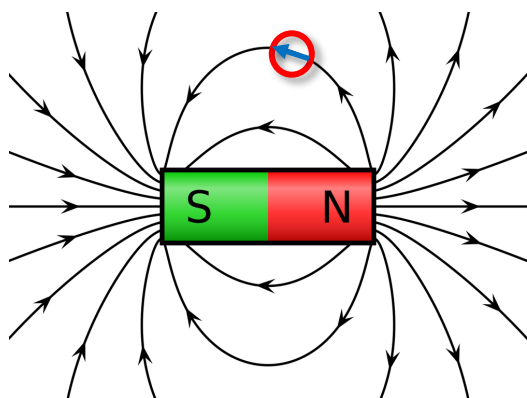


7.1 Permanent magnets and fields

Around any magnetised object there is a region of space where we can detect a magnetic field. We can do this by placing a compass at any point and noting what direction it points. The compass consists of a small, magnetised needle which contains a north and south pole. The magnetic field exerts a torque (turning force) on the compass causing it to align along a magnetic field line.

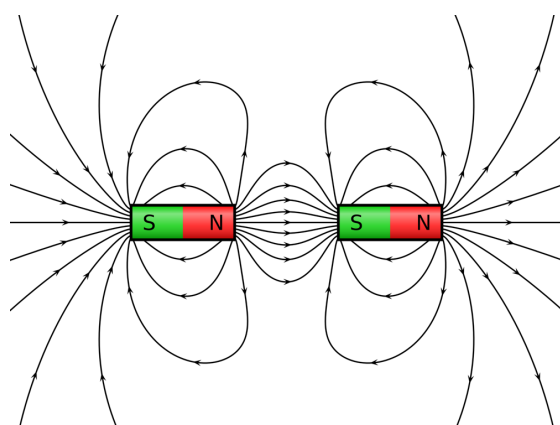


In this diagram, left, you can see that a plotting compass is pointing along the direction of the magnetic field line. Magnetic field lines go from a north (N) magnetic pole to a south (S) magnetic pole.
(1) *To which end of a permanent magnet does a compass point?*

Magnetic field lines can never cross. The magnetic field (called the 'magnetic flux density') is strongest where the field lines are closest together.

(2) *Where is the magnetic flux density the highest, in the diagram?*

(3) *In which direction would a compass point if there was no magnetised object nearby? Explain.*



If we have more than one permanent magnet, we find that a north pole of one will attract a south pole of the other. On the other hand, like poles (e.g. N and N) will repel.

The magnetic field lines between two permanent magnets is shown, left.

(4) *At what pole do magnetic field lines always originate?*

(5) *At what pole do magnetic field lines always terminate?*

(6) *Sketch the field lines you would expect to see between the two permanent magnets, below.*



Some materials are naturally strongly magnetic. They often contain the elements iron, nickel and cobalt. Some are able to hold on to a permanent magnetisation (i.e. they have a magnetic north and south pole). They are known as ‘hard’ magnetic materials. An example is steel. If you take a steel needle and swipe it over one pole of a permanent magnet, the needle becomes permanently magnetised. Other magnetic materials will become magnetised, if they are placed in a magnetic field, but will lose their magnetisation once they are removed from the field. These are known as ‘soft’ magnetic materials.

Consider the following situation:



A soft magnetic material is moved towards a permanent magnetic material. This magnetises the soft magnetic material, so that it develops a S pole closest to the N pole of the magnet. Therefore, the soft magnetic material is attracted to the permanent magnet.

(7) *What would happen if the permanent magnet were reversed, so that the S pole was closest to the soft magnetic material?*

(8) *If you had two metal bars, how could you tell that you had two permanent magnets rather than one permanent magnet and one soft magnetic material?*

The Earth has a magnetic field, roughly aligned with the axis of rotation. The field is generated from the flow of electric currents in the iron core.

(9) *Looking at this diagram, why is the 'Magnetic North Pole' misnamed?*

