Chapter 20. Electromagnetic Forces

Contents:

Commutator brush cathode-ray tube

4.5.3 Magnetic effect of a current

Core

1 Describe the pattern and direction of the magnetic field due to currents in straight wires and in solenoids

2 Describe an experiment to identify the pattern of the magnetic field (including direction) due to currents in straight wires and in solenoids

3 Describe how the magnetic effect of a current is used in relays and loudspeakers and give examples of their application

Supplement

4 State the qualitative variation of the strength of the magnetic field around straight wires and solenoids

5 Describe the effect on the magnetic field around straight wires and solenoids of changing the magnitude and direction of the current

4.5.4 Force on a current-carrying conductor

Core

1 Describe an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing:
   (a) the current
   (b) the direction of the field

Supplement

2 Recall and use the relative directions of force, magnetic field and current

3 Determine the direction of the force on beams of charged particles in a magnetic field

4.5.5 The d.c. motor

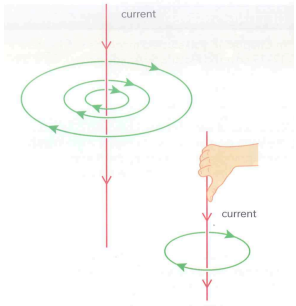
Core

1 Know that a current-carrying coil in a magnetic field may experience a turning effect and that the turning effect is increased by increasing:
   (a) the number of turns on the coil
   (b) the current
   (c) the strength of the magnetic field

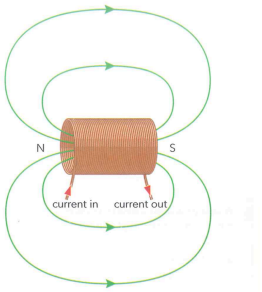
Supplement

2 Describe the operation of an electric motor, including the action of a split-ring commutator and brushes

20.1 The Magnetic Effect of a Current - Summary



1. Magnetic field(B) direction: **right hand grip rule**
2. Outer => weaker
3. Increase **I** => increase **B**



1. Magnetic field(B) direction: **right hand grip rule**
2. Inside: uniform B, outside: weaker and weaker
3. Increase **I** => increase **B**

Exercise 20.1:

Complete the following sentences.

There is a magnetic field around a conductor when it carries __current_____

The field lines around a straight wire are ____circular_____

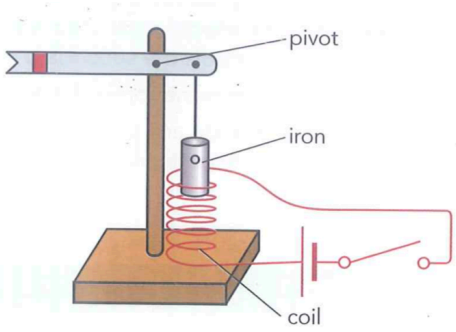
The direction of these field lines cam be found using _right hand rule_____

The field around a solenoid is the same as that around a __bar magnet_____

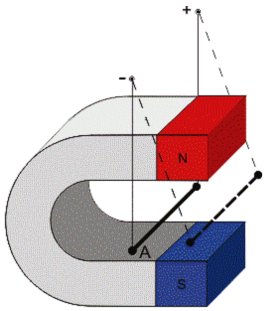
Exercise 20.2:

Explain what happens when the switch is closed, and then when it is re-opened

When the switch is closed current flows through the coil creating a magnetic field. This attracts the iron, pulling it down, so the signal lifts up.
When the switch is opened, no current flows. The field is lost, so gravity pulls the signal back down.



20.2 Force on a Current - Carrying conductor



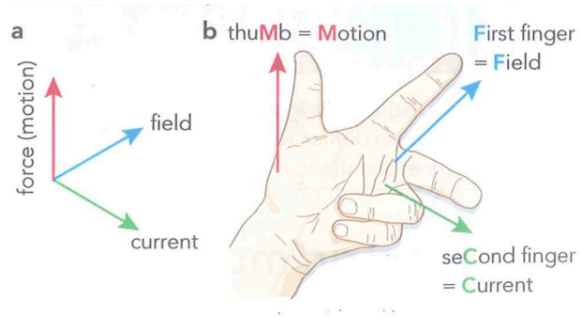
Motor effect: When **current** flows in a wire in a **magnetic field** which is not **pa** current, a force is exerted on the wire

Basic requirements for motor effect:magnetic field + current

The direction of force can be reversed by:
Reversing the direction of **current**
Reversing the direction of the field of the permanent **magnet**(given the magnet can be changed)

Motor effect application: loudspeaker

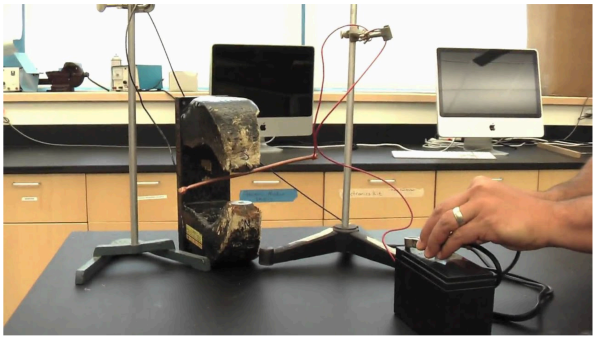
How do we determine the direction of force (Ampere's force)?
=> **Fleming's left-hand rule**



- the First finger is Field
- the seCond finger is Current
- the thuMb is force or Motion.

Ampere's force = demo

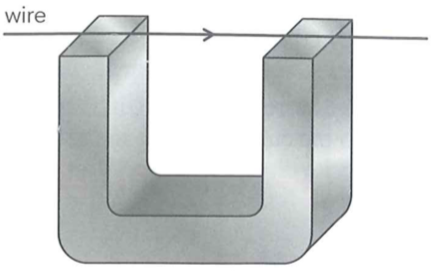
Prove reversion of force



Exercise 20.3:

Explain why the wire will not move.

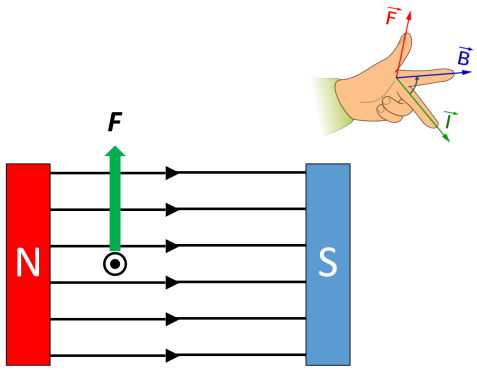
current is **parallel** to direction of magnetic field

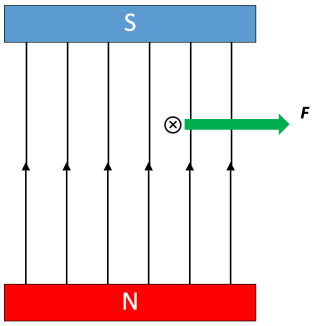


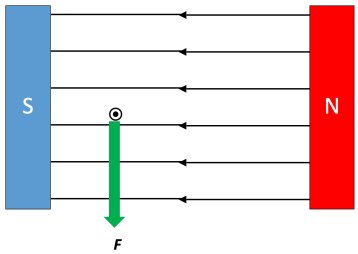
Exercise 20.4:

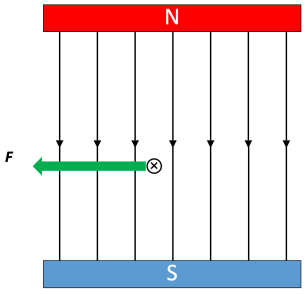
Can you determine the direction of force that the wire experience in the following settings?

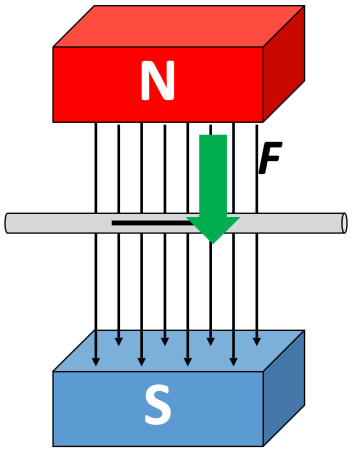
First one is done for you as an example.

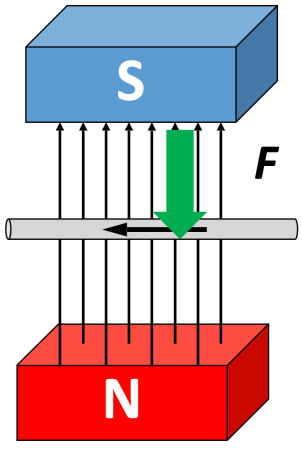


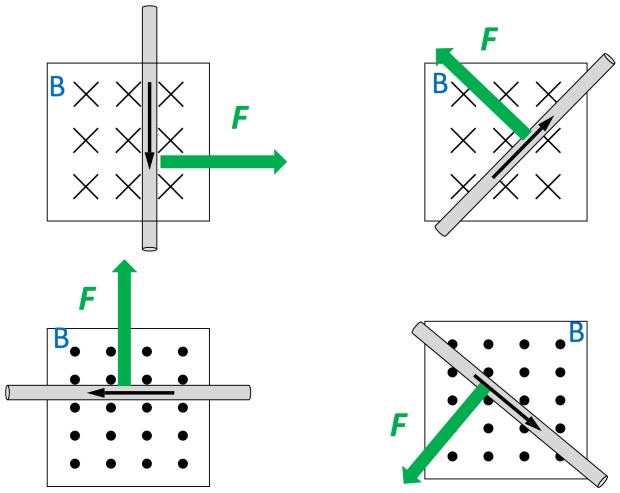


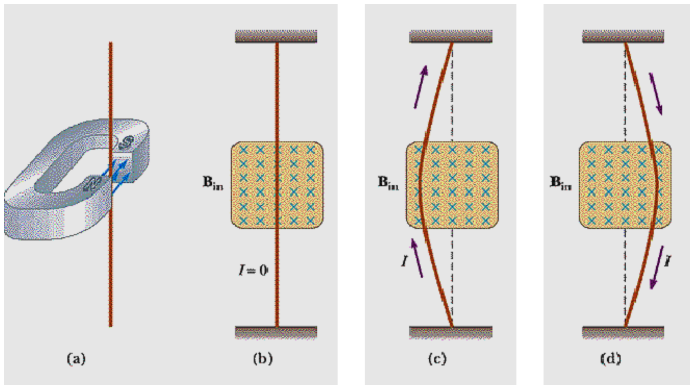






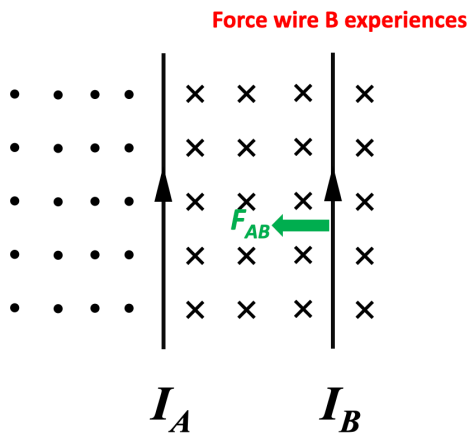


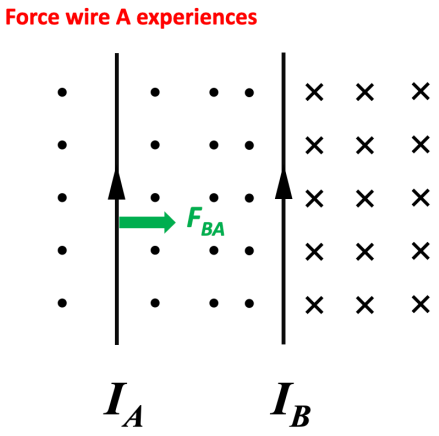


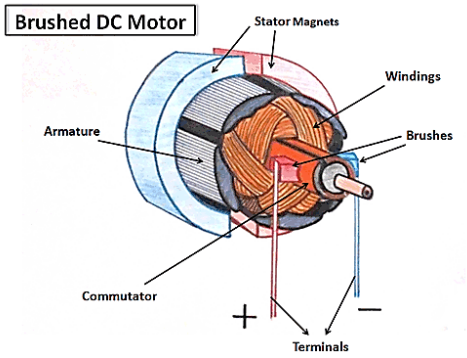


Exercise 20.5:

Can you use what you just learned to explain why two wires carrying same/opposite direction of current will appear attractive/repulsive to each other

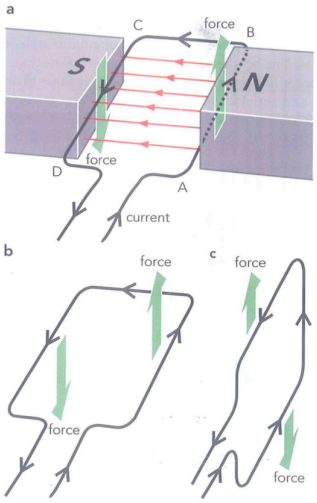


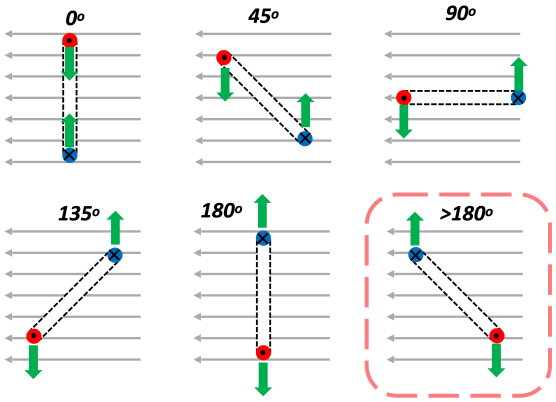




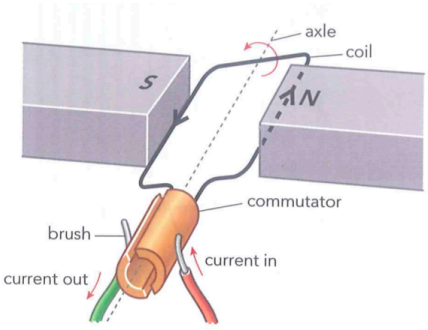
20.3 Electric Motors (d.c. motor)

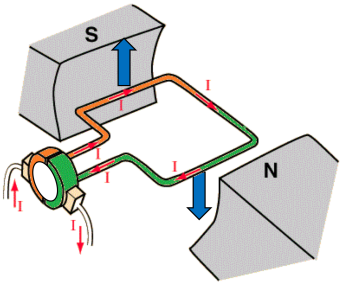
How motor works?

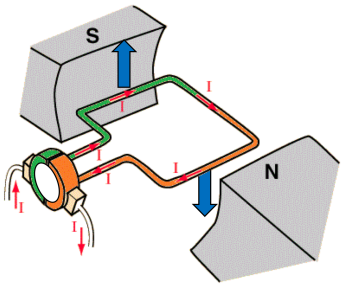


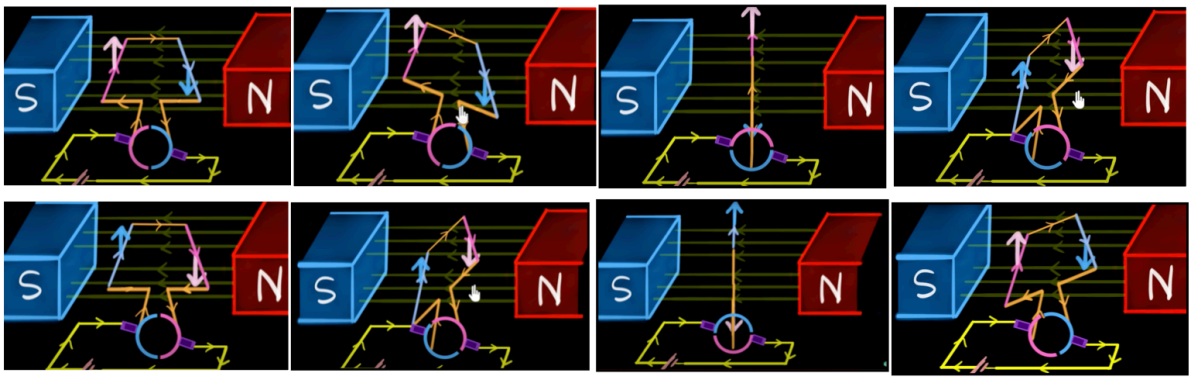


keep the motor turning? => <u>Brush + Commutator</u>









How to increase turning effect?

1. Increase the **current**
2. Increase the **number of turns** of wire in the coil
3. Increase the strength of magnetic field/use a stronger **magnet**

Exercise 20.6:

Describe the energy transfers that happen in

A an electric motor

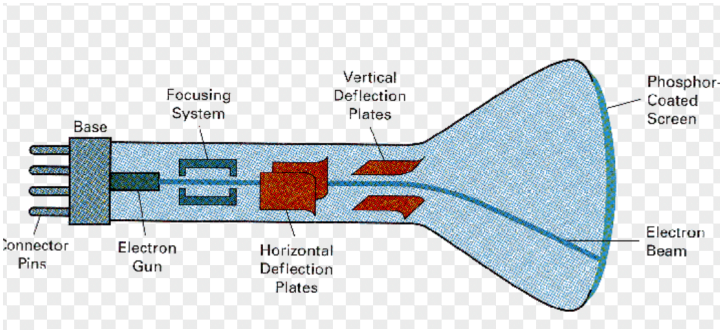
B a loudspeaker

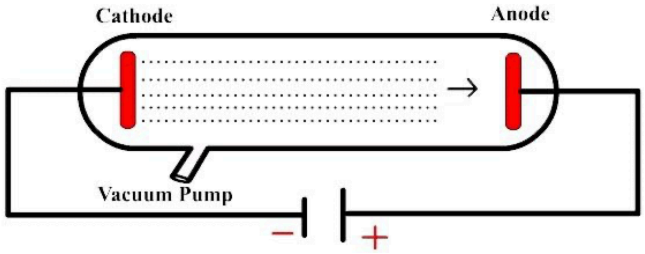
Exercise 20.7:

Describe the motion that would be seen if the coil in a motor was attached directly to a d.c. power supply without a commutator

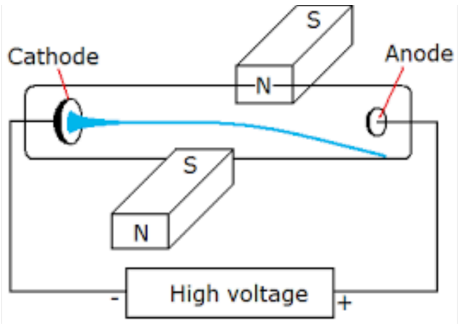
20.4 Beams of charged particles and magnetic fields

Cathode-ray tube && Cathode-ray oscilloscope





Electron beam in cathode-ray tube



Particle accelerator in CERN