straight. This might seem obvious to many, but is not always obvious to students.

Following the demonstration, students were given some typical paper-based problems at appropriate levels in years 9, 11 and 12 (ages 14–17) in order to transfer their understanding from the original track light set-up, through the modification and on to paper-based problems. Without formal verification, I felt that the students generally had a better grasp of the concepts than with methods I have used before.

This very simple and cheap, yet effective, approach has become part of my electric circuits teaching programmes from key stage 3 to A-level (in England, ages 11–19) and readers will, I am sure, see other practical uses for the method and other conversations that could ensue.

Acknowledgement

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Using the Science Museum's 'Mystery Boxes' as a model for science and 'How science works'

Matt French

The Science Museum in London has made available for purchase a set of six 'Mystery Boxes' (Figure 0). These allow pupils to develop an understanding of science and 'How science works'. Each of the numbered boxes contains an object that is unknown to the pupils and to the teacher – there are no answers provided at all. The boxes are sealed shut and are never opened.

For this activity, the class is divided into six groups and one box is handed to each group. The groups have a number of minutes to try to work out and record their ideas about what is in each box. The boxes are then switched around so that each group investigates every box. The pupils can examine the boxes by a range of methods, from simple assessments of the mass and size to more detailed measurements such as the objects' magnetic properties or density. The activity can be drawn to a close with a mini scientific conference or a sharing of ideas between the groups. Full detailed instructions and a pupil worksheet are included with the boxes.

Figure 0 The set of six Mystery Boxes from the Science Museum

The activity allows the teacher to emphasise that nature is like the shut box: we can't just look inside the box to find the correct answer. We can only probe nature with experiments and become more certain about a result when the experiment is repeated and a consistent result emerges. In the same way, we can only probe the boxes by shaking them, weighing them, and so on, and getting different groups of pupils to repeat the experiment.

It is very interesting to watch the online video that the Science Museum has published showing a group of science researchers discussing their opinions about the contents of the boxes (see *Websites*).

In the world of scientific research, increasingly complex experiments are performed by each generation of researchers to discover more detail about current knowledge and to uncover new phenomena. To extend the idea behind the boxes as a model for science investigation, a colleague and I performed our own 'more complex' experiment. We X-rayed the boxes using a hand

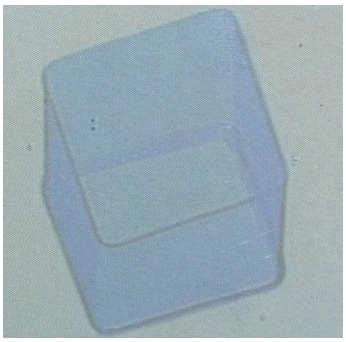

Figure 1 X-ray image of Box 1. This appears to show nothing in the box!

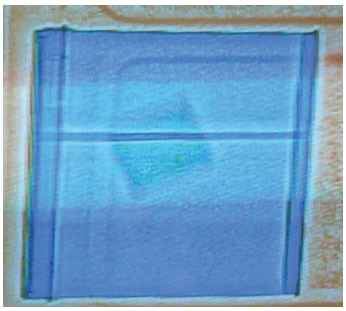

Figure 2 X-ray image of Box 2. The green colour of the shape inside the box suggests that it is dense plastic.

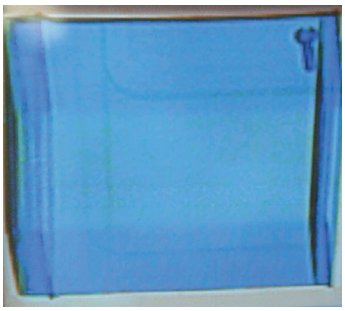

Figure 3 X-ray image of Box 3. This is one of the most conclusive images – it shows a small metal screw in the top right corner.

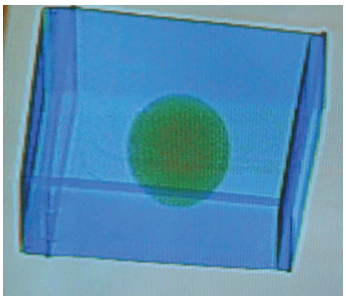

Figure 4 X-ray image of Box 4. This is another fairly conclusive image – a dense plastic circle or sphere in the box.

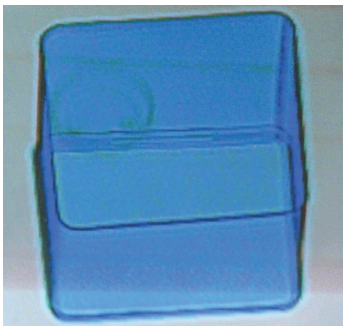

Figure 5 X-ray image of Box 5. A dense plastic or light metal ring is shown in the top left of the image.

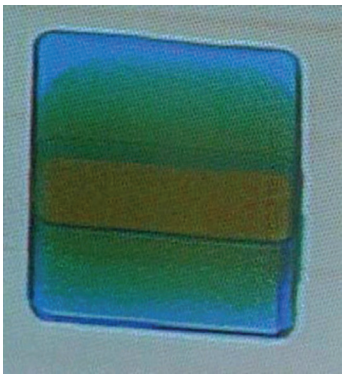

Figure 6 X-ray image of Box 6. The box is imaged diagonally so the contents appears thicker in a horizontal band across the middle of the image in orange. Towards the edges, the contents is thinner and in green. The contents does not go right into the corners of the box, which suggests that it might be contained within a bag.

luggage X-ray machine, thanks to the generous cooperation of our local airport where we had the opportunity to use the crew security section rather than a public area. In some cases, the X-ray images are quite conclusive and in other cases they provide little information.

The main purpose of this *Science note* is to share these X-ray images with other teachers so that they may use them in discussions with their classes. Figures 1–6 show the X-ray images for the corresponding boxes, and video versions have also been uploaded to *YouTube* (see *Websites*). Materials absorb and reflect X-rays in varying ways and to different degrees. This is used to create a false-colour image to provide an idea of the type of material being observed: blue indicates metal, orange indicates an organic substance and green indicates dense plastic.

Websites

Science Museum – Mystery boxes scientists: www.sciencemuseum.org.uk/videos/mystery_boxes_scientists.aspx.

matthewmjfrench on *YouTube* – X-ray videos:
Box 1: www.youtube.com/watch?v=XtUSOroh1gc
Box 2: www.youtube.com/watch?v=2x0yiftoV_U
Box 3: www.youtube.com/watch?v=iyTL6M3f9tc
Box 4: www.youtube.com/watch?v=gUkGuApFFQk
Box 5: www.youtube.com/watch?v=ADvn5FKNR-I
Box 6: www.youtube.com/watch?v=myFEngnVBS8.

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