Kræsjkurs i magnetisme

Start punkter

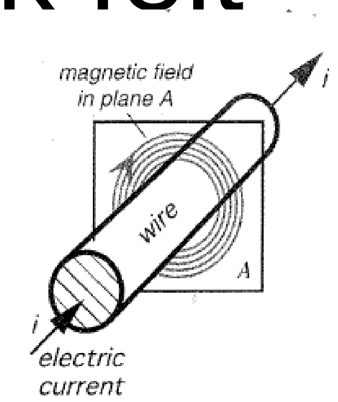
- Strømførende ledere og magneter lager magnetiske felt
- Ladede partikler i et magnetisk felt føler en kraft

Kan ”utlede”

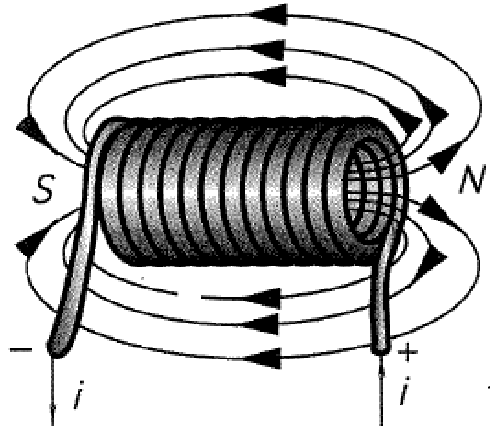
- Kraft på leder i felt
- Dreining av magnetisk dipol i felt
- Flukskonsentrasjon i ferromagnetiske medier
- Induksjon (emf)
- Transformator
- Selvinduktans

Magnetisk felt

- Genereres av strøm
- Regnes ut fra Amperes lov:
- Blir sterkt og homogent i en spole
- Synliggjøres med magnet eller jernfilspon

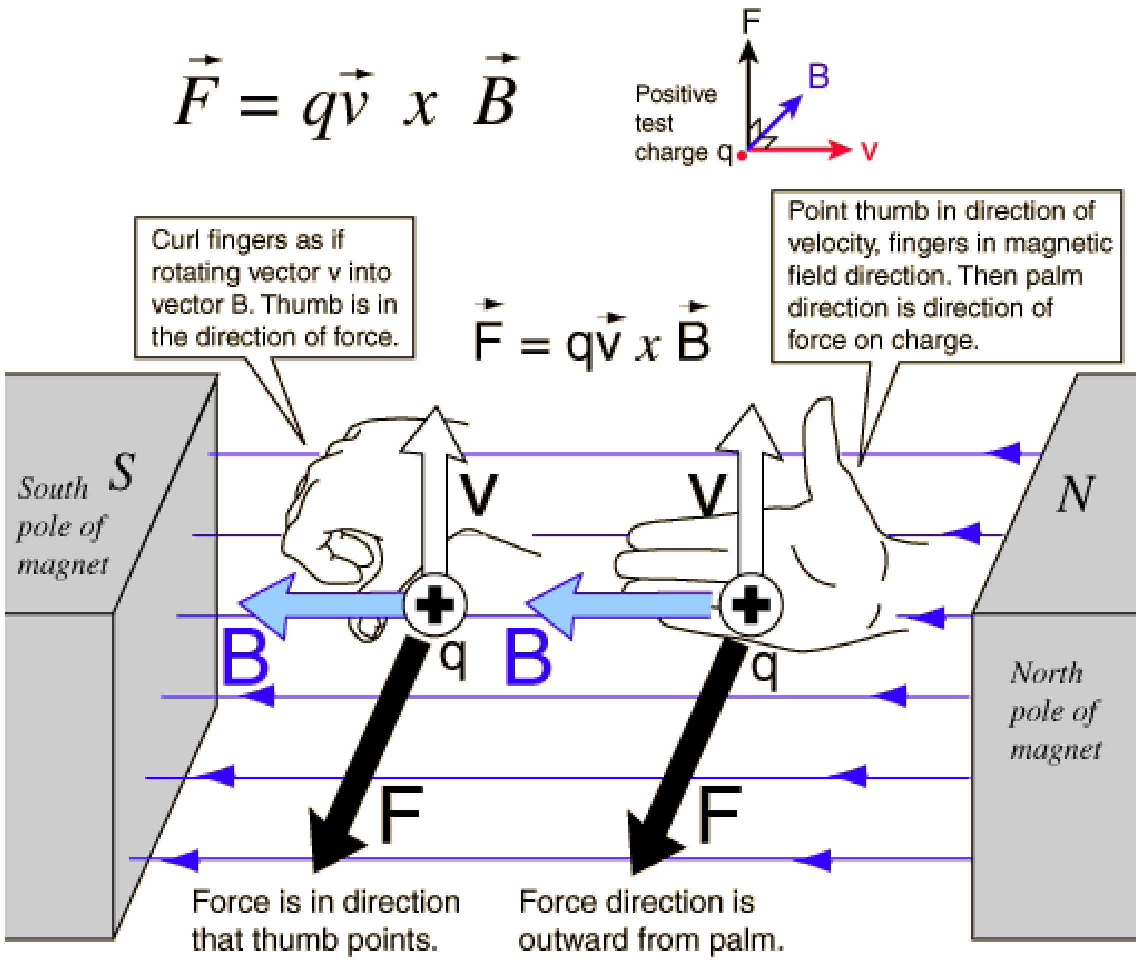


$$\oint \vec{B} \cdot d\vec{l} = \mu_0 i \quad \Rightarrow B = \frac{\mu_0 i}{2\pi r}$$



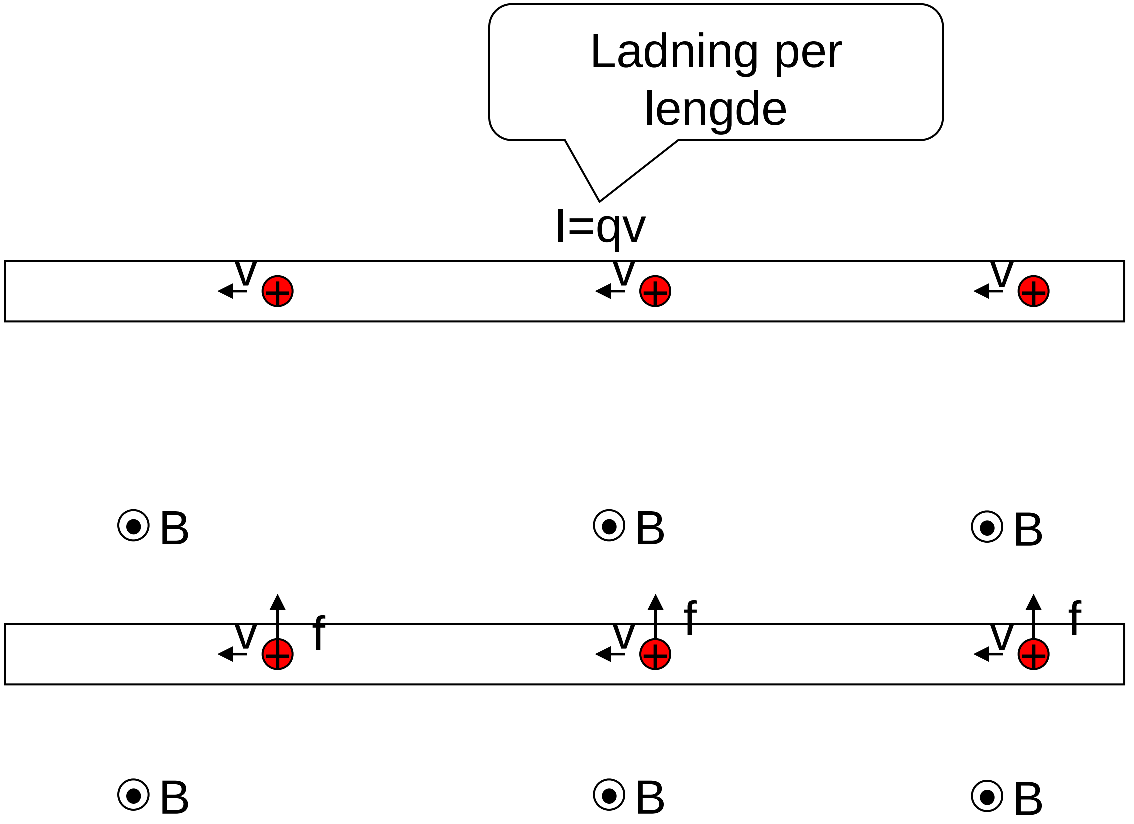
$$B = \mu_0 i n$$

Ladet partikkel i fart i magnetfelt



Hyperphysics

Strømførende leder

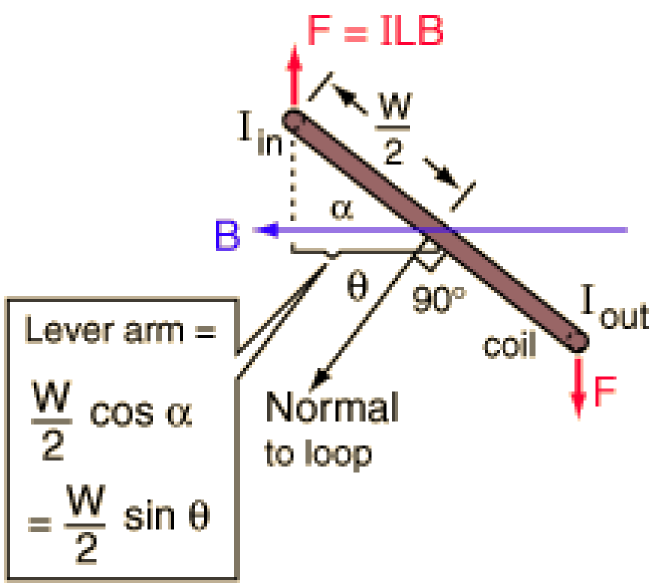


Kraft per lengdeenhet: $\vec{f} = q\vec{v} \times \vec{B}$

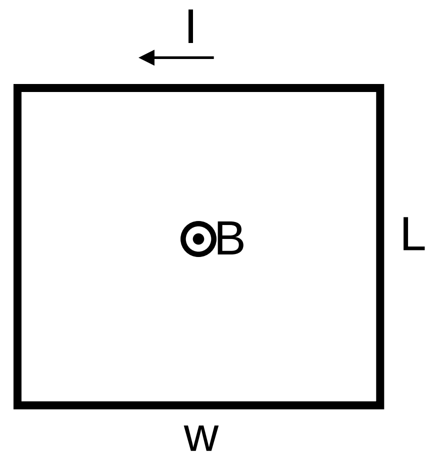
Total kraft: $\vec{F} = q\vec{v}L \times \vec{B} = i\vec{L} \times \vec{B}$

Magnetic dipole

Top view



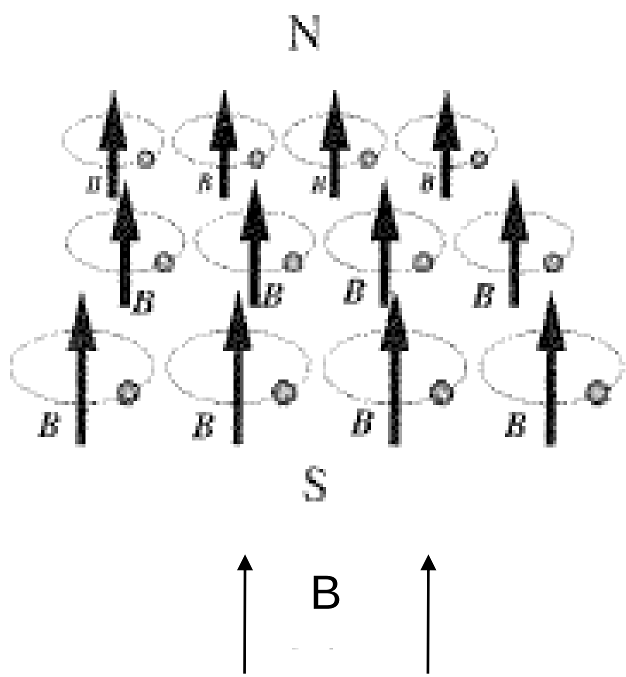
Front view:



= IA = IwL

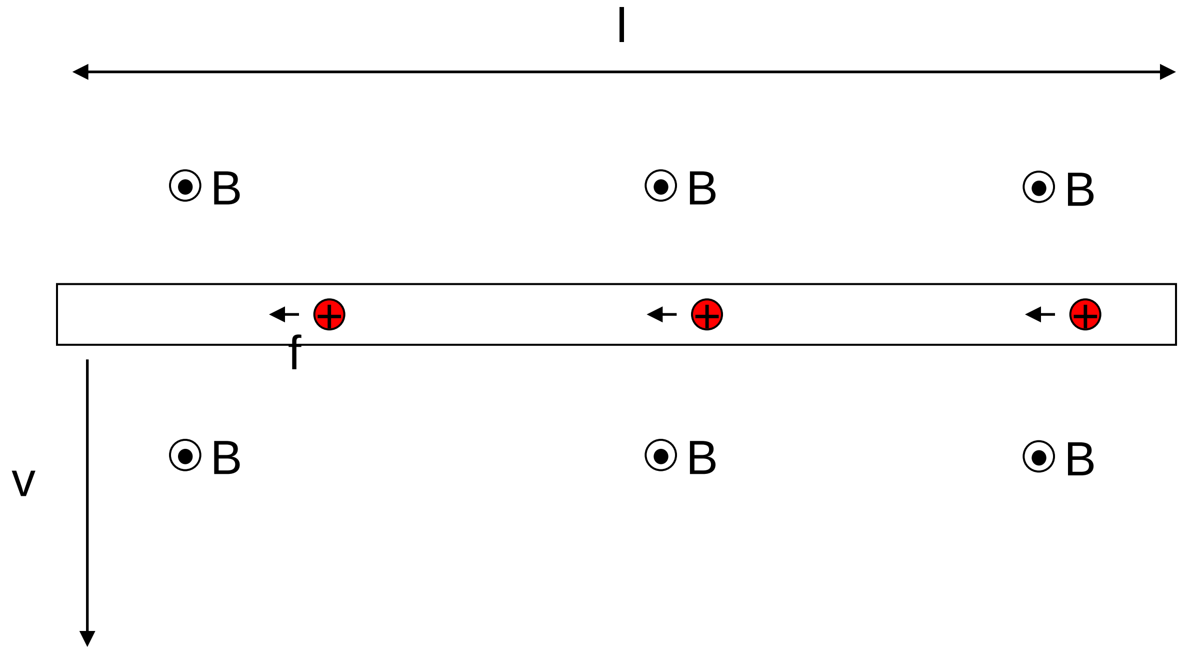
$$\tau = \mu \; x \; B$$

Feltforsterkning av dipoler



$$\oint \vec{B} \cdot d\vec{l} = \mu_r \mu_0 i$$

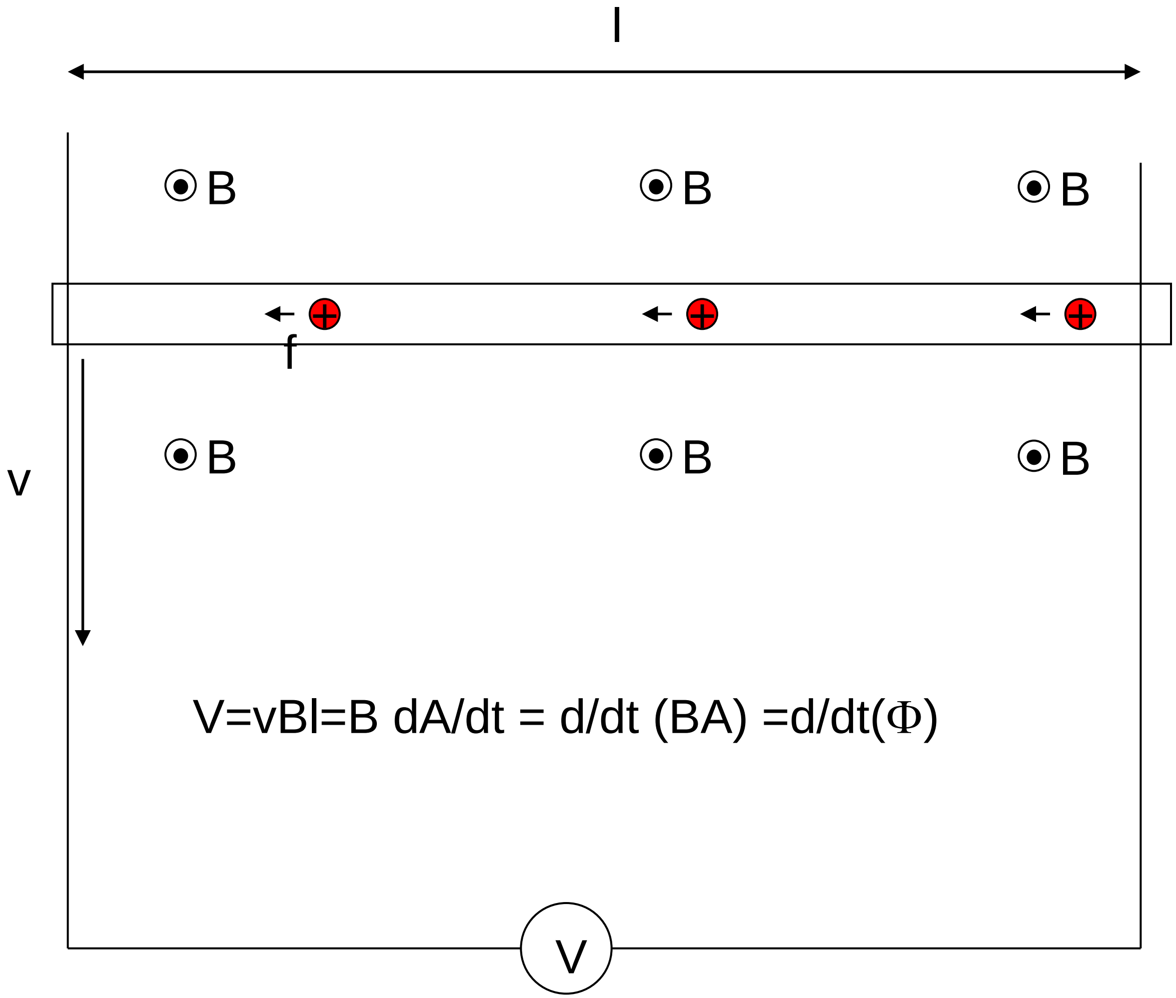
Kraft på ladninger i beveget leder



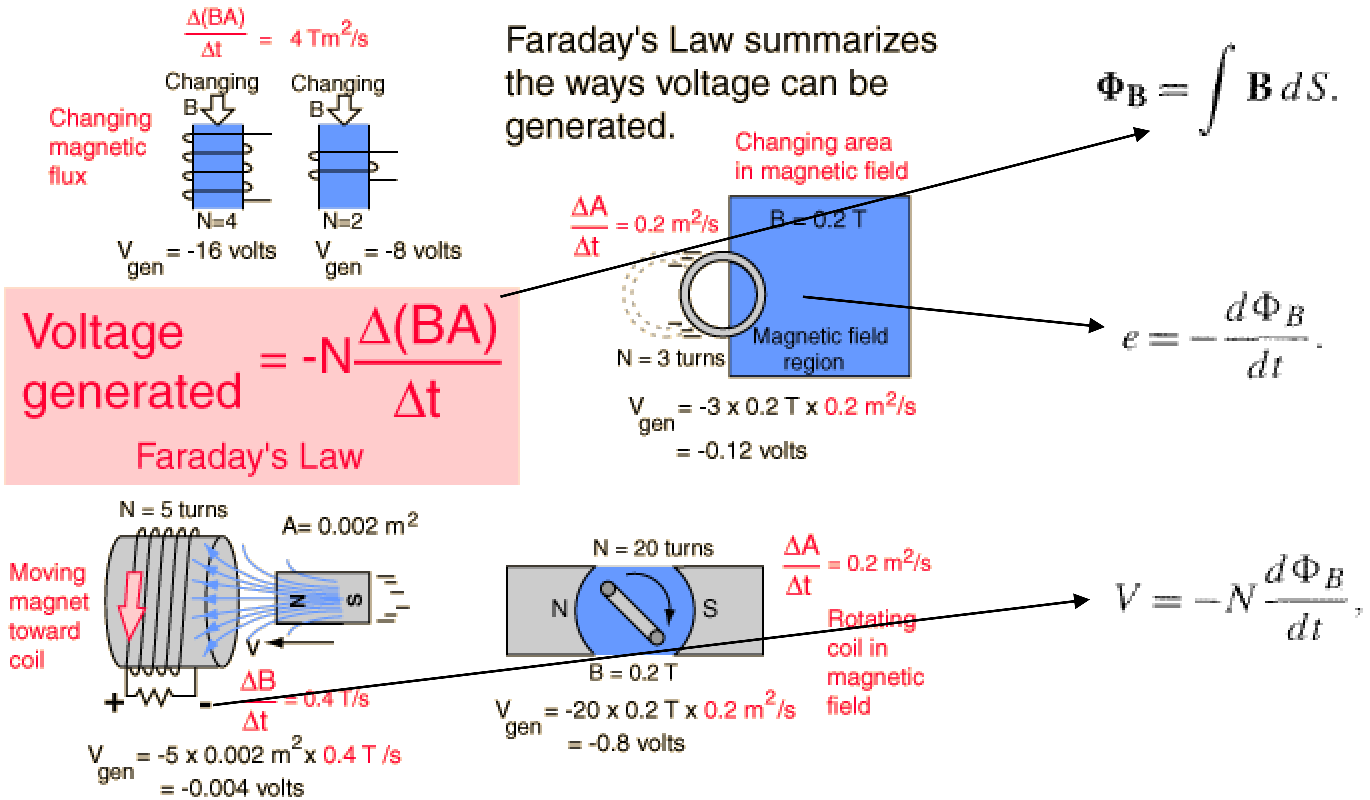
f=qvB

V=vBl

Kraft på ladninger i leder



Induction – Faradays law



Hyperphysics

Magnetic material behaviour

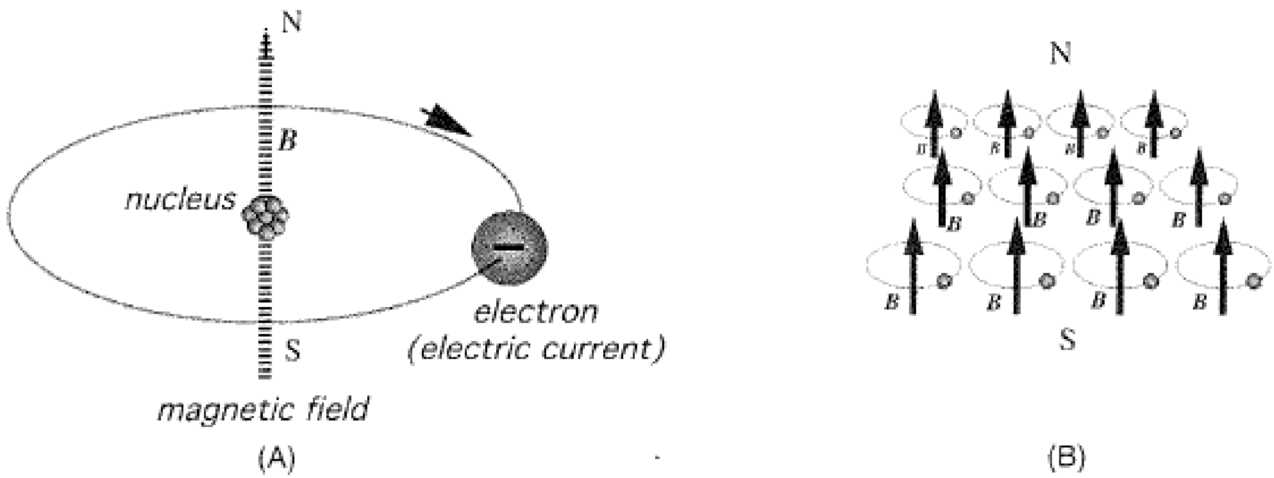
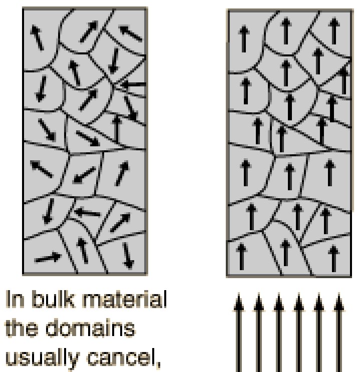


Fig. 3.12. Moving electron sets a magnetic field (A); superposition of field vectors results in a combined magnetic field of a magnet (B).



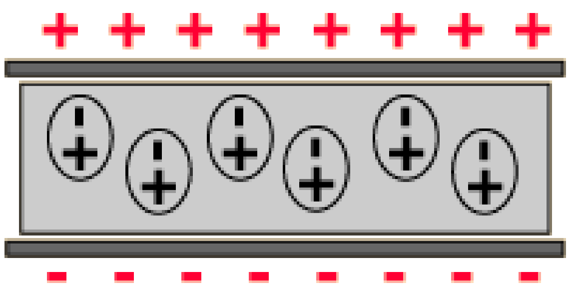
In bulk material the domains usually cancel, leaving the material unmagnetized.

Externally applied magnetic field.

NB! Usually adds to the magnetic field!

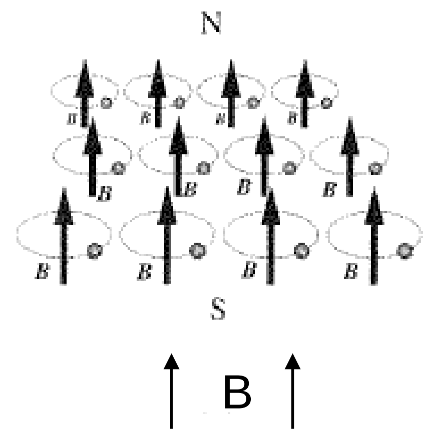
Simple dipole effect

Electric:



Reduced field

Magnetic:



Increased field

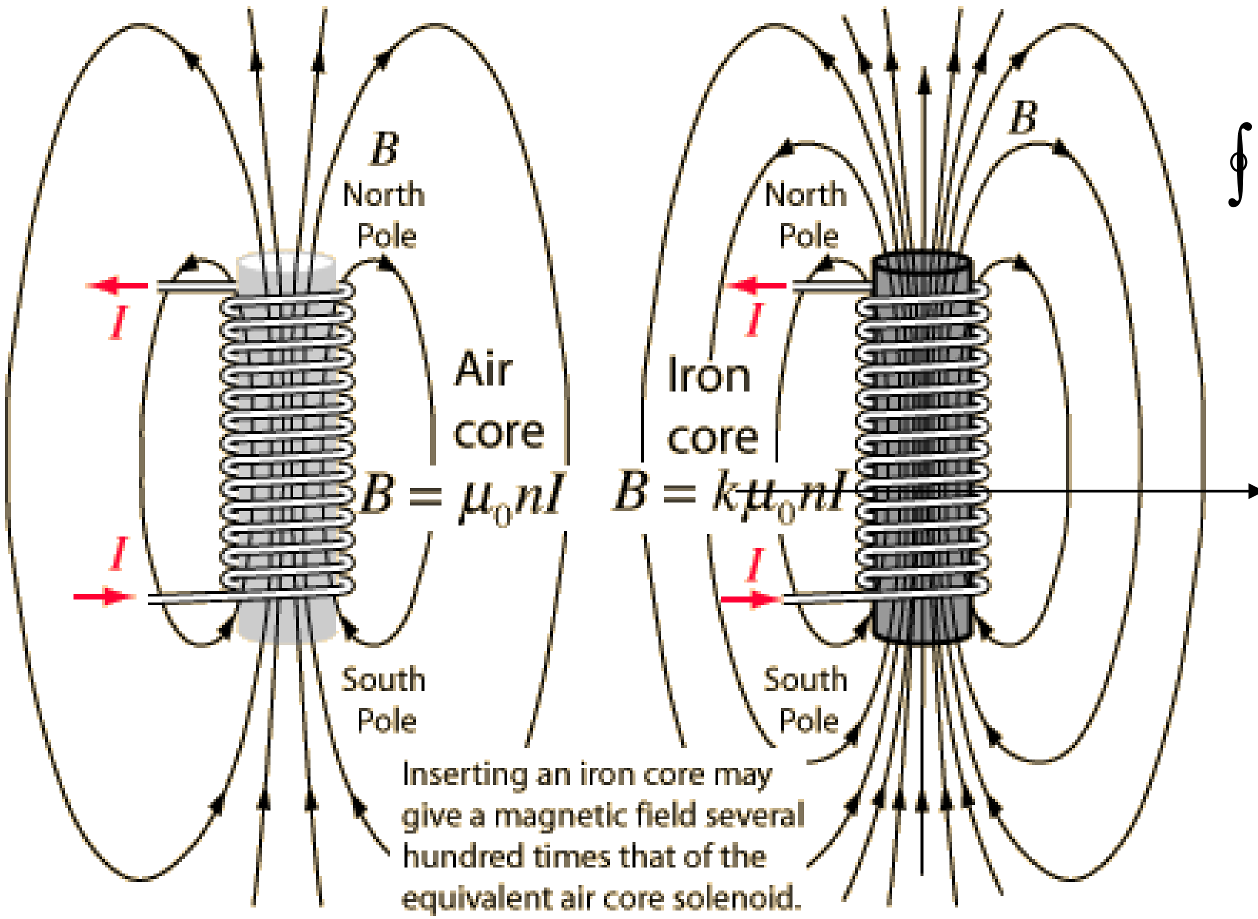
$$\oint_S \vec{E} \cdot d\vec{S} = \frac{q}{\varepsilon_r \varepsilon_0}$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_r \mu_0 i$$

Linear for most field strengths and materials

Often negligible (μ_r=1) or highly nonlinear

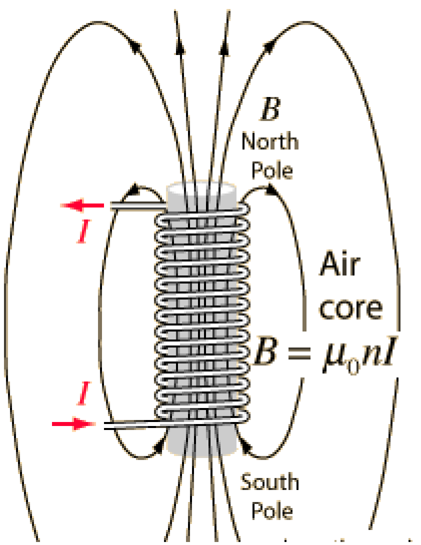
Field amplification



$$\oint \vec{B} \cdot d\vec{l} = \mu_r \mu_0 i$$

$$k = \mu_r$$

(self) inductance



$$v = -\frac{d(n\Phi_B)}{dt}.$$

$$n\Phi_B = Li,$$

$$v = -\frac{d(n\Phi_B)}{dt} = -L\frac{di}{dt}.$$

Transformers

$$v_2 = -M_{21} \frac{di_1}{dt},$$

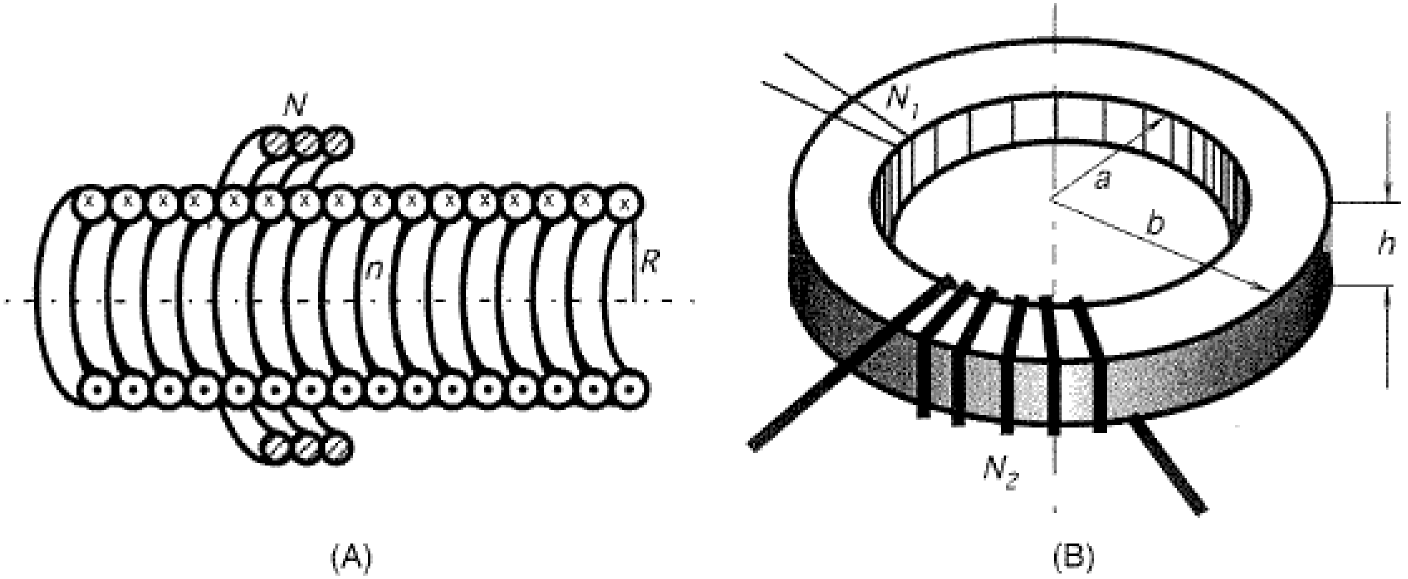


Fig. 3.15. Mutual inductances in solenoids (A) and in a toroid (B).

Linear variable differential transformer

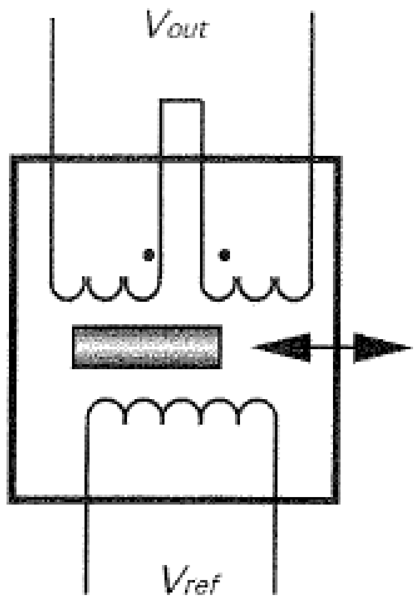
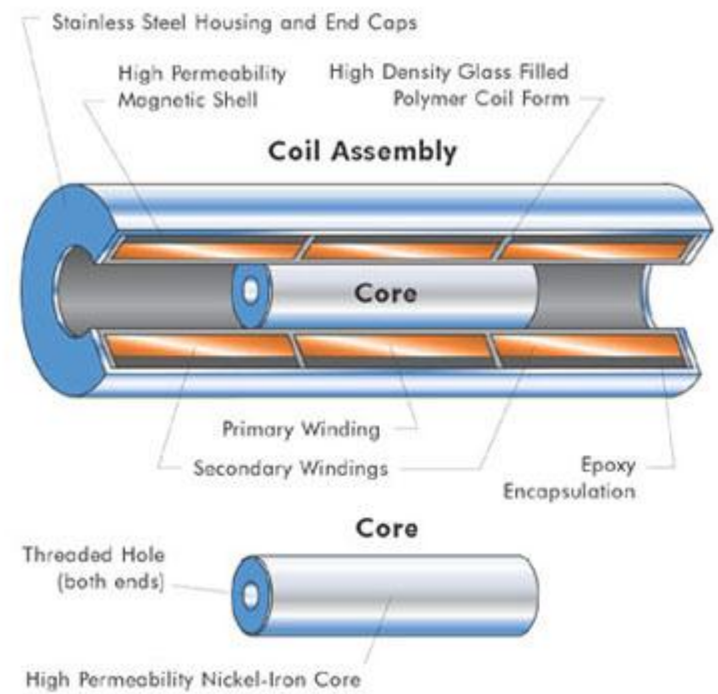


Fig. 7.9.



http://www.macrosensors.com/lvdt_macro_sensors/lvdt_tutorial/index.html

LVDT eksempler

Performance

Stroke Range	+/- 0.5 to 8.0 in.
Non-Linearity (max.)	+/- 0.25% Full Scale
Output Load (min.)	2,000 Ohms
Output Impedance	2 Ohms
Output Sensitivity	+/- 2 VDC (nominal)
Isolation	1,000 V input to output
Polarity	Output positive for outward stroke

Environmental

Temperature, Operating	-58° to 158°F
Temperature, Effect	
Zero (max.)	0.006% Full Scale/°F
Span (max.)	0.017% Full Scale/°F

Electrical

Element Type	DC-DC LVDT
Input Supply (acceptable)	
Regulated	5 VDC @ 100 mA max.
Unregulated	+6 V to +18 VDC @ 100 mA max.
Ripple	30 mV peak to peak
Electrical Termination	Multiconductor Shielded Cable (6 ft.)
Reverse Polarity Protection	Yes

Mechanical

Case Material	Stainless Steel
Probe Material	Stainless Steel
Armature Type	Free Unguided
Probe Thread	M5 x 0.8
Weight	See Above Table
Spring Force (max.)	Not Applicable

http://www.sensotec.com/lvdt.asp