto N_1 \frac{dB}{dt}$ $\quad V_{out} \propto N_2 \frac{dB}{dt}$ $\quad \frac{V_{in}}{V_{out}} = \frac{N_1}{N_2}$