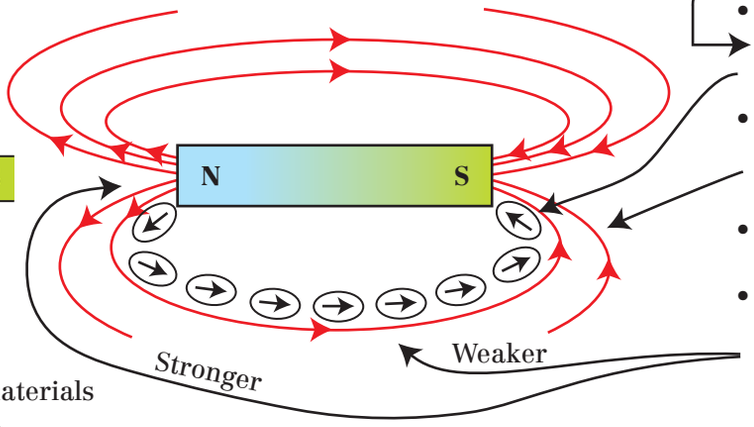
MAGNETIC FIELDS Magnetism and the Earth's Magnetic Field

A magnetic field is a region of space in which magnets and magnetic materials feel forces. The only magnetic materials are iron, steel, nickel, and cobalt. We represent magnetic fields by drawing magnetic field lines.

Like poles repel

Unlike poles attract

Un-magnetized magnetic materials are attracted to either pole.



- Plotting compasses line up with these and help us to draw them.
- They always point from a north pole to a south pole.
- They never cross.
- The closer the field lines the stronger the field.

The Earth's magnetic field

The north geographic pole is actually a south seeking magnetic pole so the north end of a compass is attracted to it.

North and south seeking poles attract

North geographic pole

Compass needle is a small bar magnet. It lines up with the Earth's magnetic field.

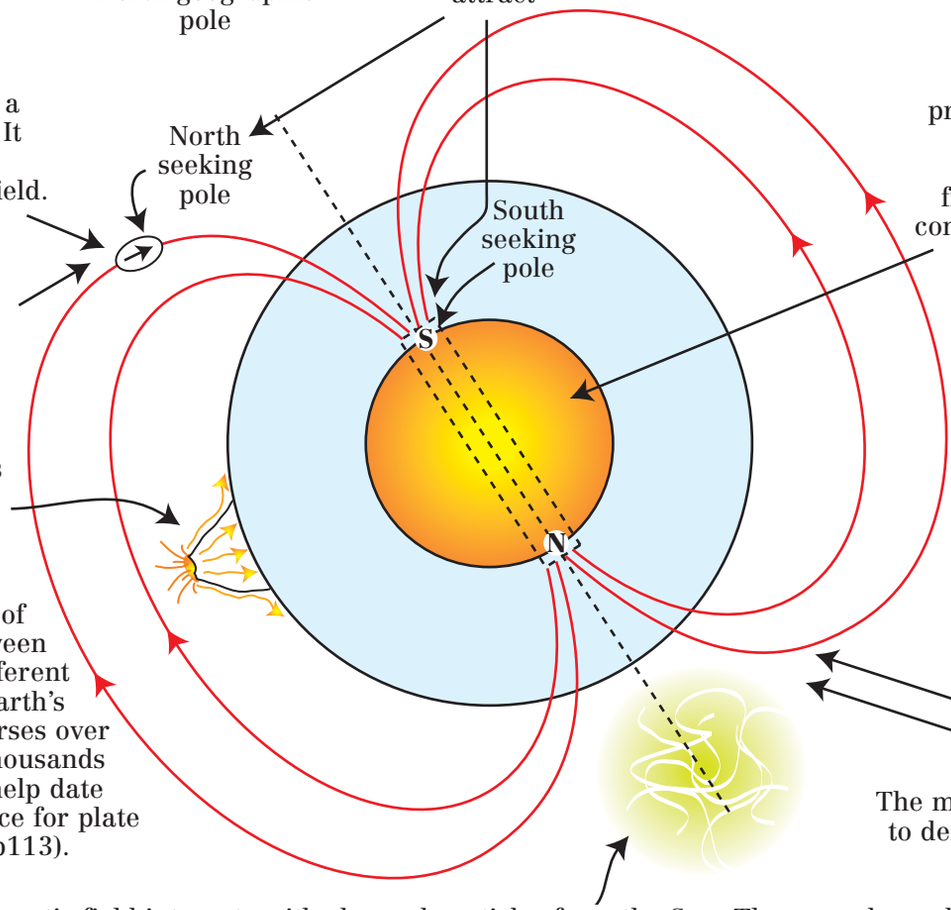
North seeking pole

South seeking pole

Molten *iron* core produces circulating currents. These create a magnetic field as if the Earth contained a giant bar magnet.

Earth's field used for navigation.

Field lines always point from a North magnetic pole to a South magnetic pole.



New volcanic rocks are magnetized by the Earth's magnetic field.

Changing direction of magnetization between rocks formed at different times tells us the Earth's magnetic field reverses over a period of many thousands of years. This can help date rocks and is evidence for plate tectonics (see also p113).

Cosmic rays – high-energy charged particles from space. They create gamma rays when they hit the Earth's atmosphere.

The magnetic field helps to deflect some of these charged particles.

The Earth's magnetic field interacts with charged particles from the Sun. They are channelled to the poles where they interact with molecules in the atmosphere making them glow. This is the aurora.

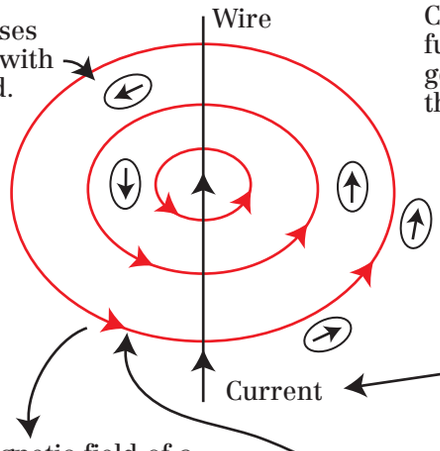
Questions

1. What is a magnetic field? Make a list of three properties of magnetic field lines.
2. Make a list of the four magnetic materials. How could you test an unknown material to discover whether it is one of the four in the list?
3. Using a magnet how would you tell if a piece of steel was magnetized or un-magnetized?
4. If the Earth's magnetic field were to disappear, it would be very bad news for our health. Explain why. (You might need to look at p69.)
5. Why might a magnetic compass not work very well close to the North or South Pole?

MAGNETIC FIELDS Electromagnetism and The Motor Effect

A current carrying wire produces a magnetic field around it.

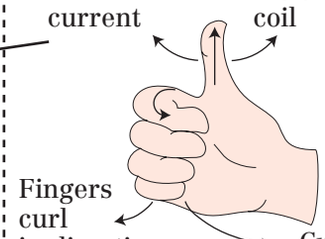
Plotting compasses line up with the field.



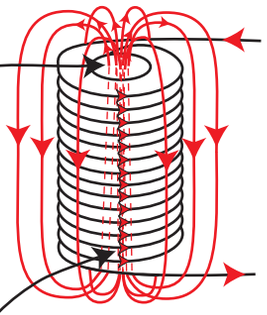
Circular field lines (getting further apart as the field gets weaker further from the wire).

The magnetic field of a wire can be made to interact with another magnetic field to produce a *catapult field*, which exerts a force on the wire.

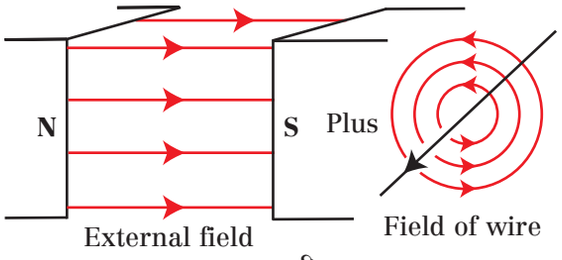
Right Hand Grip Rule

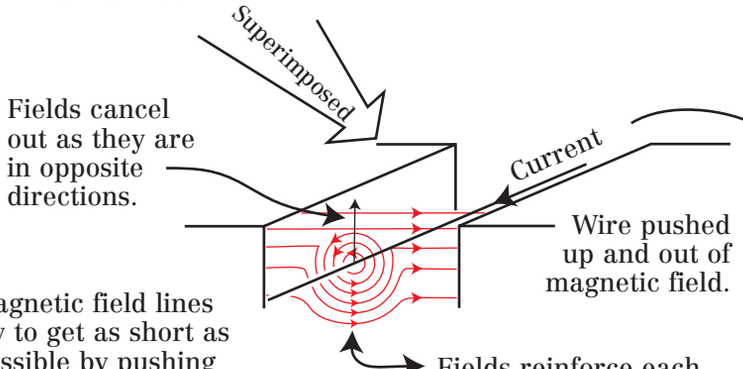


A coil (or solenoid) produces a magnetic field through and around it.



The more turns on the coil, a bigger current and adding a soft iron core all strengthen the magnetic field.





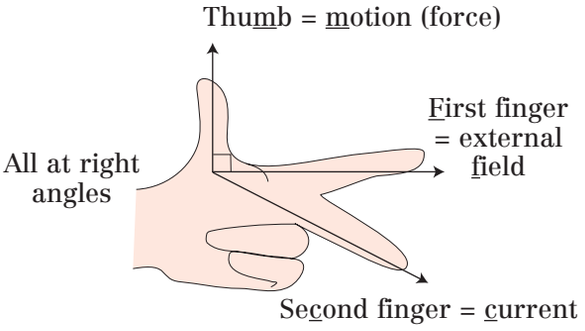
Fields cancel out as they are in opposite directions.

Wire pushed up and out of magnetic field.

Magnetic field lines try to get as short as possible by pushing the wire out of the field and removing the distortion.

Fields reinforce each other as they are in the same direction.

The directions of the external field, current, and the resulting force (and hence motion of the wire) are remembered by Fleming's **Left Hand Rule**.



Reversing **either** current *or* field will reverse direction of the force.

If the current is parallel to the external magnetic field the two magnetic fields are at right angles to each other and cannot interact so no force is produced.

Size of the force can be increased by:
- Using a larger current
- Using a stronger external field

Questions

1. In what ways are the fields around a bar magnet and around a long coil (solenoid) similar and in what ways are they different?
2. What would happen to the direction of the magnetic field lines around a wire, or through a coil, if the current direction reverses?
3. Make a list of five uses for an electromagnet and suggest why electromagnets are often more useful than permanent magnets.
4. What happens to the direction of the force on a current carrying wire if both the field and current directions are reversed?
5. Copy the diagrams (right) and add an arrow to show the direction of the force on the wire.