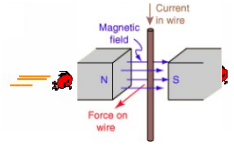
Motors (Flemings Left Hand Rule)

Definitions

Magnetic fields exert forces can be used to induce movement in a wire (the motor effect).



$F = BIL$

The direction of this force may be worked out by use of Flemings left hand rule.

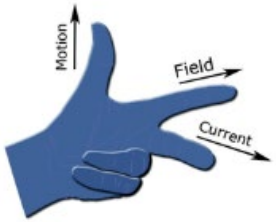
Magnetic fields exert forces on individual moving charges to cause them to deflect.

$F = Bqv$

When deciding on the deflection for a charged particle, Flemings left hand rule is used but, in this case, the second finger determines the direction a positive charge would be deflected.

Equations

$F = BIL$	Force	F	N
	Magnetic Field Strength	B	T
	Current	I	A
	Length	L	m
$F = Bqv$	Force	F	N
	Magnetic Field Strength	B	T
	Charge	q	C
	Velocity	v	m s^{-1}
$V = IR$	Voltage	V	V
	Current	I	A
	Resistance	R	Ω



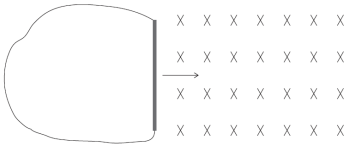
Questions

Electromagnetism (2014;4)

A proton of charge +1.6 × 10^{-19} C moves at right angles across a magnetic field of strength 0.65 T. The constant speed of the proton (in the magnetic field) is 4.8 × 10^{3} m s^{-1}.

(a) Calculate the size of the magnetic force on the proton while it is in the field.

A piece of conducting rod whose ends are connected by a wire as shown, is moved through a magnetic field that is directed into the page. The direction in which the rod is moved is indicated by an arrow.



(b) On the diagram draw an arrow to show the direction of the induced current (conventional current) around the loop formed by the rod and wire.

(c) Explain why there will be an induced current in the rod and wire due to movement of the rod across the magnetic field.

Terms

Tips

- Don't be afraid to draw a hand to help explain Flemings left-hand rule.
- Flemings left-hand rule (at this level) explains interactions at right angles ("perpendicular") to each other of 3 things – you should be able to narrow down a prediction of one to a 50-50 chance (and if needs be you should guess)
- You may have to use Ohm's law and F = B I L if you are given the voltage and not the current
- There is more than one way to explain this - we have chosen not to discuss the slap rules (but your teacher may have done)

Answers

(a) $F = B\,q\,v = 0.65 \times 1.6 \times 10^{-19} \times 4.8 \times 10^{3} = = 4.992 \times 10^{-16}$ N

(b) Conventional current will be anticlockwise (up the rod).

(c) The magnetic force on the electrons causes charge separation.
Charge separation results in the formation of an electric field.
This results in an induced voltage across the ends of the wire.
Since it is a complete circuit, there will be a current.