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Electromagnetism and the hand rules - In 1960, the most popular high school physics textbook in America was Modern Physics by Dull, Metcalfe, and Williams and published by Holt, Rinehart and Winston in New York. It had very good diagrams of electromagnetic phenomena scattered through the chapters on electromagnetism. Since the curriculum at the time emphasized the knowledge that these diagrams contained and would be subject to testing, the decision was made to create a collage of these important diagrams on one sheet to make studying the information easier; each student received a copy. The diagrams were placed in the order they were studied and numbered. The order may be changed. Slight additions were made to clarify certain situations. The current was electron flow, and the left hand rule was mostly applied; that was the standard at the time in high school physics. The idea of a "test compass" had been introduced earlier whose N end always points in the direction of the magnetic field being tested.
Times change,and curriculum and standards change. This collage may be out of date, but the idea of a single sheet of diagrams for organized study may not be. Positive current flow, right hand rules, etc. may be the standard today, but the outcome remains the same; the physics is still correct.

Some comments about each diagram: 1. The thumb points in the direction of electron flow while the fingers point in the direction of the magnetic field around the wire. The magnetic field's direction is determined by a "test compass".

2. and 4. Turning a straight wire into a simple loop creates a new situation. Now the magnetic field of each segment of the wire begins to coalesce into a distinct N and S pole on the faces of the loop. Note the direction of the field inside and outside of the loop which can be observed with a "test compass".

3. This is a review, a reminder, of what was studied earlier about the direction of a magnetic field inside and outside of a permanent magnetic and how it compares with the single loop in 2. ; it's exactly the same! The simple rule is that the direction of the field inside the magnet is S to N and outside, N to S, which the loop also shows.

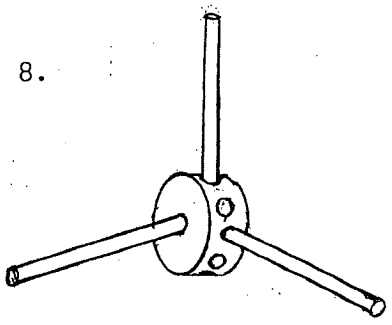
5. Going from a single loop to many loops, a coil, or a solenoid, introduces a variation of the left hand rule. This time point the fingers in the direction of electron flow, and the thumb will point toward the N pole. Going back to 2., 5. and 2. are saying the same thing in different ways.

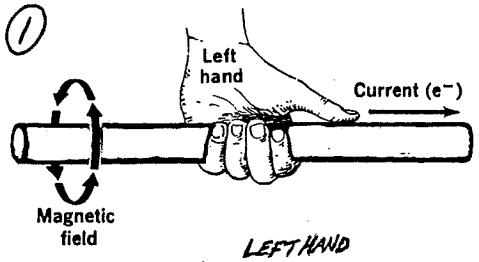
Note: 1. through 5. can be studied firsthand on the overhead projector. See "Demonstrations on the OHP" elsewhere on this website for details.

6. and 7. Use the children's substitute for pistols while playing "cops and robbers". Simply extend the middle finger 90° out to the side so everything is perpendicular with each other. Note that each "pistol" (hand) is a mirror image of the other just like a generator and a motor. A generator takes in work and turns out energy; a motor takes in energy and turns out work. All of the important elements are the same. The thumb represents thrust; the index finger represents field; and the center finger represents current. An old tinker toy connector (junction) and three dowels make a good model (8.).

It's a proven system. Change anything that you wish to fit your teaching style, and then make copies for your students.

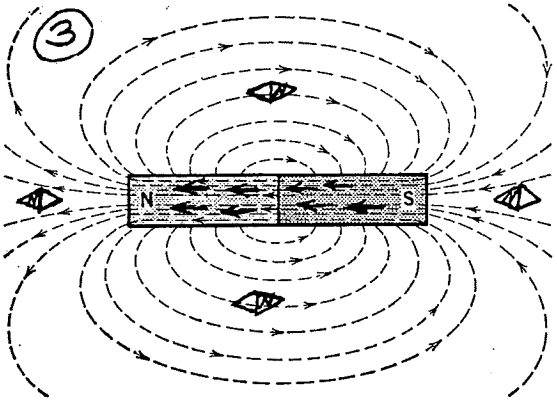
8.





LEFT HAND

Fig. 21-26. Ampère's rule for a straight conductor (WIRE).



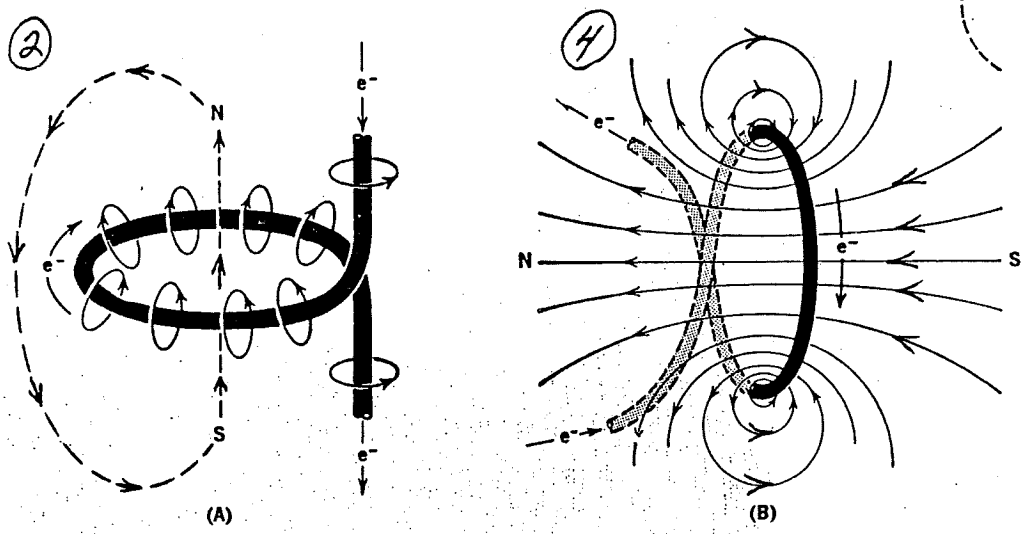
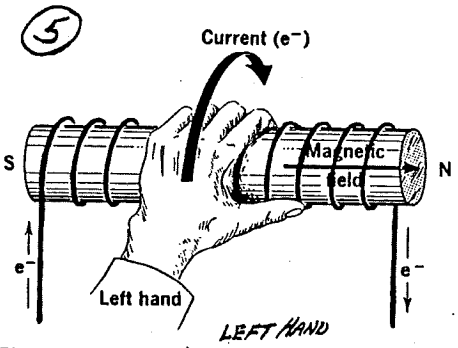


Fig. 21-27. The magnetic field through a current loop.

AND AROUND



LEFT HAND

Fig. 21-29. Ampère's rule for a solenoid.

(COIL)

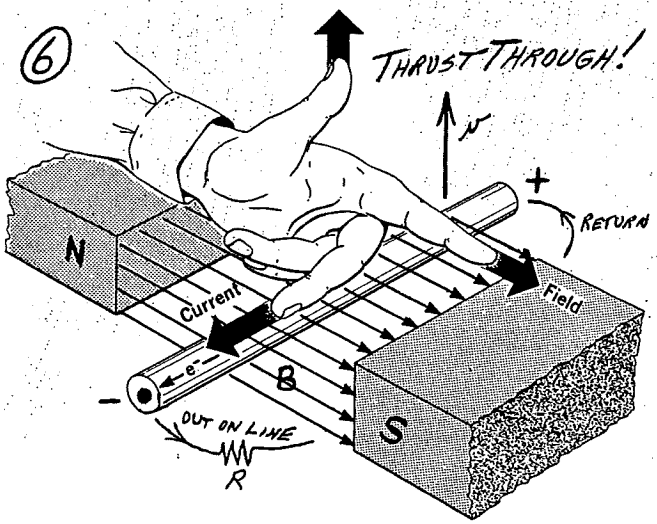


Fig. 22-8. The left-hand generator rule.

$EMF = B\ell v$

(VOLTS)

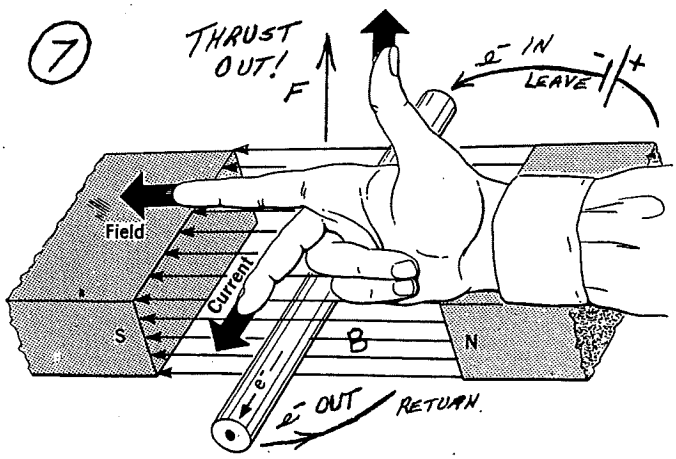


Fig. 22-29. The right-hand motor rule.

$F = BI\ell$

$F = Bqv$