THE ROYAL SOCIETY OF CHEMISTRY

1. Only dust – is there a sign of life?

Time

2 h on the day. A hand-out, including a list of the contents of the kits, can be given to groups the day before .

Curriculum links

Optical activity, stereospecificity of terrestrial life.

Group size

3 – 4.

Materials and equipment

Materials per group

Dust:

- sand
- vermiculite
- D-fructose

Each sample should contain *ca* 5 g D-fructose.
(Alternatively, amino acids can be used.)

- For calibrating polarimeter: 10 g D-fructose, deionised water.

Equipment per group

Items from the junk list (pXX). Miscellaneous items including:

- sealing wax
- rubber bands
- rubber tubing
- glass tubing and rods (various)
- protractor
- paper
- test-tubes
- test-tube holder and rack
- beakers (various)
- weighing bottles (various, flat bottomed)
- filter funnel
- filter paper
- 25 cm^3 and 100 cm^3 measuring cylinders

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- petri dishes
- pasteur pipettes
- optical filters (coloured, polarizing, clear, diffuse)
- clamps and stands
- corks
- copper wire
- light source
- wash bottle
- mirrors (small)
- Bunsen burner
- plastic gloves
- safety glasses.

Safety

Eye protection must be worn.

Risk assessment

A risk assessment must be carried out for this activity.

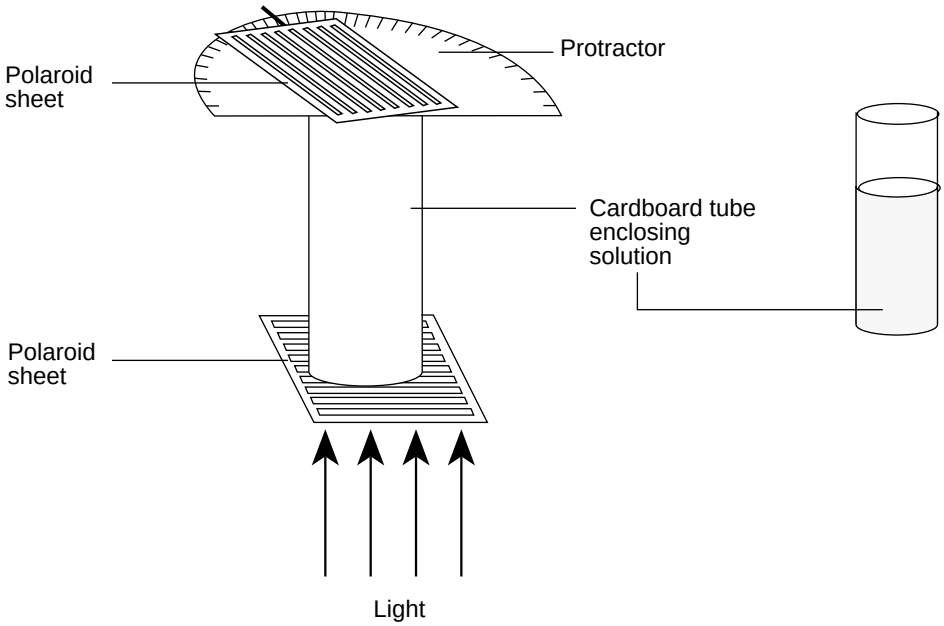
Commentary

Some students may need help in remembering that the building blocks of proteins and carbohydrates – amino acids and sugars – are chiral and therefore stereospecific. They may also need help in recalling how a polarimeter works. However, the instruction to test a physical property of organic compounds from living sources, plus the presence of optical filters in the equipment, prompted most students to test for optical activity by constructing a polarimeter. This problem has been used successfully in competitions.

Possible approach

The hand-outs, including a list of the contents of the kits, can be given to groups the previous day. The main challenge must be seen as the construction of an arrangement capable of giving a reliable estimate of the optical activity in the sample.

A possible design for a polarimeter is sketched below; a way of measuring the angle of rotation must be devised.



Extension work

If this method was used to analyse dust from a meteoric crater for signs of extra terrestrial life, what assumptions would the students have to make to analyse their results?

Evaluation

This problem was set as a competition and marks were awarded as follows.

1. Marks were awarded for the construction of the polarimeter.

2. Marks were awarded for use and demonstration of optical activity in the dust.

3. Marks were deducted for hints that were given.

Acknowledgement

This problem is based on a suggestion by John Liggat and originated from a competition set in the Chemistry Department of the University of Glasgow in 1986.

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- Determine whether the sample of dust originates from a living source (plant or animal) or a non-living source (rocks or sand).
- Design a test for the dust sample that exploits a physical property of organic molecules from living sources, using only the equipment provided.