7.1 Permanent magnets and fields

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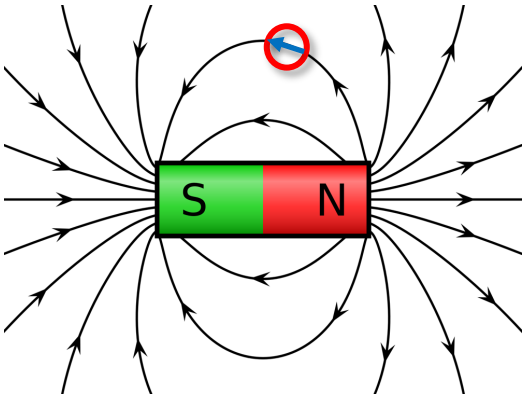
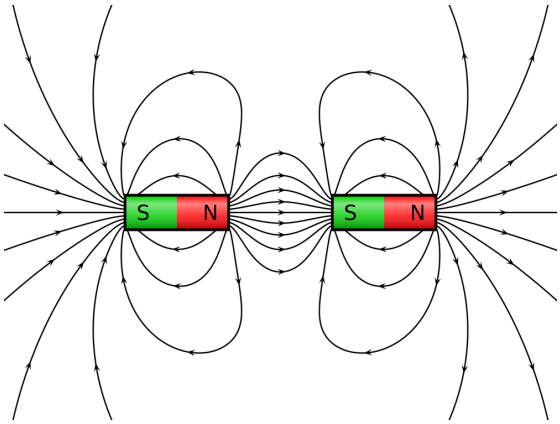
Around any magnetised object there is a region of space where we can detect a magnetic field. We can do this by placing a compass at any point and noting what direction it points. The compass consists of a small, magnetised needle which contains a north and south pole. The magnetic field exerts a torque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