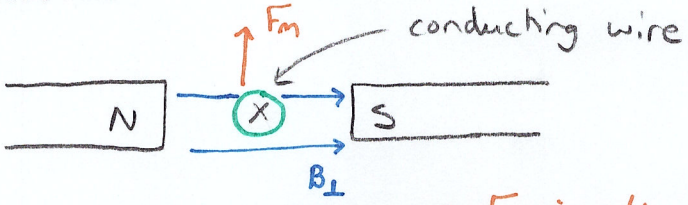
Conductors in Magnetic Fields

- A conducting wire with a current running through it will experience a magnetic force when placed perpendicularly inside a magnetic field, just as a charged particle will experience a force when moving perpendicular through an external magnetic field
  - 3rd Left Hand Rule applies because you still have moving charges in a magnetic field

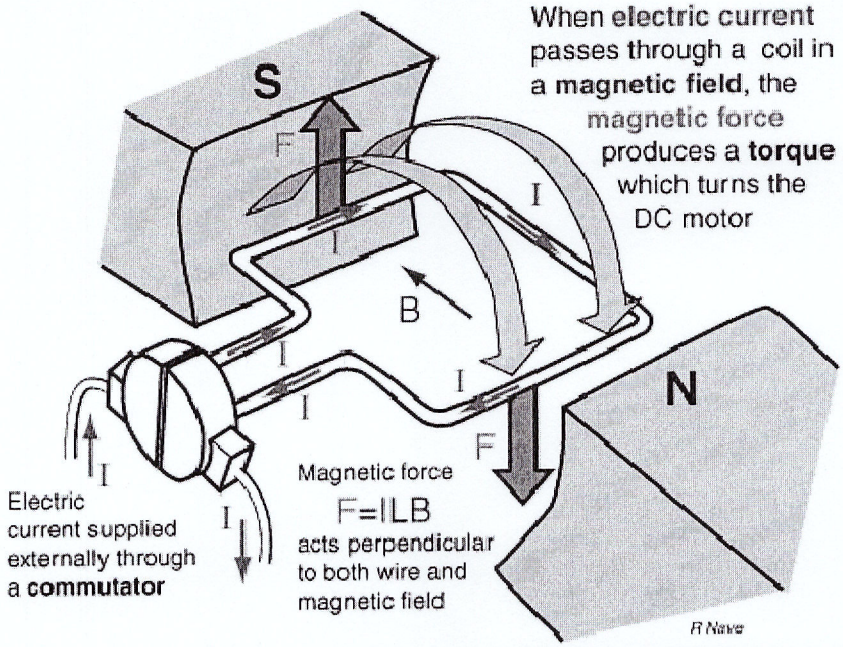


∴ Fm is directed north!

- The magnetic force acting on a conductor can be calculated by using the equation $F_m = Il_\perp B$

  where F_m is magnetic force acting on the conductor/wire (N)
  I is the current in the conductor/wire (A)
  $l_\perp$ is the length of the conductor/wire *in and perpendicular* to the magnetic field (m)
  B is the magnetic field strength (T)

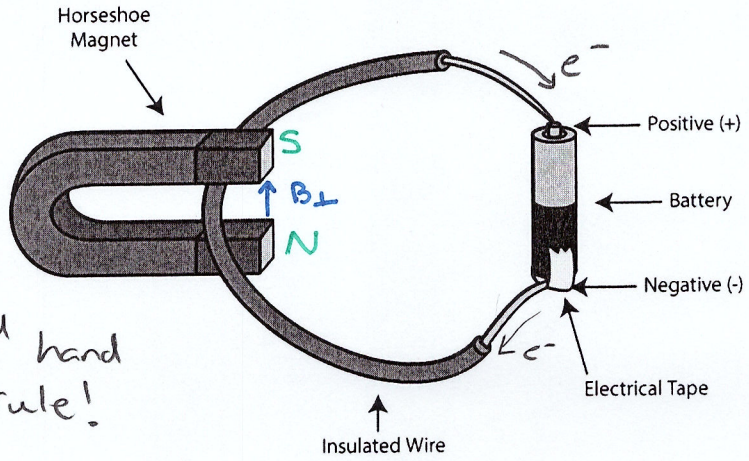
- An important application of this is seen in the design of an electric motor



This picture is using a ***conventional current!*** ∴ use right hand!

EXAMPLES:

1. If the conducting wire is deflected towards the back of the u-shaped magnetic, determine the polarity of the magnet.



use 3rd hand rule!

2. A 0.120 m long copper wire has a mass of 9.02g and is carrying a current of 5.10A perpendicular to a uniform magnetic field. This apparatus is placed in a strong magnetic field and the wire is found to levitate. Calculate the magnitude of the magnetic field strength.

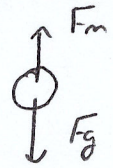
↳ $F_{net} = 0.0_N$

$m = 9.02g \times \left(\frac{1kg}{10^3 g}\right)$

$m = 9.02 \times 10^{-3} g$

$l_\perp = 0.120 m$

$I = 5.10 A$



$\cancel{F_{net}}^{0.0_N} = F_m + (-F_g)$

$F_g = F_m$

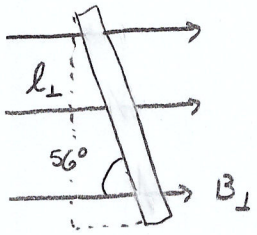
$mg = I l B_\perp$

$B_\perp = \frac{mg}{Il} = \frac{(9.02 \times 10^{-3} g)(9.81 m/s^2)}{(5.10 A)(0.120 m)}$

$B_\perp = 0.14459\ldots T$

$\boxed{B_\perp = 0.145 T}$

3. A piece of wire with a length of 1.44m has a current of 2.78A running through it. If the wire is placed 56° to the magnetic field with a strength of 5.00T, what is the magnitude of force experienced by the wire?



$\ell_\perp = \sin(56°)(1.44m)$

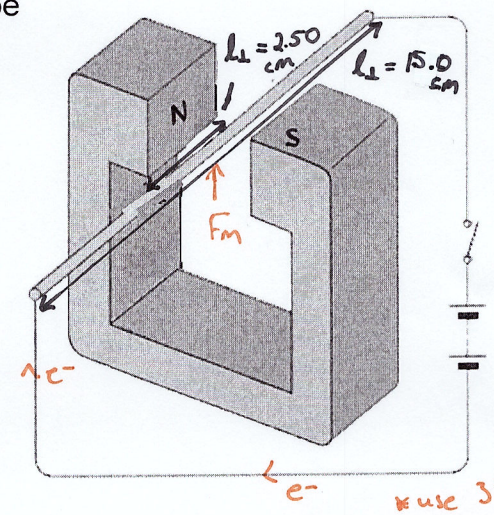
$\ell_\perp = 1.193\ldots m$

$\therefore F_m = I\ell B_\perp = (2.78A)(1.193\ldots m)(5.00T)$

$F_m = 16.5827\ N$

$\boxed{F_m = 16.6\ N}$

4. The magnetic field strength between the horse shoe magnet is 0.335 T. What is the magnetic force acting on the conducting wire when a current of 2.65A is running through the wire?



$B_\perp = 0.335\ T$

$F_m = ?$

$I = 2.65\ A$

$\ell = 2.50cm \times \left(\frac{10^{-2}m}{1cm}\right)$

$\ell_\perp = 0.025\ m$ * don't use 15.0cm!

$F_m = I\ell B_\perp = (2.65A)(0.025m)(0.335T) = 0.02219\ldots N$

$\boxed{F_m = 0.0222N,\ north}$

*****Now try pg. 163 #1-3, 5-6, 9 (acceptable), 11, 13, 17, 18 (intermediate)*****