

KS4 Mini-projects

At the beginning of Science Year, we would like to involve all interested schools and science teachers to help develop these novel KS4 mini-projects.

- Each project should be based on some property or behaviour that is intriguing or counter-intuitive e.g. plants grow faster in the dark, if only for a short time.
- There should be opportunities for a variety of different lines of investigation, including finding information on the Internet.
- It should be possible to link the activities to some explanatory theory which is accessible at KS4

We are keen to evaluate both the learning outcomes and the effects on student attitudes, and to develop assessment guidelines for this type of activity.

The three outline suggestions provided illustrate the type of projects we are looking for. We hope that you and your students will want to work up experiments from at least one of them, and that you will take part in the evaluation.

We plan to develop a web forum for exchange of ideas about the projects.

Please contact us at

Science Education Group
FREEPOST (Y0264)
YORK YO10 5BR
tel: 01904 432524
email: pen1@york.ac.uk
www.uyseg.co.uk

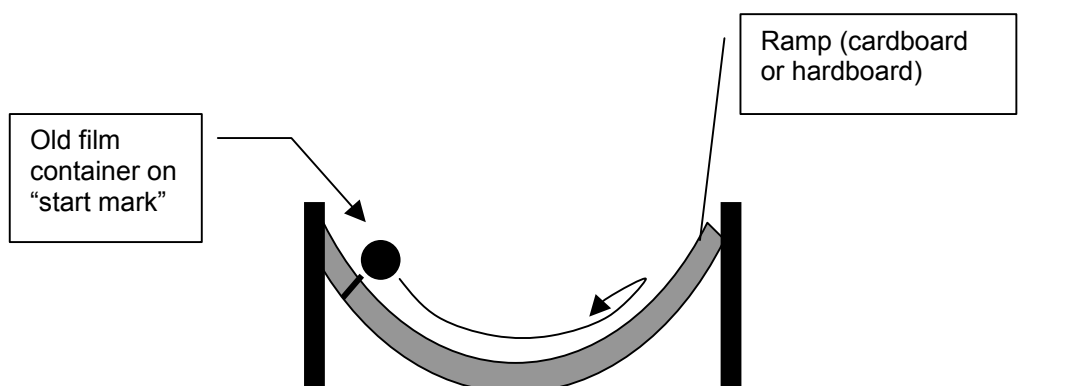
Mini-project 1: Rolling Bean Cans

If you drop a can of baked beans and a can of soup down a ramp they roll back and forth, but which stops first and why?

1. Take a 35 mm plastic film container and glue a spare lid onto the bottom (possibly using a glue gun, or plastic adhesive)



2. Make a ramp. We propped up a 1.5m x 20 cm piece of cardboard between two chairs. Mark a starting point to roll the can from.



3. Allow the canister to roll down and count how many times it goes up the other side. If you are careful, for a demonstration you could roll two side by side. Do not let them go too fast or they may roll off the edge.

(Alternatively, use a food can with a ring-pull lid to avoid using a can opener and having very sharp edges. Pet food tins are good. Empty the contents and wash the can out well. Purchase a plastic lid-seal that creates a suitable rim on the top. Your track may need to be a little wider.)

4. Select variables to investigate:

- The filling: water, sand, soil, baked beans, treacle, oil, dried peas, lead shot.
- The quantity: filled, half filled, quarter filled etc.
- The height of drop.
- The type of surface. If you have a plastic or painted track surface, try releasing various quantities of different liquids to alter the friction e.g. water solution, sugar solution, treacle.

5. Measure the mass of the containers and other variables such as:

- How many times the can rolls up the opposite side to which it started.
- The distance a can reaches up the far side after a set time. This will need careful measuring. It depends here whether you want students to consider speed etc.
- The time taken to come to a standstill.
- Change in temperature inside the can. This will be larger when there is more "slopping" and when the filling has a low heat capacity. For example, compare lead shot and a solid lump of lead.

It may be possible to use light gates or other data logging instruments to calculate speed. A data logger with SEP button may be sensitive enough to show up any temperature change inside the can.

6. What Scientific Ideas are being used?

At a simple level pupils could make use of ideas about speed or potential and kinetic energy changes. They may be able to use ideas about friction and forces.

(The actual energy changes involve angular rotational energy which is beyond most A-Level students.)

7. Possible extensions:

- Designing various cross-sectional shapes for boats.
- Considering how material "slops" around in boats e.g. car ferries, possibly using a ripple tank.

Mini-project 2: Slime

Slimes are semi-liquid mixtures which behave differently depending on how quickly you try to move them! Examples include "gakky stuff" and "silly putty". Many recipes have been offered on websites, some of which work better than others. We offer two well-tried recipes, both of which allow a wide range for testing different concentrations. We hope your students may be encouraged to explore some of the recipes from the web (subject to careful assessment of hazards first).

(a) This recipe uses polyvinyl acetate and borax.

The PVA is most conveniently obtained as pva glue. Mothercare and toyshops sell a very suitable variety, or you can experiment with different brands of pva woodwork glue. Mix the glue with an equal volume of water. Stir well until evenly distributed. In a separate container, dissolve two slightly rounded teaspoons of borax in 250cm³ of water. Mix equal quantities of the two solutions and stir until the mixture thickens. The slime can be rolled between the hands (wear thin plastic gloves).

Variables:

- Different proportions of pva and borax.
- Varying concentrations of one or both solutions.
- Whether it makes any difference which solution is added to which, or how quickly.
- Adding food colour to one or other solution before mixing.
- Incorporating baby talc to produce a drier end-product.

The finished product can be squashed by slow, gentle pressure. It will flow very slowly, like a thick liquid. If dropped onto a hard surface, it bounces like "silly putty". Try holding up a fairly large lump, so that it gradually stretches and begins to flow down. When it has reached a good length, snip it in the middle. The upper end climbs back up to your hand!

(b) This recipe requires polyvinyl alcohol, which is less readily available.

Dissolve in water (hot water is best) to make an approximately 4% solution. Mix 5 parts by volume of this solution with 1 part of 4% aqueous borax. Again, dyes can be added for colour effects.

The long, flexible molecules of the polyvinyl alcohol become cross-linked by the borax. The result is increased difficulty in molecules moving past each other. The behaviour is rather like that of a heap of cooked spaghetti. If you try to lift it slowly on a fork, you can pull up a thin thread. If you try to lift too quickly, the molecules can not move past each other fast enough, and it all comes up together.

Mini-project 3: Cornflour and other food mixtures

This project is also based on the 'odd' behaviour of mixtures that contain long, flexible molecules. Slowly stir a little water into cornflour, to produce a paste about the consistency of double cream. If this is very slowly stirred, it remains liquid. If stirred rapidly it thickens so much that it can be lifted out of the container on the end of the spoon or stirrer.

Variables:

- Types of solid – cornflour, potato flour, starch
- Concentration – what range of water content allows this behaviour?
- Temperature effects
- Stirring speeds and recovery times

The corn-flour mixtures are rather similar to slimes. They flow if moved gently, but stiffen if rapid movement is attempted. Students can explore the opposite effect, thixotropy, which is shown by mayonnaise, tomato ketchup and many paints. Recipes for mayonnaise offer almost endless variety for testing.