Thermocolour film

Background

Thermocolour film is a useful material for exploring changes in temperature. This changes colour depending on the temperature. This film allows a very wide range of phenomena to be explored much more readily than using a thermometer, providing a striking visual means of displaying temperature changes. The film responds quite rapidly, and since different regions of the film can be at different temperatures, spatial variations in temperature are shown. It can be used to illustrate many concepts linked with heat and temperature, including friction, conduction, insulation, feeling hot and cold, convection, radiation, evaporation, the greenhouse effect, land and sea breezes and the seasons.

The use of thermocolour film at different levels:

Students who may have difficulties communicating verbally, with limited motor control, can be encouraged to experiment with thermocolour film, seeing the changes, moving on to recognise that something will happen when they touch it. This relates to progression within the p levels (pre level 1).

It forms a focus for discussions and simple observations. For example “What happens when you touch the film? What happens when you hold it for longer?” Recognising that the colour changes relates to level one on the N.C. which states “Pupils communicate observations of changes in light, (sound or movement) that result from actions.” Others will progress to recognise the range of colours produced.

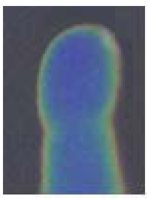
Concepts and ideas relating to heat and temperature can be addressed without having additional numerical issues. Abstract ideas to explain familiar phenomena relate to Level 5 within the N.C. It can be just as fun and interesting to use the film with students who may work towards higher levels to visually demonstrate phenomenon relating to heat and temperature.

Tips on its use

Before pupils use the thermocolour film for the first time, they should spend a little time becoming familiar with it. Putting the card on your fingertips allows you to see the range of colours produced as the film warms up - from black to brown through to green and blue. It is important for pupils to realize that the colour shown when it is hot (dark blue) is quite similar to the colour when it is cold (black) so they should be careful not to confuse the two.

Something that may puzzle pupils is predicting what will happen if you blow on the film. Perhaps it will get colder - after all, we blow on a cup of tea to cool it down. But perhaps it may warm up because we blow on our hands on a cold day to make them warmer. Some pupils may even be tempted to investigate the idea that it is the shape of our mouth as we blow that determines whether things warm up or cool down. They key idea here is that it is temperature differences that cause energy transfers - our breath is warmer than room temperature, so blowing on the film causes it to warm up and eventually it turns blue.

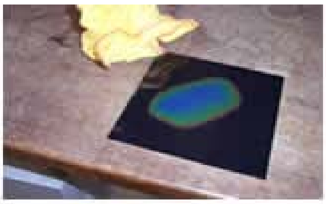
Cognitive challenges with the more able students



With older pupils, putting a finger on the film can lead to a more sophisticated discussion about why there is a gradation in temperature around the point where the fingertip is in contact with the film. Initially, the film warms up by conduction through the film, but after a while a steady state is reached. At each point on the film, the energy escaping is balanced by the energy input and a constant temperature is maintained - the further from the finger, the lower the temperature.

Ideas for its use

Friction

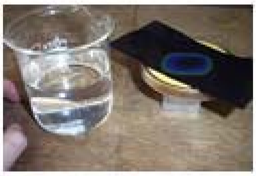
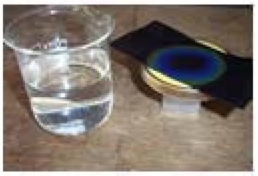


If you put a thermocolour sheet on the bench and 'polish' it with a cloth, it will quickly warm up. The effects of friction can be seen quite easily, and only a little polishing will show a change in the colour of the film. Using a thermometer, such temperature changes are more difficult to detect.

An alternative is to put a piece of paper over some thermocolour film and rub the piece of paper with a rubber as though you were getting rid of a pencil mark (the paper is for protection as the film may be damaged if you rub it directly). Some pupils may believe that it the act of pressing, rather than the movement, which causes the temperature to rise. This is simple to dispel, by pressing the rubber onto the paper without moving it, demonstrating no temperature rise.
These ideas relate to Forces and Energy topics within the curriculum.

Conduction

The thermocolour film is extremely useful for showing how energy moves along a conductor due to a temperature difference. Remove the backing from a piece of thermocolour film (it is self-adhesive), and stick it onto a tin lid. Put a metal block in some warm water for a little while, then remove and put the tin lid on top of it. The colour of the film changes to blue in the middle of the card first and then gradually spreads out until the whole film changes colour. This shows how the temperature differences tend to disappear as energy 'spreads out'.

Alternatively, you could also a rod of metal heated at one end, following the temperature change using a piece of film, and could compare the conductivity of different materials.

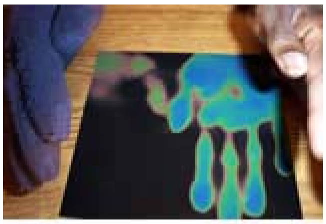
A “magic” trick

The conjuror asks an audience member to choose one coin out of a bag of coins, to pass it around the audience for inspection (eg to read the date) and then replace it in the bag. It is easy for the to identify the chosen coin as it warmer than the others. This effect can be demonstrated using the thermocolour film.

Pupils can put some small objects (e.g. a coin, a rubber, a paper-clip) on the film, and note if anything happens. Then they should hold each object in their hands, and put it on the film. Objects that are at room temperature will have no effect on the film, but if they are held in the hand for sufficient time, they will warm up to the same temperature as the hand. However, some objects (e.g. a coin) will warm up faster than others (e.g. a rubber) depending on their conductivity, and will also make the film warm up faster when placed on it.

Insulation

Wrapping a piece of thermocolour film in gloves will show that gloves do not “make you warmer” but they reduce the heat that is escaping. Discuss this with the students before trying it out to develop ideas about insulation.



To understand why gloves make our hands warmer, pupils could put a glove on one hand and hold onto the film with both hands at the same time. Pupils may be surprised to see that the hand without the glove makes the film warm up more than the gloved hand.

Explanation
Our bodies are normally maintained at a higher temperature than the surroundings, and so there is a constant energy flow from our hands to the air around them. The gloves act as a barrier to energy flow and help to maintain this temperature difference. More energy stays in and less escapes to warm up the film. This is a higher level of scientific reasoning but the experiments are thought provoking and fun to try out with most groups.

If you ask pupils whether wrapping a blanket around someone will make them feel warmer, they will all know the answer. To see if they really understand the role of insulation as a barrier to energy flow, try asking them what would happen if you wrapped a blanket round some frozen food. Would it thaw quicker or slower?

These are just a selection of suggestions. For more ideas visit http://www.sep.org.uk/ and select “Experimenting with Thermocolour film”.

Where to obtain Thermocolour film:

Middlesex University Teaching Resources,
Unit 10, The IO Centre, Lea Road, Waltham Cross, Herts, EN9 1AS

http://www.mutr.co.uk/

At the time of writing, a sheet 150mm x 150mm cost just over £2. These can be used as they are for pupil practical work, or alternatively cut into 4 pieces (so you could buy a class set for under £10). Middlesex University supports the Technology Enhancement Programme, which is connected to the Science Enhancement Programme.

Diffusion in a gel

Background

In this experiment, a petri dish is filled with jelly containing universal indicator, and then the diffusion of hydrochloric acid and sodium hydroxide is observed.

This practical is intended to meet the needs of teaching 3.Ib of the KS3 National Curriculum (England) to a Y7 class:

How the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of state, gas pressure and diffusion.

Equipment

To make the jelly filled petri dishes:	**Each student pair will need:**
15g of gelatine	goggles
25ml Universal Indicator Solution	1 jelly plus Universal Indicator filled petri dish
5.5cm petri dishes	access to a cork borer
boiling water	0.5molar Hydrochloric acid (HCl)
	0.5molar Sodium Hydroxide (NaOH)

Instructions

- Make a jelly solution by dissolving 15g of gelatine in half a litre of water.
- Add 25ml of Universal indicator solution.
- Pour the solution into 5.5cm petri dishes and put them in the fridge to set.
- Give the students a petri dish (in pairs).
- Make a hole in each side of the jelly using a cork borer.
- Using a pipette fill one hole with half-molar hydrochloric acid and the other with half-molar sodium hydroxide (goggles required).
- Place a lid on the petri dish and leave to observe.

Note: Placing the lid on the petri dishes is important to stop the jelly drying up and cracking.

Safety

- Ensure all students wear eye protection when doing the experiment.
- Ensure that students realise that it is not normal jelly so it cannot be eaten.
- Sodium Hydroxide (0.5M) is corrosive and Hydrochloric Acid (0.5 M) is an irritant. Teachers should know how to deal with spillages or accidents. For more information refer to *Hazcards* (CLEAPSS, 2000) or *Safeguards in the School Laboratory* 10^{th} edn (ASE, 1996).

Learning outcomes

The experiment reinforces work done on acids and bases in previous lessons.

Some children will be able to explain that when the two liquids meet a neutralisation reaction occurs.

It is not crucial to the experiment that the students understand acids and bases. They do not need to know what the liquids are; they just need to observe that they move through the jelly. It provides a clear demonstration of diffusion.

Some students may make observations in terms of the spreading out of colours.

The bright colours used and safe, manageable amounts of chemicals involved make this a suitable practical that could be performed in a variety of learning environments.

Higher level outcomes

Students may progress on to more abstract concepts describing the jelly as an open structure that allows liquids to diffuse through it.

Some may observe the different rate of diffusion for hydrochloric acid and sodium hydroxide, suggesting possible reasons and ideas.

More ideas

Students could be encouraged to discuss further investigations such as the effect of light and heat on the rate of diffusion. Children could vary heat and light levels.

A starter activity for the lesson could be spraying some perfume down one end of the classroom; asking the students to predict what they thought would happen and why they thought this would happen.

As a plenary discussion, the scientific model of diffusion could be applied to other contexts (such as oxygen diffusing through water and allowing aquatic life to breathe).

The petri dish results could be examined on an overhead project (comparing before and after) as a focus for class discussion.

Digital photographs of the petri dish could be taken at regular time intervals and used afterwards to recap and possible data analysis.