Physics 30 Unit B - Forces and Fields

Electric Current

"I love...lamp..."

Diploma Question Alert!

16. A proton and an alpha particle have identical circular orbits in a magnetic field. The proton has a speed of 4.4×10^5 m/s. The speed of the alpha particle is

A. 1.1×10^5 m/s

B. 2.2×10^5 m/s

C. 4.4×10^5 m/s

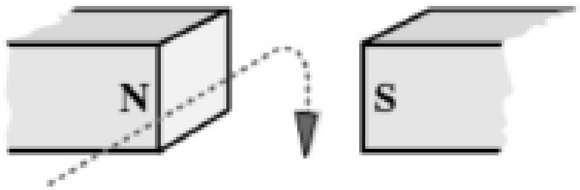
D. 8.8×10^5 m/s

Diploma Question Alert!

22. The path followed by a moving proton in an external magnetic field is shown in

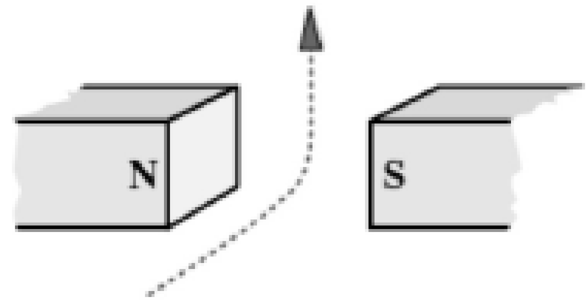
A.

vertically down



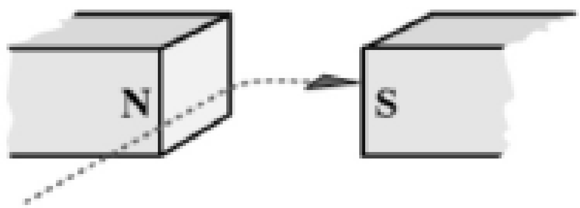
B.

vertically up



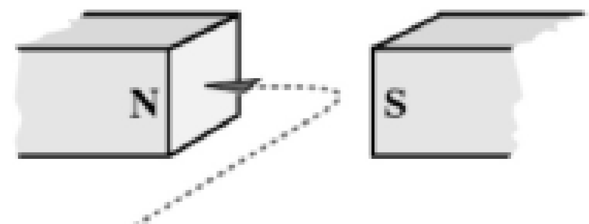
C.

horizontally right



D.

horizontally left



Diploma Question Alert!

24. The magnitude of the magnetic force exerted on a charged particle in a magnetic field will be doubled by doubling **any one** of

A. the charge of the particle, or the speed of the particle, or the mass of the particle

B. the magnitude of the field or the angle of entry of the particle

C. the speed of the particle, or the mass of the particle, or the magnitude of the field

D. the charge of the particle, or the speed of the particle, or the magnitude of the field

Diploma Question Alert!

25. One $\dfrac{N \cdot C \cdot m}{A \cdot m \cdot s}$ is the same as

A. 1 A

B. 1 N

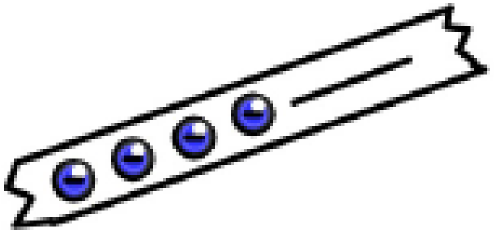
C. 1 C

D. 1 J

Electric Current

- the rate of flow of electrical charge

ex) the flow of electrons through conducting wire



ex) the flow of electrons through electronic devices

Current Defined Mathematically:

$$I = \frac{q}{t}$$

where: I = current (C/s)
q = charge (C)
t = time (s)

- the rate of flow of electrical charge

*Notice this is the same concept as the definition of velocity, acceleration, momentum, power, etc.

Units of Current:

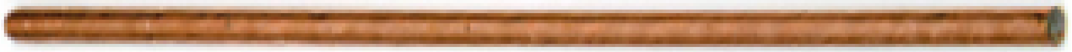
C/s = A

The units of current are defined as coulombs per second (C/s) or amperes, named after the 19th century physicist Andre-Marie Ampere, who is one of the first people (along with Orsted) to link electricity and magnetism.

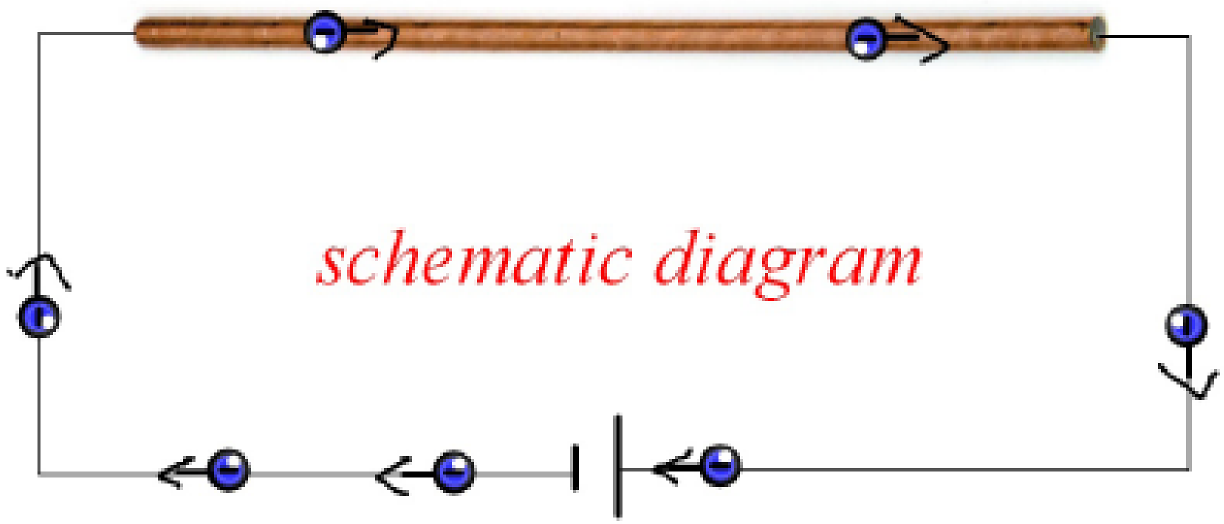
(amperes are usually just called "amps")

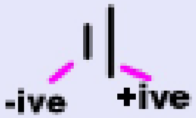
A current thought-thing:

Imagine a copper rod. How do we create a current in it?



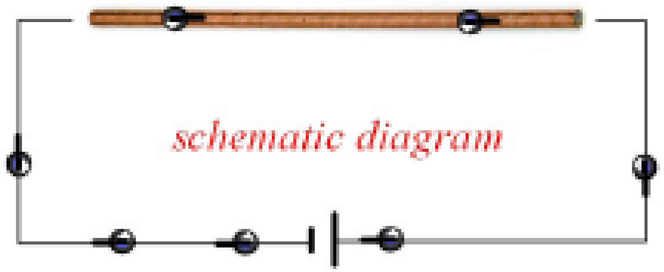
Answer: we introduce energy, or <u>potential difference</u>:





recall the symbol for a cell

This forms a simple *circuit.*



The difference in potential energy causes electrons to leave the negative terminal of the battery with energy.

The electrons then travel through the wire and rod before returning back to the positive terminal to gain more energy.

Question: where does the energy of the electrons go?

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-
-

Current Carrying Wires

- recall Hans Christian Oersted's discovery:

"A current carrying wire produces a magnetic field!"

- we can determine the direction of this B-field using the first LHR:

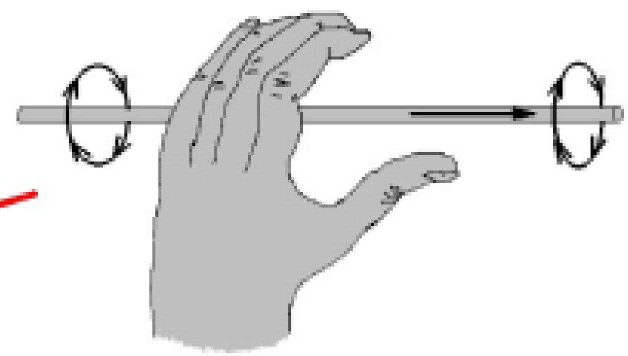


FIGURE 8: Left hand rule for current flow through a wire generating magnetic flux lines.

- we have also seen that charged particles placed in an external magnetic field experience a magnetic force:

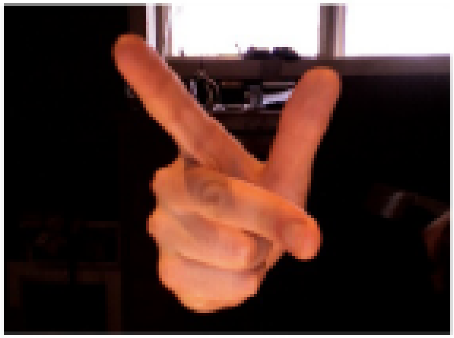
$$\vec{F}_B = q\,\vec{v}\,\vec{B}_{\perp}$$

force on a charge in a B-field

Force in a Current Carrying Wire

A current carrying wire placed in an external magnetic field experiences a magnetic force, just like a point charge.

The direction of the force can be found by using the 3rd LHR.



The magnitude of the force can be found using the equation:

$$\vec{F}_B = \vec{B}_\perp IL$$

where:
I = current (A)
L = length of wire (m)