Jets of liquids

Introduction
This problem does not work well on a damp day or in a damp laboratory!
Teachers who have not used the problems before should read the section Using the problems before starting.

Prior knowledge
Familiarity with polar covalent bonding and that such bonds have charged ends; and that like charges repel and opposite charges attract. A detailed knowledge is unnecessary as students are encouraged to consult textbooks and data books during the exercise.

Resources
Data books and textbooks should be available for reference.

The following equipment and chemicals should be provided at the start of the exercise:

- two burettes;
- samples of different plastics to be charged by rubbing, plastic pens, rulers etc can also be used;
- several small lightweight watch glasses; and
- a liquid hydrocarbon.

Students can request other apparatus during the practical session and this should be issued if it is safe to use.

Group size
2–3.

Risk assessment
A risk assessment must be carried out for this problem.

Results
Discussion should focus on why water is always attracted to charged plastic; and the hydrocarbon is unaffected by charged plastic. Students will find that charged plastic always attracts the water jet because the polar water molecules are pulled round by the charged plastic so that the oppositely charged end is nearest to the plastic.

Non-polar hydrocarbon molecules are not affected by charged rods at all; it is a pity that because of its toxicity we cannot test tetrachloromethane – it is also unaffected by charged plastic.

NB Bond polarity is a necessary but not a sufficient condition for attraction. Thus tetrachloromethane is not attracted by the approach of the charged plastic as the molecule is symmetrical and the bond polarities cancel out. It is suggested that this should only be mentioned if it arises in the discussion.

Suggested approach
During trialling the following instructions were given to students and proved to be extremely effective.

1. Working as a group, plan the investigation and write up in note form what you are going to do. It is essential that both positively charged and negatively charged plastics are used.

2. Get your method checked for safety and then carry out the practical work using water. Do plastics with opposite charges affect water in the same way?

3. Now carry out the practical work using the hydrocarbon. Does the hydrocarbon behave in the same way as water?

4. Discuss your results and write a brief account of what you did with explanations. Ask for advice if you are not convinced that your explanations are correct.

5. Working as a group, prepare a short (ca 5-minute maximum) presentation to give to the rest of the class. If possible all group members should take part: any method of presentation (such as a blackboard, overhead projector, etc) can be used.

Outline the problem, describe what you did and explain your conclusion. After the presentation, be prepared to accept and answer questions and to discuss what you did with the rest of the class.

Background information

School Science Review, 1983, **64**, 508. The liquids investigated were ethanol, propanone and water, but only the results of ethanol are given. The authors reported that it was difficult to produce an assembly that could yield consistent results.

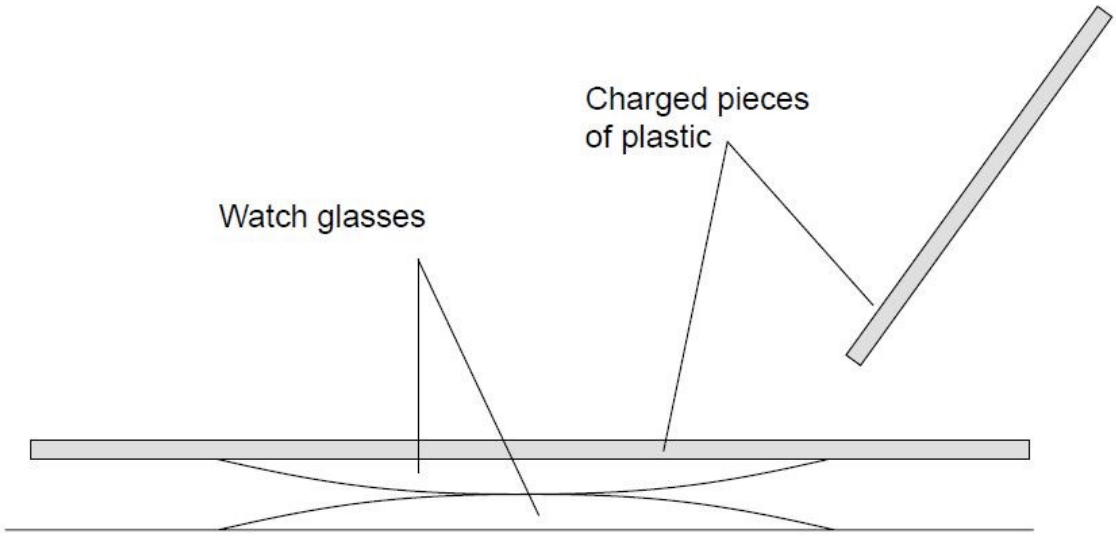
Jets of liquids

Investigate what happens when different charged plastics are held near a jet of water issuing from a burette, and explain your observations.

If time permits find out whether a hydrocarbon liquid behaves in the same way as water.

Plastic is charged by stroking it rapidly against different fibres: you can check out how effective this is by seeing how well it picks up small pieces of paper. If you can't get this to work well, it is unlikely that the experiment will work. (It doesn't work well on damp days or in damp laboratories). Some plastic/fibre combinations give the plastic a positive charge, others a negative charge.

You do not need to know which have a particular charge, but you do need to know which have the same charge and which have the opposite charge. Recalling that like charges repel and opposite charges attract, charge pieces of plastic and find out if they attract or repel – an easy way of doing this is to balance one charged piece of plastic on two watch glasses with convex surfaces together, and bring another charged piece close to it.



You should refer to any sources of information that you think might help such as your notebooks, textbooks and data books. Ask for assistance if you get stuck.

Safety

Normal safety procedures when handling chemicals should be adhered to and eye protection worn.

You must get your method checked for safety before starting on the practical work.