The electric compass needle

Demonstration

Comparisons with magnetic fields may be helpful here.

Apparatus and materials

Power supply, EHT (0-5kV) and/or Van de Graaff generator

Polystyrene balls, metallised, approx 3 cm diameter

Perspex rods, to hold balls, 2

Retort stands and bosses, 2

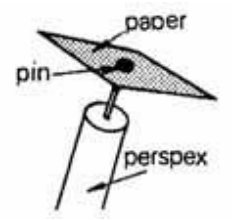
Perspex rod (about 60 cm) with paper vane

Metal plates with insulating handles

Health & Safety and Technical notes

Read our standard health & safety guidance

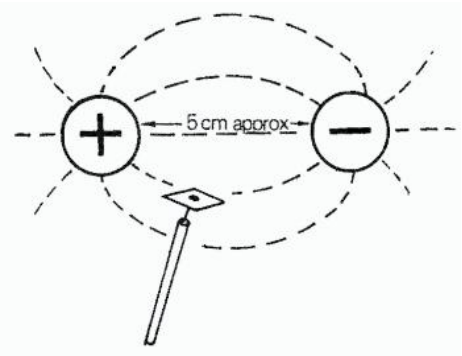
Paint the polystyrene balls with Aquadag or other conducting paint, or spray them with antistatic spray to give them a conducting surface. (Metal balls are equally good, but they should be large: diameter at least 5 cm.) Support each on a horizontal insulating rod (e.g. Perspex). Tape a small piece of aluminium foil onto each ball, to serve as an electrode. Use crocodile clips to attach leads to the supply.



Make a small paper vane, like a compass needle, about 4 cm long. Attach it to a long Perspex rod with a pin as pivot. The paper must be slightly conducting; paper is hygroscopic enough to ensure conduction in most cases. If necessary, breathe on the paper.

Procedure

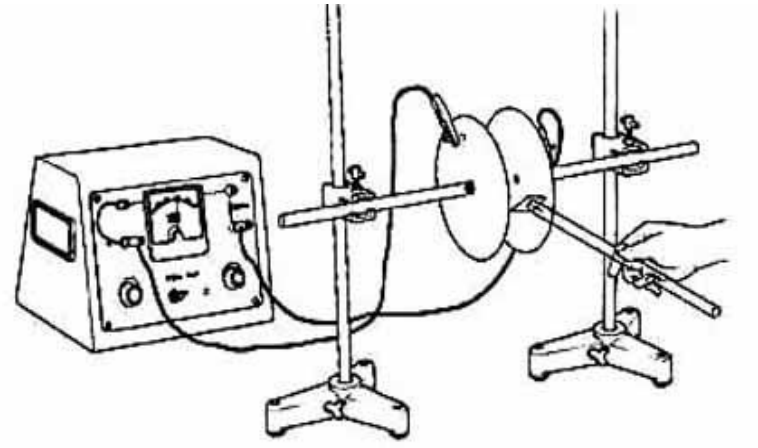
a Fix the two balls approx 10 cm apart, centre to centre. Connect the balls through the 50 MΩ safety resistor to the 5,000-volt supply's + and - terminals, both unearthed.



b Make sure the paper vane is free to rotate. Hold it by the long rod in the space between the balls. It will set along the field lines, because it develops induced charges in the field - rather like the behaviour of iron filings or soft iron in a magnetic field.

c Starting with the vane near one ball, move it, steering 'straight ahead by the compass' to map a line of force of the electric field. Show several such lines in quick succession. Ask students where they have seen a magnetic field of similar shape.

d The device can also be used to show that the lines are not straight at the edge of a plate.



Teaching notes

1 The paper indicator acts by developing induced charges in the field. This is why it must conduct, although it need not conduct well. The charges were in the paper before, in equal amounts of positive and negative charge. They cancelled out each other's effects until the field dragged them apart, so that negative charges collect at one end and positive charges at the other. The field tugs on the charged ends of the paper indicator and pulls it round until it points along the field. In this way we can map the electric field in a similar way to mapping a magnetic field with iron filings.

2 With a Van de Graaff generator you may be able to show the same field patterns, but corona discharge (from the higher potential) may mar it.

This experiment was safety-checked in December 2006

Related guidance

Electric charge and current - a short history

Electric fields

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