SLOW WAVES

The University of Manchester

You will need:

- a clear bottle with a tight lid
- water
- water-based food colouring
- vegetable oil

What to do

1. Fill the bottle about 1/3 full with water, add a few drops of food colouring and seal tightly.
2. Hold the bottle horizontally and tilt it back and forth. Watch the movement of the water. How long does it take a wave to travel the length of the bottle?
3. Now carefully add oil on top of the water until the bottle is almost full and close tightly. Allow the bottle to stand for a moment so the layers fully separate.
4. Now repeat step 2. How long do the waves take this time?

Work Responsibly

- **Ask an adult for permission** before you start.
- Ask an adult to help pour the oil. Use a funnel if you have one.
- Blot spills with kitchen towel, then mop with warm soapy water.
- **Disposal:** When you have finished, stand the bottle upright to allow the liquids to separate. Carefully pour the top layer of oil into a separate container. The water only may be disposed of down the sink. **Do not pour oil down the drain**. Small quantities of oil may be disposed of in a sealed container in the general waste bin or taken to your local recycling centre. Recycle or reuse your bottle.

What is going on?

You should notice that with oil above the water, the waves move surprisingly slowly.

The speed of the wave depends on the difference in pressure on the water under the deep and shallow parts. There is more pressure on the water under the deep areas so water is pushed towards the shallow parts, driving the wave along.

When the space above the water is filled with air, the pressure difference is large. This creates a strong driving force and the wave moves fast.

When the space above the water is filled with oil, the difference in pressure is less than with air. The driving force is smaller and the wave moves more slowly.

What we do

We are a research group at the University of Manchester. We use mathematics to model and test the properties of materials and waves. Examples of our research include understanding and reducing noise; modelling the behaviour of ligaments and tendons; and the design of *metamaterials*: special materials with extraordinary properties.

Mathematics of Waves and Materials