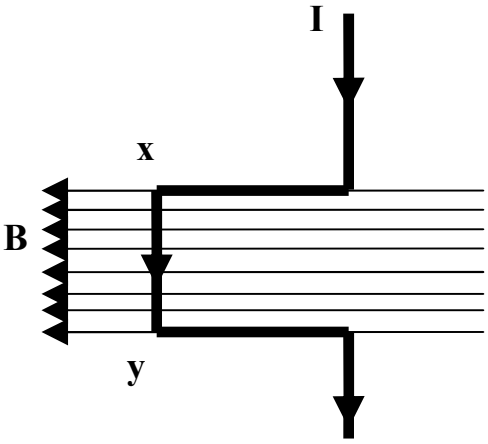
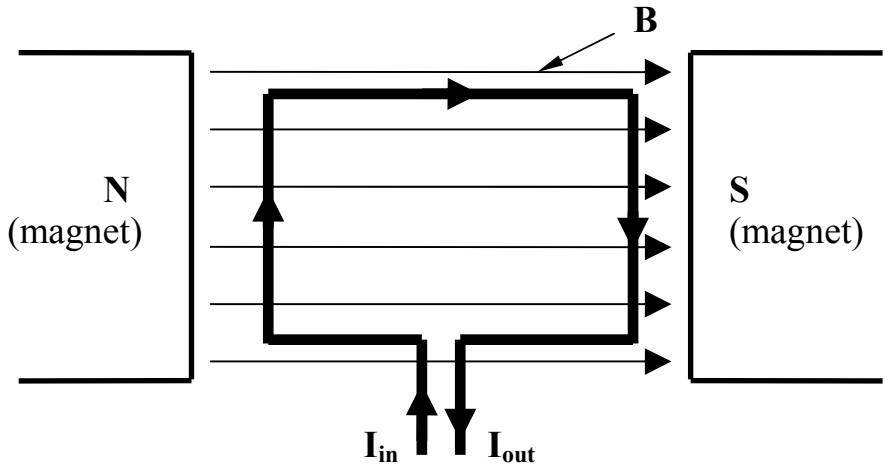
The Motor Principle

Examine the following diagram, showing a bent current-carrying wire partially exposed to a magnetic field **B**.



The magnetic field **B** causes a magnetic force **F** to push *down* on the wire between **x** and **y** only (check using **RHR**); the other sections of wire affected by **B** are parallel to **B**; ∴ no force occurs here

Now suppose a freely-rotating rectangular loop of current is placed inside a uniform field as shown below:



To determine the effect of the magnetic field **B** on the current-carrying loop:

- first determine which segments of the loop will be affected by a magnetic force;
- next, use the **RHR** to determine the direction of the magnetic force on each affected segment
- finally, determine the direction of rotation of the loop, and be prepared to explain why.

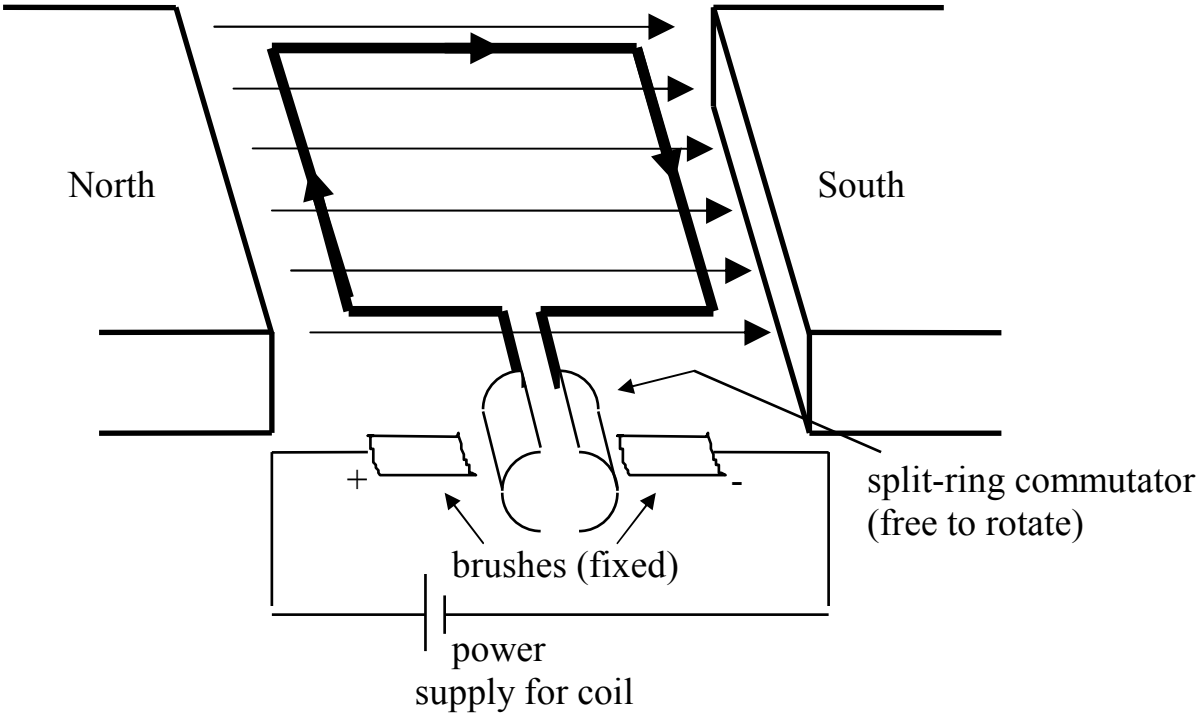
Example #10: Determine the direction of rotation for the loop in the above diagram.

(see Electromagnetism Ex 10 for answer)

Note that the force is applied to cause rotation only until the face of the coil is ⊥ to **B** (i.e coil rotates 90° from the above diagram). This is because a *torque* is applied here, and for torque to occur, **F** must be ⊥ to the distance **d** from the circuit. Once the coil face is ⊥ to **B**, the force created is parallel to **d** and is directed at the pivot; ∴ no torque occurs.

If the coil manages to rotate *past* 90°, then those same forces, acting in the same direction, will reverse the rotation, bringing the coil back until its face is once again ⊥ to **B**. Eventually, the coil becomes stationary in this position.

A technique is needed to keep the loop rotating in the right direction. A device called a *split-ring commutator* is attached to the coil to change the direction of current in the loop at approximately every 180° (1/2 turn). This keeps the magnetic force constantly "down" on the *left* and "up" on the *right*:



Sometimes the rectangular coil is mounted on a large cylinder called a *rotor* or *armature*, which in turn is mounted on an axle. This device is an *electric motor*, which turns continuously in one direction due to the above set-up.