6.2 Electric fields

Electrical charges exert forces upon one another. Just as with gravity, these forces can be understood in terms of fields that exist between ‘charged’ particles

Demonstration – electric field lines

Apparatus and materials

Power supply, EHT, 0-5 kV (or Van de Graaff generator)

Electric field apparatus

Semolina

Castor oil

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| **Electrical** | Wire carefully, EHT voltagesSchool EHT supplies have an output limited to 5 mA or less, which makes them safe. In this experiment, very low currents are sufficient so the extra resistor can be included in the circuit if it is built into the supply.Do not be tempted to try an HT power supply. The current which can be delivered by such a unit is too high to be used with bare electrodes |

**0-5000 V**

**EHT**

Procedure

a) Fill the electrode unit with a layer of castor oil to a depth of about 0.5 cm. Sprinkle a thin layer of semolina over the surface. (A thin piece of glass tubing drawn out to give a fine pointed stirrer is helpful so that the semolina is evenly distributed.) It is better to start with too little semolina than to start with too much. You can always increase the quantity later.

b) Place the electrodes in the castor oil. Connect the positive and negative terminals of the EHT power supply to the electrodes. Adjust the supply to give 3000 to 4000 V. When the voltage is switched on, the field lines will be clearly visible.

c) Try electrodes of different shapes. For example, one can be a 'point' electrode whilst the other is a plate, or two point electrodes can be used. A wire circular electrode with a point electrode at the centre will show a radial field. The field with two plates quite close together should also be shown.

notes

**1** Just as scientists talk of a magnetic field in the space around a magnet, they talk of electric fields in the space around an electric charge. The grains of semolina behave like electric compass needles (electric dipoles), and line up to show the direction of the electric field.

**2** There is an electric field spreading out from any electric charge, ready to ‘grip onto’ any other charge and exert a force on it. This is similar to the Earth’s readiness to grip another mass such as the Moon, or a student, or a mug on the edge of a table, with a gravitational force. However the force that an electric field exerts is not there until there is a charge for the field to push or pull on. You could say *‘charged’ just means ‘ready to make forces’ in the same way as soldiers say that a ‘gun is charged with explosive ready to make forces on a bullet’.*

**3** Draw diagrams here to show some electric field patterns which can be modelled in this demonstration.

Field lines and equipotentials.

1) Part of the electric field pattern has been drawn in each of the diagrams below. Use your knowledge of symmetry to complete the electric field pattern in each case.



Each of the diagrams below shows a pair of electrodes connected to a voltage supply.



2) For each of the diagrams, add solid lines to illustrate the shape of the electric field between the electrodes. Draw arrows to indicate the direction of the field.

Field strength

Data required:

charge of electron = 1.6 × 10-19 C

1) Where the field strength is 1000 N C-1, what is the force on a 1 C charge? On an electron?

2) A charged sphere is placed in a field of strength 3 × 104 N C-1. If it experiences a force of 15 N, what is the charge on the sphere?

3) What is the field strength if an electron experiences a force of 4.8 × 10-14 N?

4) Work out the field strengths at the point labelled B in the diagram below, The strength at A is -1.125 x 105 N C-1 . What do you notice about the values, and why is this? Add arrows at A and B to indicate the electric field strengths there.

**-5C**

10 cm

20 cm

A

B