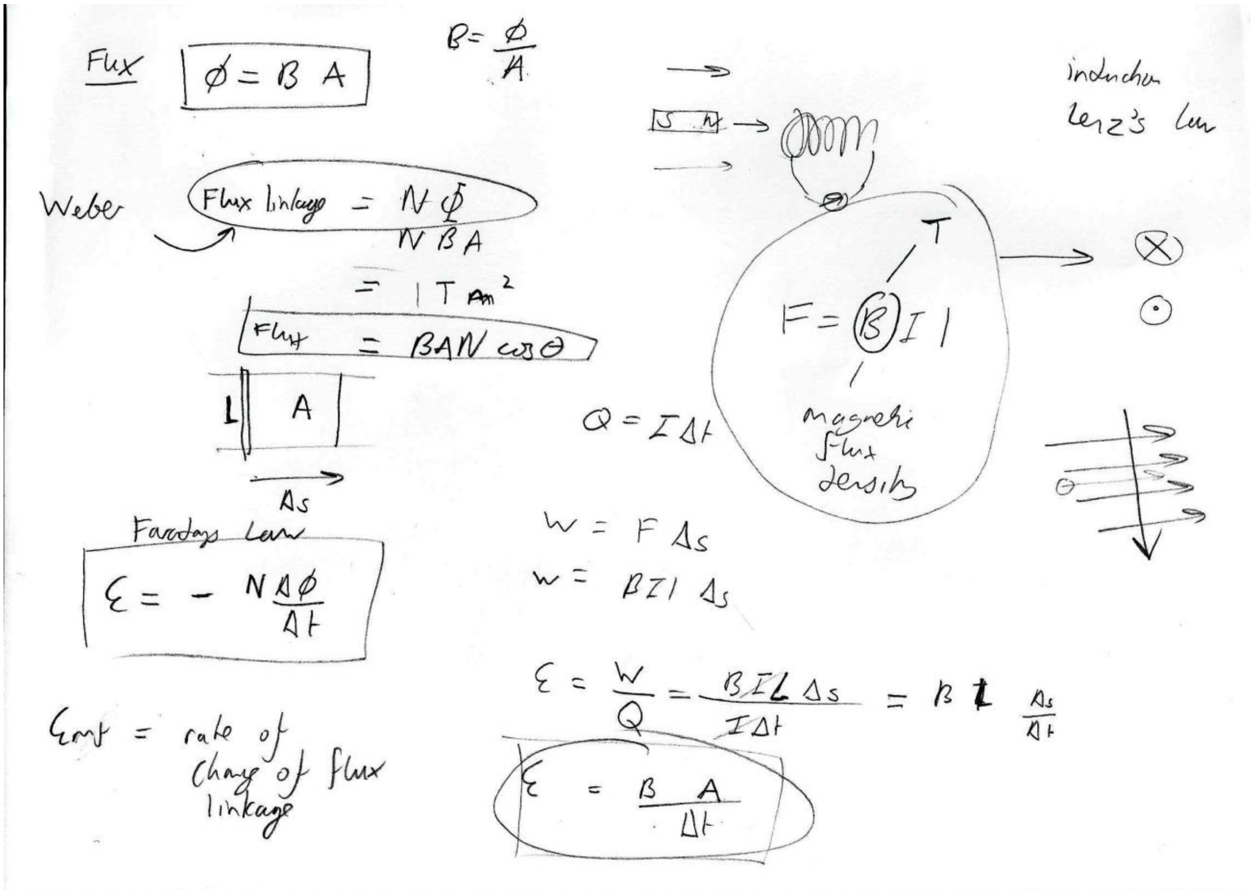


Flux $\boxed{\phi = B\ A}$

$B = \frac{\phi}{A}$

induction

Lenz's law

S N

Weber

Flux linkage $= N\phi$

$N B A$

$= 1\ T\ m^2$

Flux $= BAN \cos\theta$

L

A

Δs

T

$F = B I l$

magnetic flux density

$\otimes$

$\odot$

$Q = I\Delta t$

Faradays Law

$$\boxed{\mathcal{E} = -\ N\frac{\Delta\phi}{\Delta t}}$$

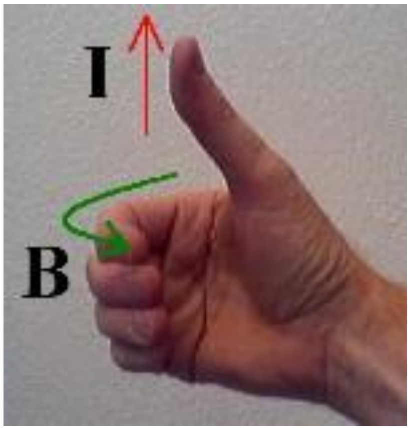
$W = F\Delta s$

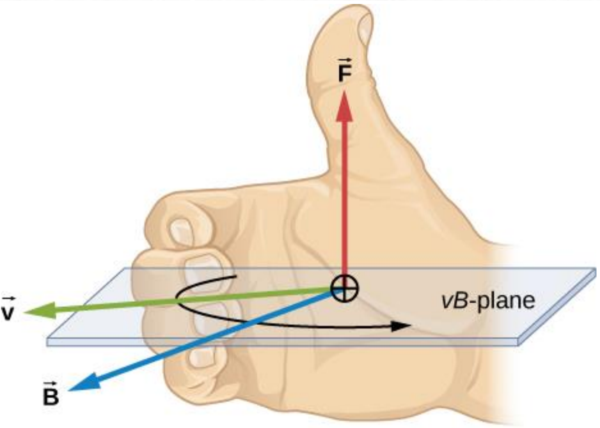
$w = BIl\ \Delta s$

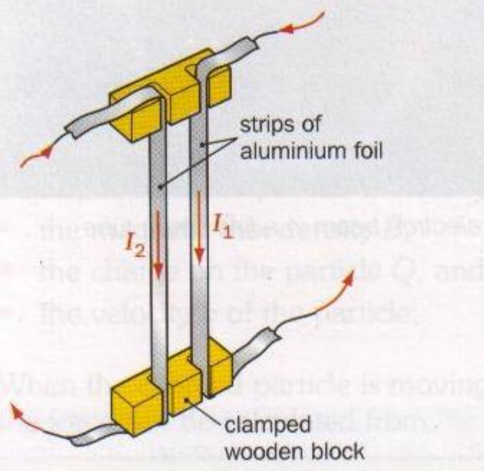
Emf = rate of change of flux linkage

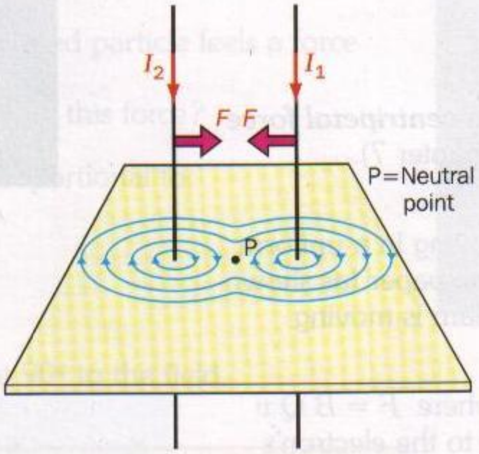
$$\mathcal{E} = \frac{W}{Q} = \frac{B\cancel{I}L\Delta s}{\cancel{I}\Delta t} = B\ L\ \frac{\Delta s}{\Delta t}$$

$$\mathcal{E} = \frac{B\ A}{\Delta t}$$

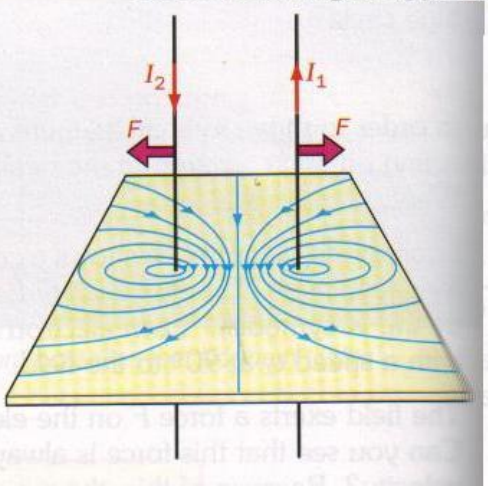


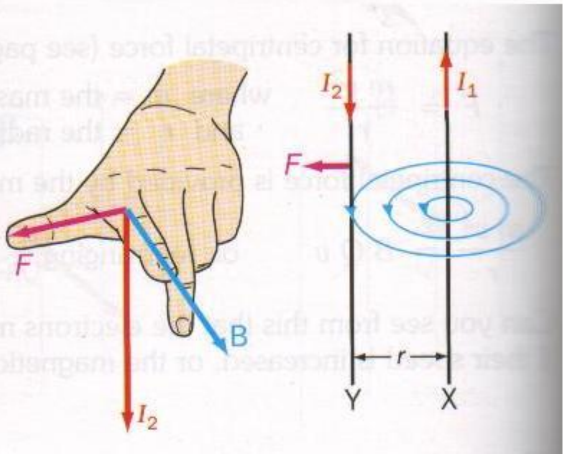


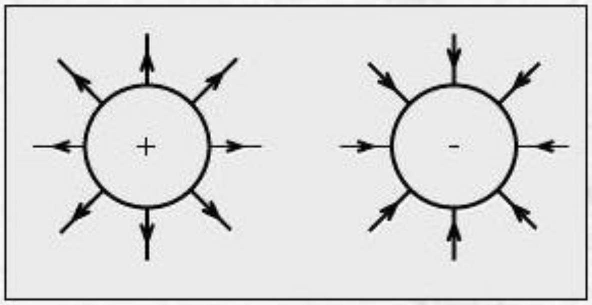




Notice that: currents flowing in the *same* direction ***attract***,
currents flowing in ***opposite*** directions ***repel***.



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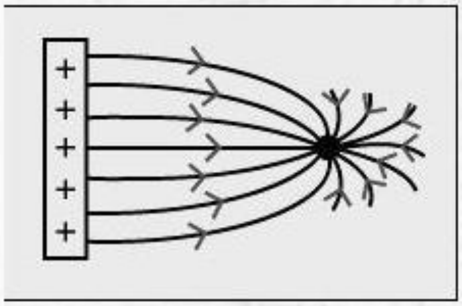
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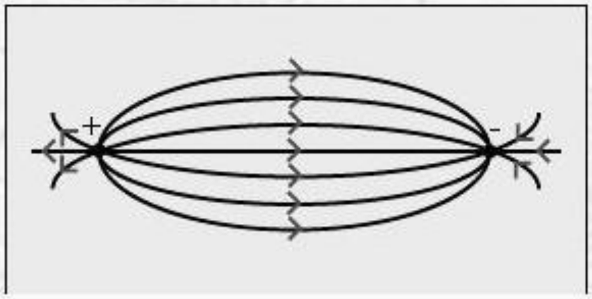
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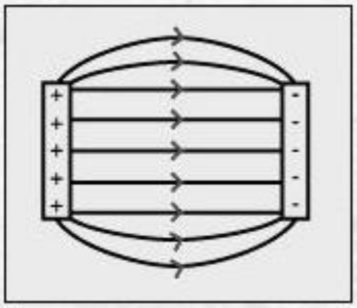
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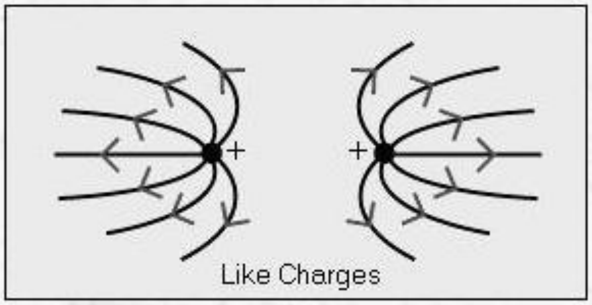
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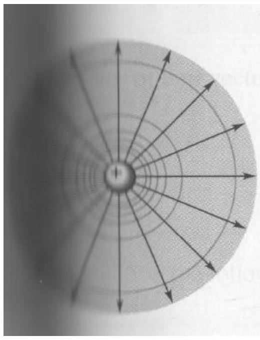
Like Charges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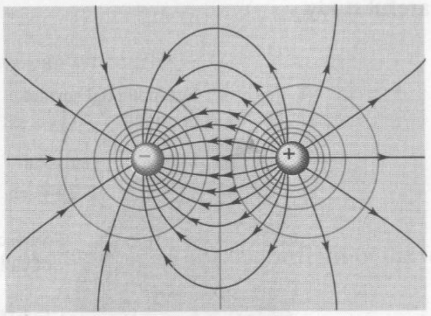
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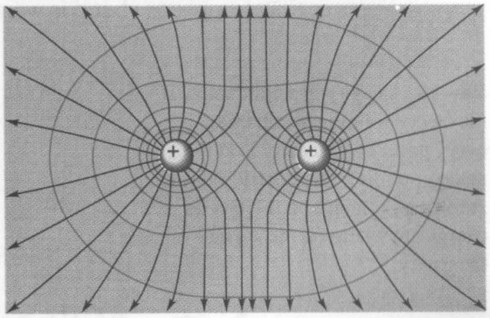
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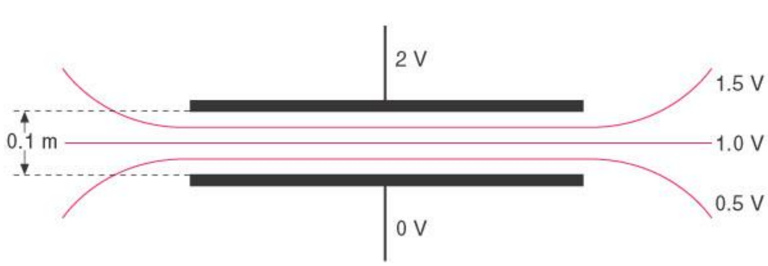
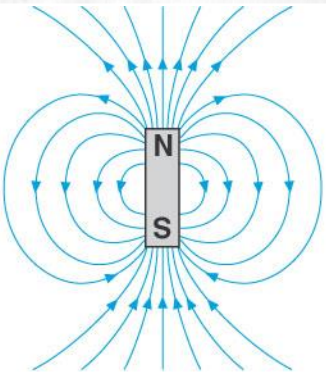
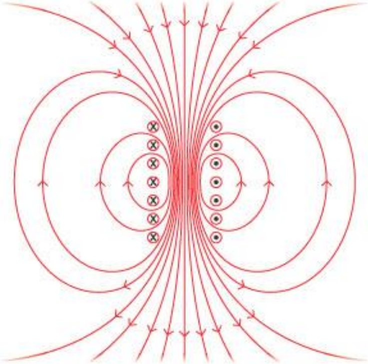
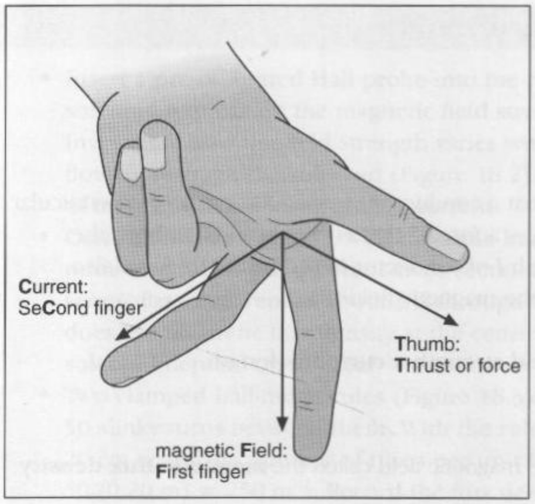
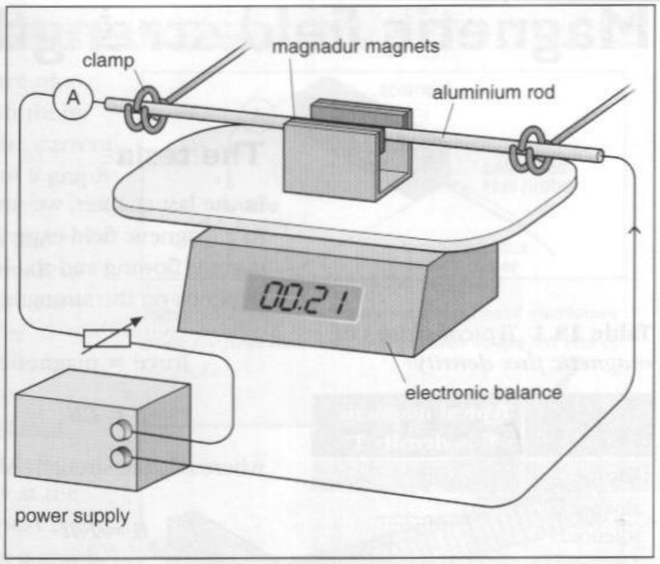

2 V
1.5 V
0.1 m
1.0 V
0.5 V
0 V


N
S

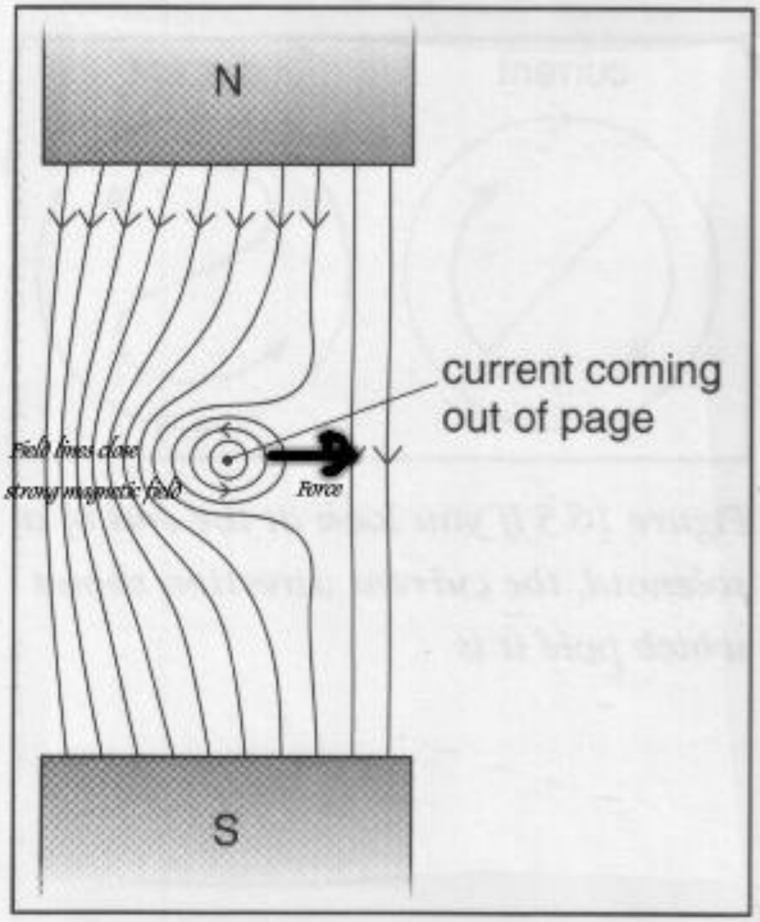




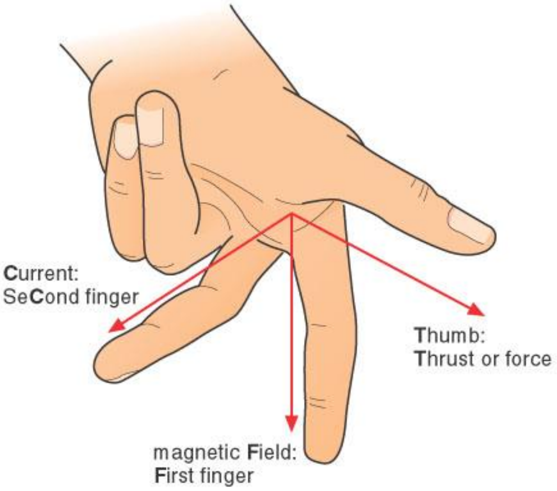
Fleming's left-hand rule: when the First finger points in the direction of the magnetic Field and the seCond finger points in the direction of the Current, the Thumb gives the direction of the Thrust (or force) on the conductor



The electronic balance measures the force produced by the interaction of the two magnetic fields



Resultant of uniform and circular magnetic fields



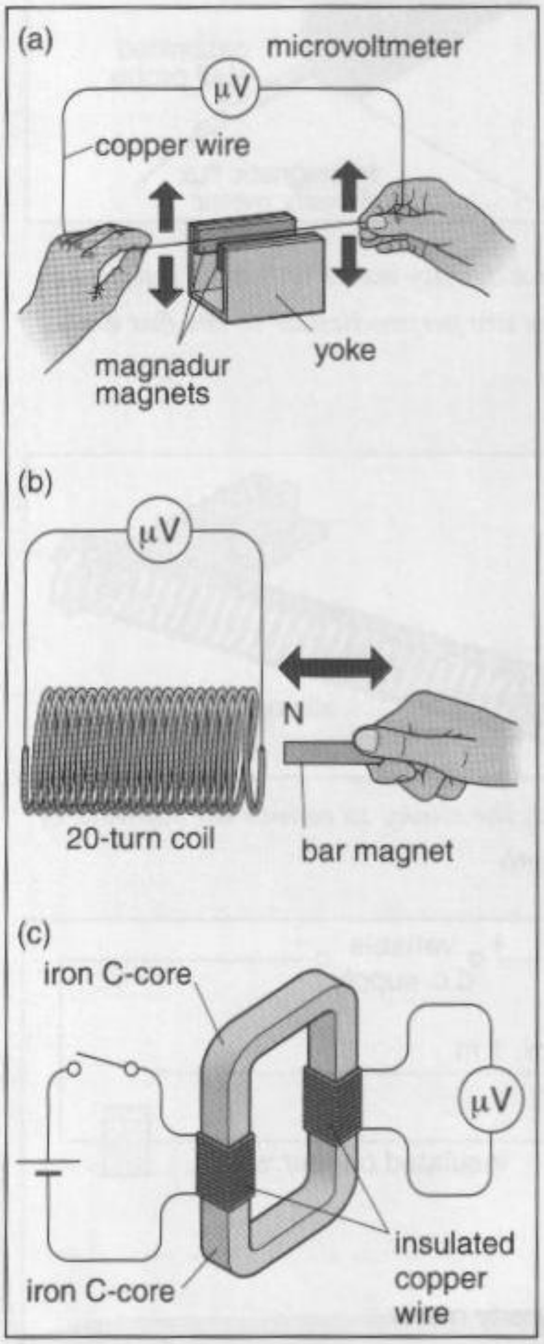


Figure 19.1 Moving conductors and magnetic fields

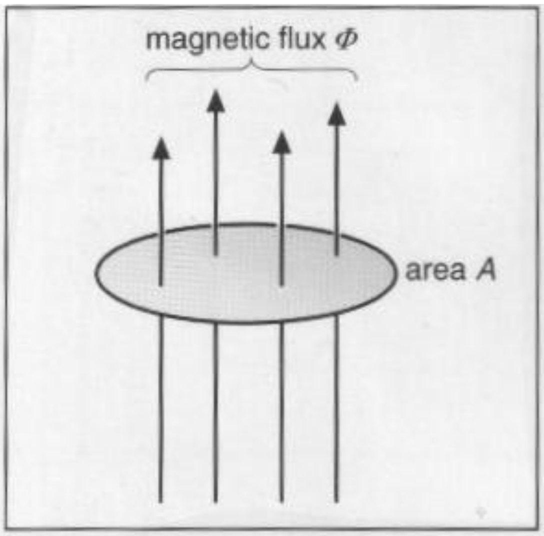


Figure 19.2 The flux density $B = \Phi/A$

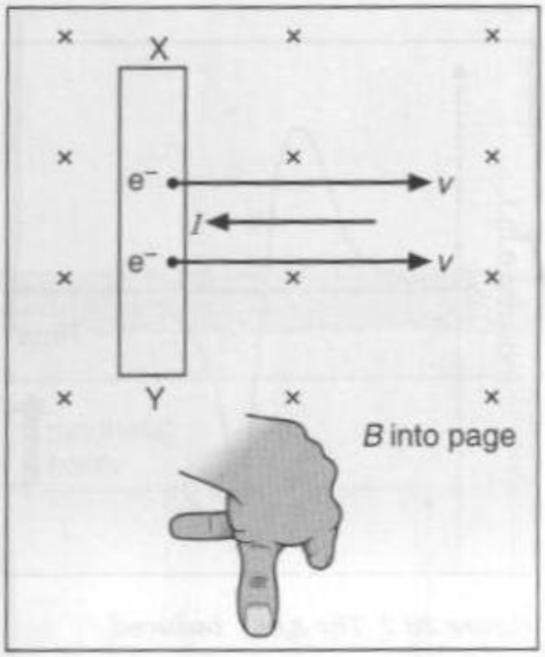
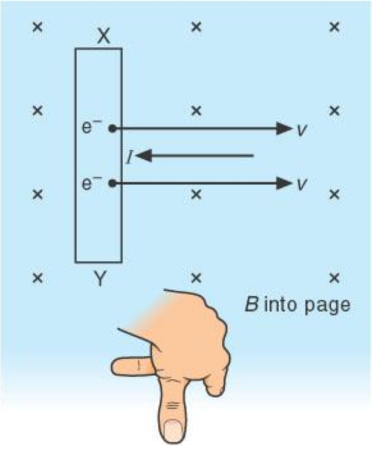
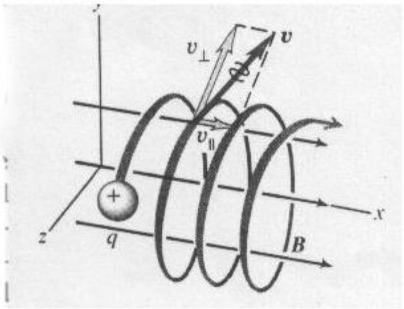
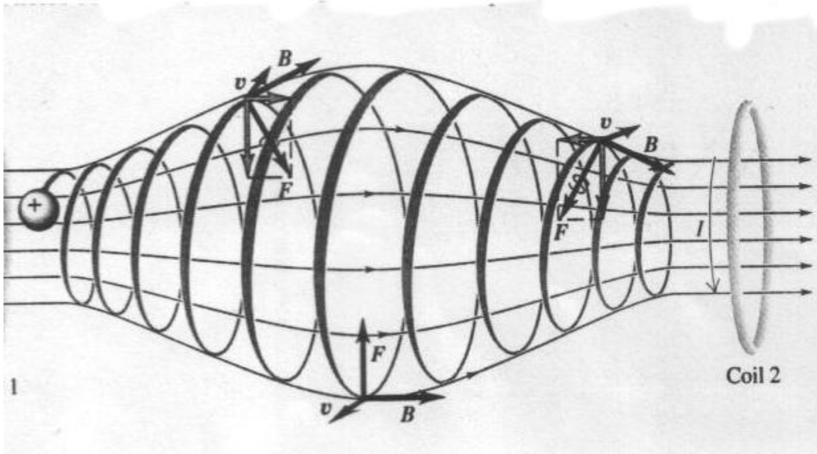


Figure 19.4 Apply Fleming's left-hand rule to the conduction electrons

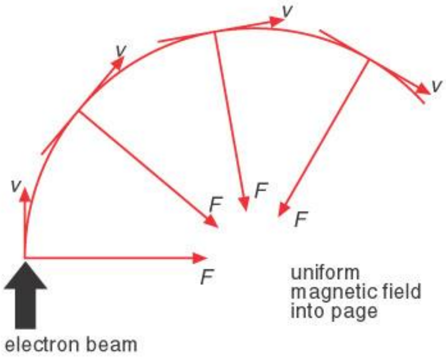


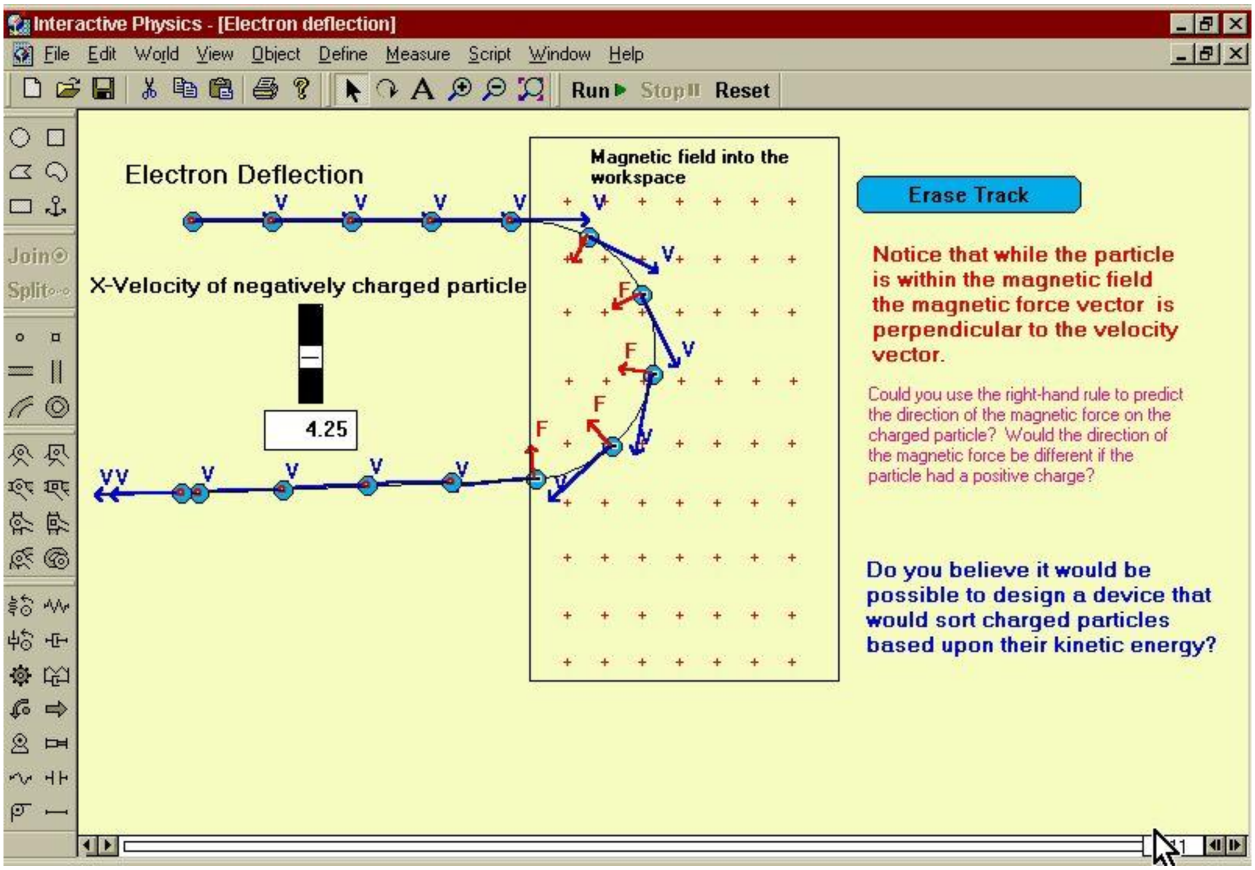


28–13 When a charged particle with constant kinetic energy has velocity components both perpendicular and parallel to a uniform magnetic field, the particle moves in a helical path.



28–14 A magnetic bottle: Particles near either end of the region experience a magnetic force toward the center of the region. This is one way of containing an ionized gas that has a temperature of the order of $10^6 K$, which would melt any material container.

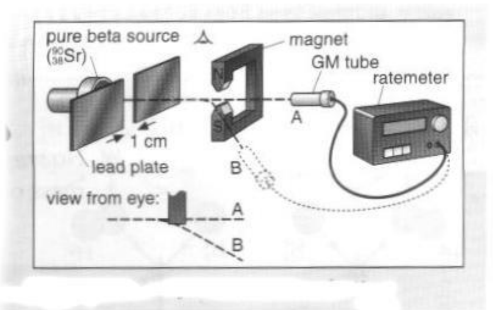


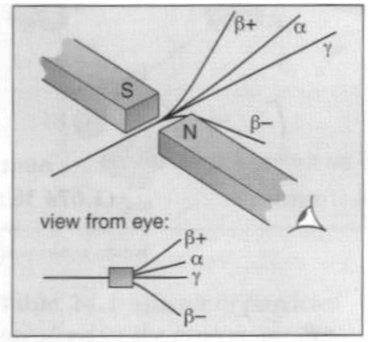


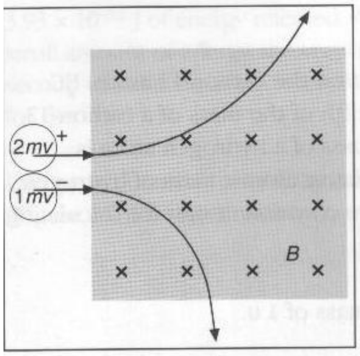
Notice that while the particle is within the magnetic field the magnetic force vector is perpendicular to the velocity vector.

Could you use the right-hand rule to predict the direction of the magnetic force on the charged particle? Would the direction of the magnetic force be different if the particle had a positive charge?

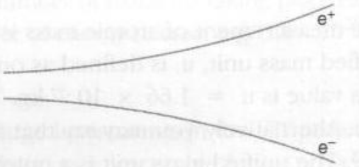
Do you believe it would be possible to design a device that would sort charged particles based upon their kinetic energy?



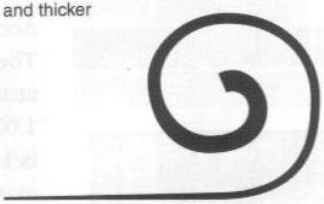




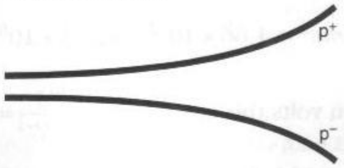
(a) Fast particles make a thin curved track



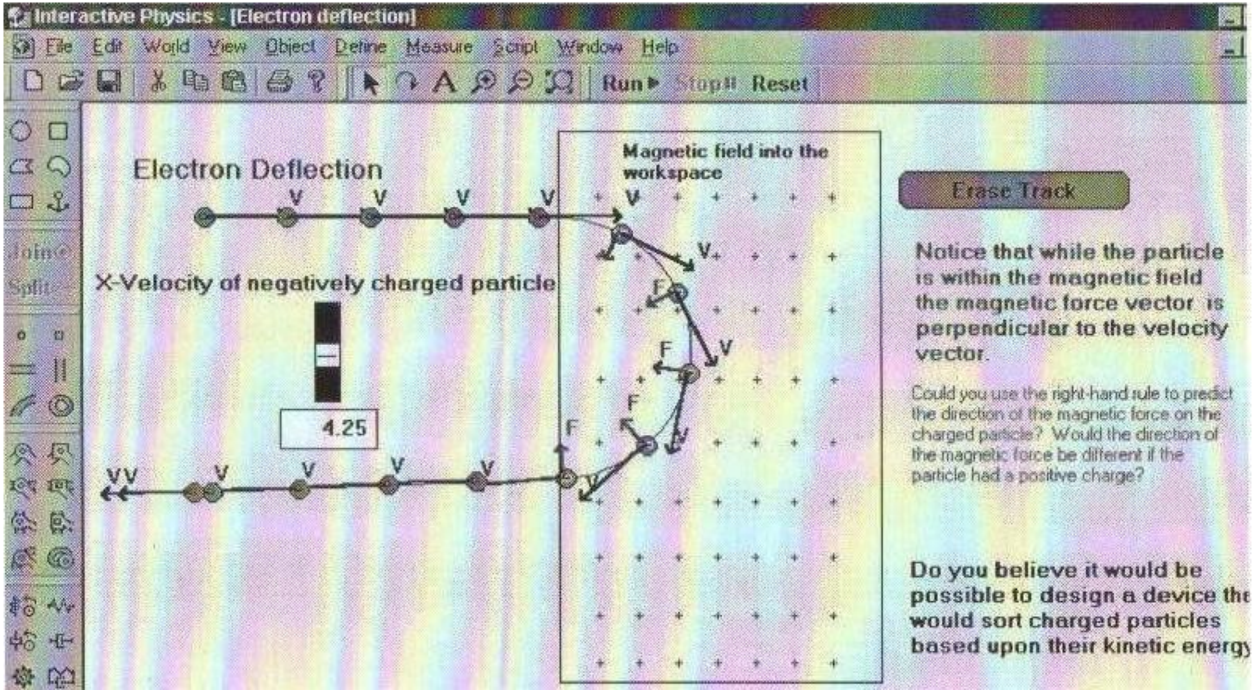
(c) Particles lose kinetic energy through ionising collisions, so track gets more curved and thicker



(b) Slow particles or massive particles cause more ionisation in a shorter distance and hence thicker tracks



(d) A decay into a charged particle and a massive neutral particle, which itself decays into two oppositely charged particles

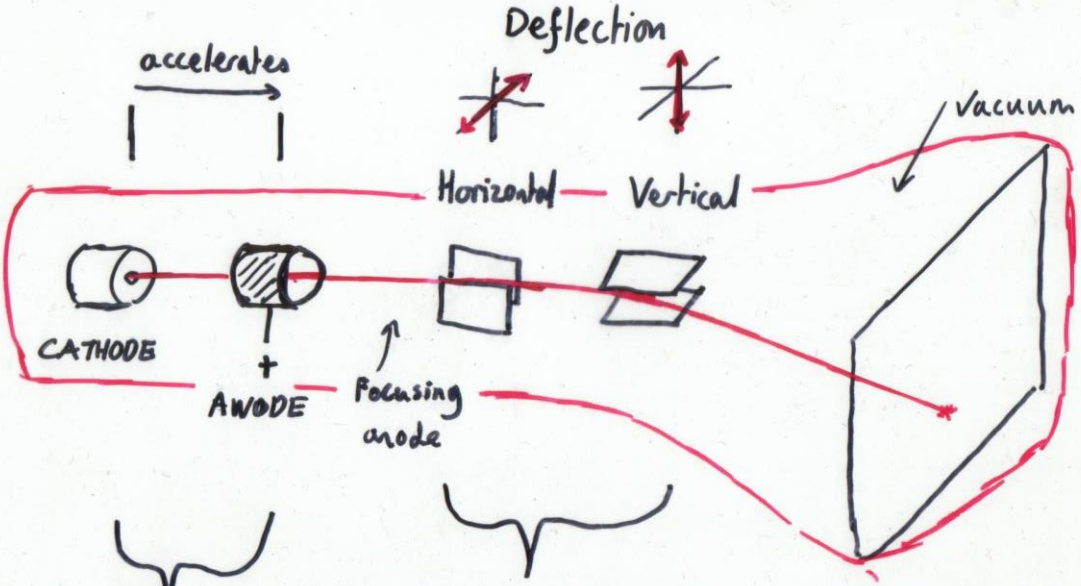


Notice that while the particle is within the magnetic field the magnetic force vector is perpendicular to the velocity vector.

Could you use the right-hand rule to predict the direction of the magnetic force on the charged particle? Would the direction of the magnetic force be different if the particle had a positive charge?

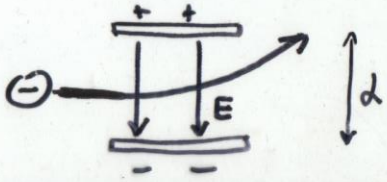
Do you believe it would be possible to design a device th
would sort charged particles
based upon their kinetic energ

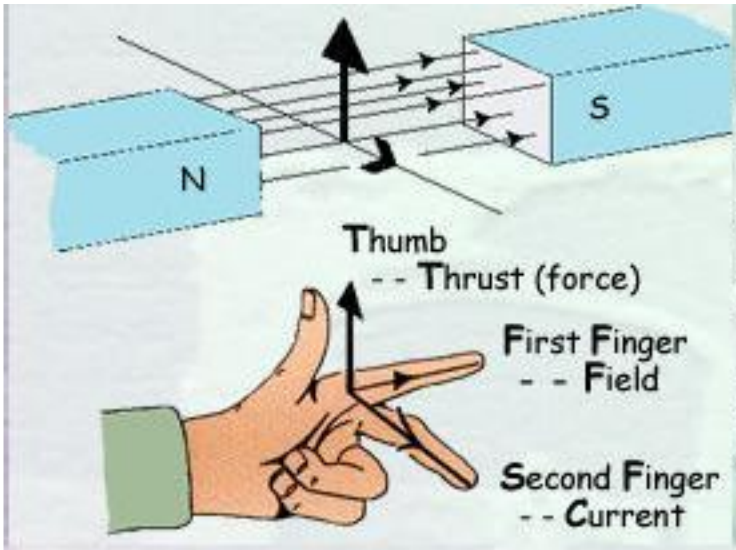
THE CATHODE RAY TUBE



$$eV = \frac{1}{2}mv^2$$

$$F = eE = e\frac{V}{d}$$

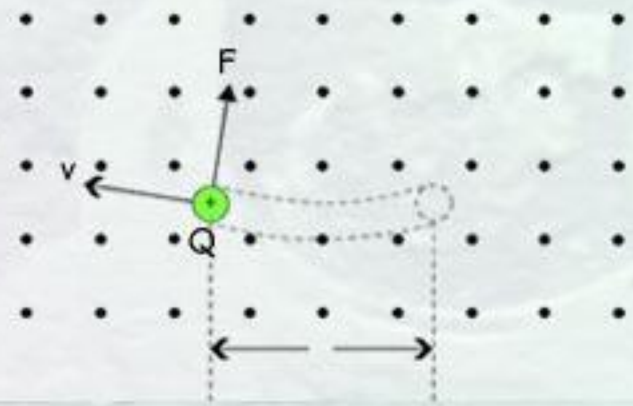




For a particle carrying a charge Q, through a uniform field of flux density B, at constant speed v, the force acting on the particle is given $F = BQv$ where B is perpendicular to v. The force direction is given by Flemings left hand rule.

For an oppositely charged particle the force direction is reversed, so would be downwards.

Uniform magnetic field directed out of the screen.



If an electron moves at $3 \times 10^7 ms^{-1}$ perpendicularly to a uniform magnetic field of flux density 0.5T, the force magnitude is

$$F = BQv$$
$$F = 0.5 \times 1.6 \times 10^{-19} \times 3 \times 10^7 = 2.4 \times 10^{-12} N$$

Because a conductor is not always part of a complete circuit, the induced current cannot always simply flow.

Instead the negative charge collects at one end of the conductor leaving the other end positively charged.

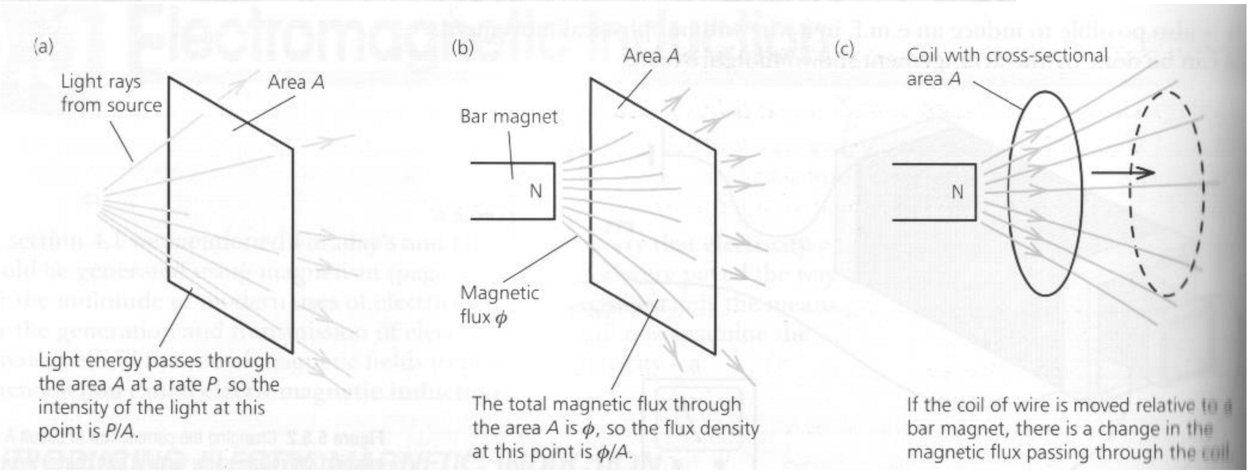
A potential difference has been established across the ends of the conductor making it a source of electrical energy.

We say that an emf has been induced.

movement +magnetism → *current*

current + magnetism → *movement*

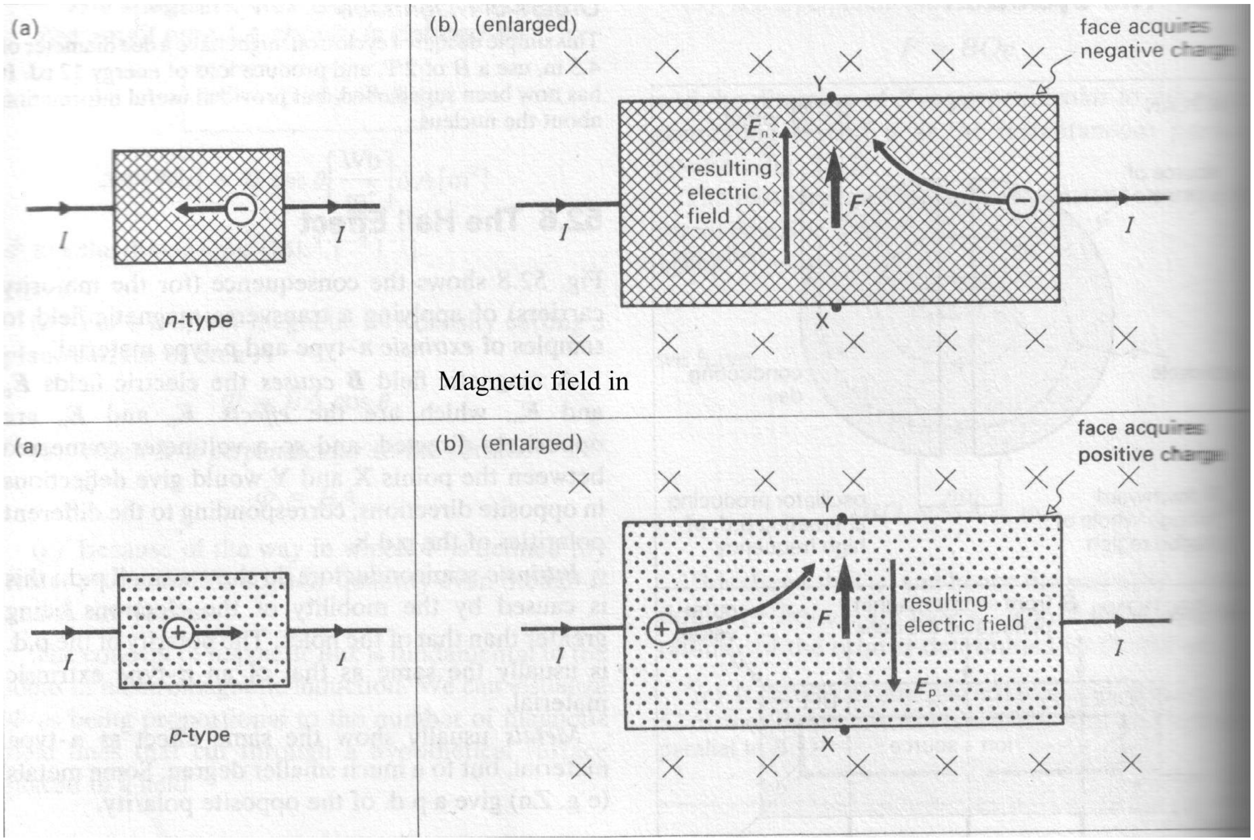
A current is induced when flux lines are cut by a moving conductor.

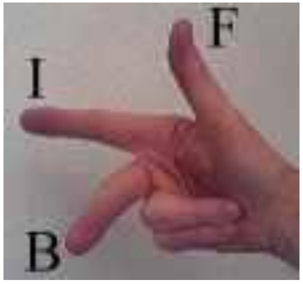


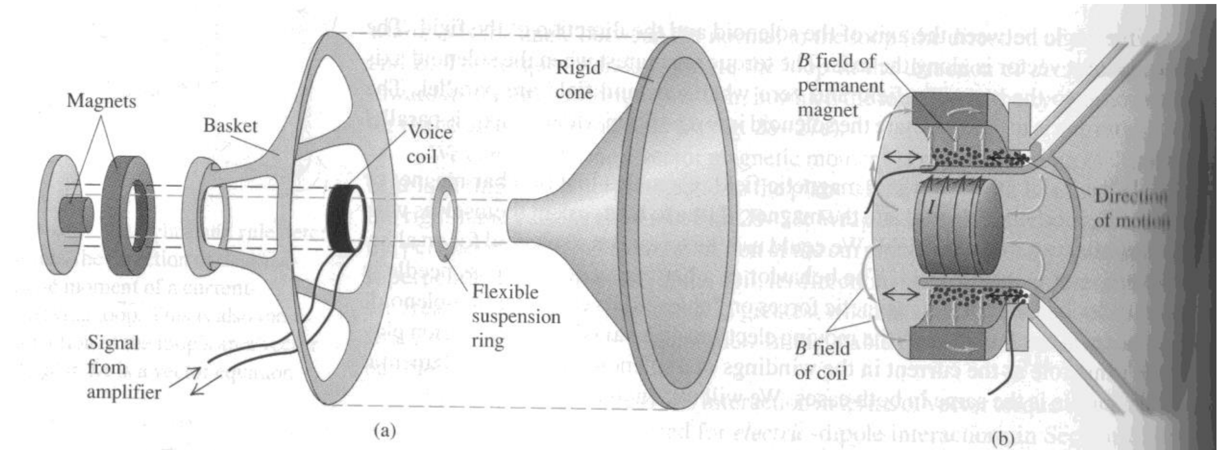
Light energy passes through the area *A* at a rate *P*, so the intensity of the light at this point is *P/A*.

The total magnetic flux through the area *A* is ϕ, so the flux density at this point is ϕ/A.

If the coil of wire is moved relative to a bar magnet, there is a change in the magnetic flux passing through the coil


(a)
(b) (enlarged)
face acquires negative charge
Y
E_n
resulting electric field
F
I
I
I
I
X
n-type
Magnetic field in
(a)
(b) (enlarged)
face acquires positive charge
Y
F
resulting electric field
E_p
I
I
I
I
X
p-type


I
F
B



28–32 (a) Components of a loudspeaker. (b) The permanent magnet creates a magnetic field that exerts axial forces on the current in the voice coil. The mechanical vibration of the speaker cone matches the electrical vibration of the current in the coil.

The d'Arsonval galvanometer, described in Section 27–3, makes use of a magnetic field torque on a coil carrying a current. As Fig. 27–10 shows, the magnetic field is uniform but is *radial,* so the side thrusts on the coil are always perpendicular to its Thus the magnetic-field torque is directly proportional to the current, no matter orientation of the coil. A restoring torque proportional to the angular displacement coil is provided by two hairsprings, which also serve as current leads to the coil.