Bottle race

Belgium

The effect of a vortex in a liquid

You will need:

- ✔ two 250 ml drinks bottles
- ✔ some parafilm or duct tape
- ✔ some water

Background

See what happens to water when you empty the bath.

Follow these steps

1 Pour water into one bottle so that it is three-quarters full.
2 Tape the two bottles together (see picture).
3 Ask the students to time how long it takes the water to flow from one bottle to the other when the bottles are inverted.
4 Repeat the experiment but this time give the water some angular velocity by moving the bottles in a circular motion before inverting them.
5 Again, get the students to time how long it takes for the water to run through to the second bottle.

What next?

If you make two sets of this apparatus you can have a race. Let the students figure out how to get the water to transfer faster.

So what happened?

The water is transferred faster from one bottle to the other after you generate some angular velocity.

The angular momentum of the water creates a vortex at the neck of the bottles, thus allowing air to move up easily through the centre of the vortex and the water to move down the sides into the empty bottle. The less chaotic motion at the neck of the bottles therefore allows the water to flow faster.

Broken hardware experiments

The Czech Republic

Making useful physics demonstrations from discarded equipment

Background

There are many experiments that can be devised using the bits and pieces that can be salvaged from old computers and other hardware. Here we show three uses for the remains of an old CD drive.

Follow these steps

1 Remove the gears and motor that operate a CD drive (pictures 1 and 2).
2 Wire the motor up to a 6 V bulb and add a handle so that the motor can be turned easily.
3 Turn the handle and note what happens.
4 Next, connect together the motors of two CD drive trays (picture 3).
5 Open one drive manually and see what happens to the other.
6 Apply different coloured stickers to a CD and place it on the motor that spins a CD when it is playing (picture 4). Note that these motors are complicated stepper motors that require a 6–12 V AC supply to get them to spin for this experiment unless their own electronics are adapted to operate them.
7 See what happens to the colours when the motor is turned on.

You will need:

- ✔ the remains of two old CD drives
- ✔ a 6 V bulb
- ✔ some old CDs
- ✔ some CD labels
- ✔ some coloured stickers (you can use CD label printing software to make these)

So what happened?

When the handle is turned the gears turn the motor at high speed and electricity is generated, thereby lighting the bulb. This simple apparatus is useful to demonstrate the conversion of mechanical energy to electrical energy.

Depending on how the two CD drive motors are wired together, opening one tray manually generates enough electricity to open or close the other. This again demonstrates the conversion of mechanical energy to electrical energy.

In the final set-up the motor and CD allow you to make an electrically driven Newton's disk. The colours should appear white when the motor is turned on.

The Coriolis effect

Important for an understanding of the movement of large-scale weather systems

Background

All places on the Earth have the same rotation rate of one revolution per day. However, the linear speed of a place depends on its latitude: places on the equator move at 1670 km/h while those near the pole have nearly zero speeds (see red arrows in Figure 1).

When an object moves north or south and is not firmly connected to the ground (air, artillery shells, etc), it keeps its initial eastward speed as it moves.

If the object is launched north from the equator, it will eventually be going faster east than the ground beneath it and will seem from the ground to be moved east by a mysterious "force" (see black arrow).

Objects moving towards the equator will eventually be moving slower than the ground and will appear to deviate to the west (see yellow arrow). In reality there is no force involved – the ground is simply moving at a different speed than at the starting point.

Thus air moving towards the poles appears to curve to the east and air moving towards the equator appears to curve to the west. This means that, for a low-pressure system in the northern hemisphere, motion is inwards and counterclockwise (figure 2). The Coriolis effect is strongest at mid-latitudes.

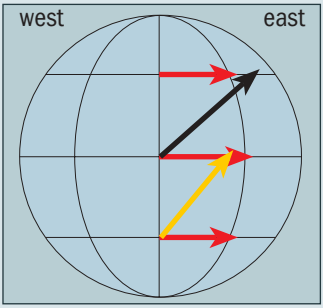

Figure 1: Apparent deflection of objects on northerly trajectories.

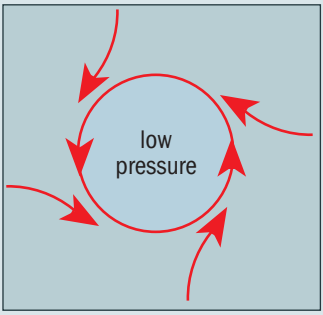

Figure 2: Vortex created in a low-pressure system.

What next?

In small-scale systems, like water draining from a sink or a bath, the Coriolis effect is usually overwhelmed by local variations, such as residual currents or irregularities in the shape of the container. It is only by very careful elimination of these factors that the Coriolis effect can be observed in the laboratory.

The rotation of the Earth does, however, influence the direction of rotation of large weather systems and large vortices in the oceans, because these are very long-lived phenomena and so allow the very weak Coriolis force to produce a significant effect with time.

Gustave-Gaspard Coriolis of Paris published his explanation of the effect in 1835. For more information, see http://www.physics.ohio-state.edu/~dvandom/Edu/newcor.html.

See pvii for a picture of the winning Coriolis demonstration from Ireland.