SCIENCE YEAR
teachers' booklet
[a.k.a. science]

INTRODUCTION
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The Department for Education and Employment (DfEE) is launching Science Year in September 2001. The year will promote the relevance of science to everyday life and highlight some of the fun aspects of science. Focusing on ten to nineteen year olds Science Year will aim to engage young people and boost the take up of science subjects in higher education. The year will underpin the work being done to put science subjects at the heart of the Secondary National Curriculum.

The year will also seek to:

- strengthen links between schools, industry and higher education institutions;

- encourage significant involvement from the scientific community, parents and teachers in shaping the programme to most effectively support young people;

- increase the take up rate of science in further study and career options, particularly teaching;

- celebrate achievements in science and identify role models.

Between March 2001 and the launch of Science Year in September it is planned that there will be a series of "warm-ups" taking place to raise the profile of the Year. TV advertising aimed at 10 –15 year olds and will be broadcast from March 2001 and will be the first truly public activity. These advertisements have been commissioned by DfEE and have been researched with the target audience. The intention is that the adverts will highlight the role that science and scientific principles play in everyday activities. The tag line that will be used is "a.k.a. Science". For those without criminal or musical interests, "a.k.a." stands for 'also known as'. The ads end by encouraging young people to 'phone for a smart pack and directing them to the Science Year website (www.scienceyear.com). Copies of this booklet are downloadable from the web site.

The pack contains ‘cards’ of seven interesting materials. These are examples of what are often known as ‘smart’ or ‘intelligent’ materials, because they respond in some way to their environment.

Card Type:

- Magnetic
- Scratch and Sniff
- Blood Bag
- Hexagonal-celled polymeric material
- Heat sensitive
- Neon edge Perspex
- Glow in the dark

The packaging materials are also of interest. The cards come in a wallet made of polypropylene, a tough polymer, which can be scored to make hinges. It can be flexed many thousands of times without breaking, so there is no need to use hinges of any other material. The wraparound (which advertises Science Year) is printed on Tyvek; a form of paper made from randomly arranged fibres of polyethylene. This is another tough material, impossible to tear.

It's a Magnet

For Teachers:

This card is linked to a TV advertisement showing how electromagnetic forces within loudspeakers produce sound waves.

How it Works:

This 'card' is made of magnetic PVC. Powdered ferrite (a magnetic ceramic) is mixed with PVC and then magnetised. Other magnets made of ferrite: many fridge magnets, magnets in loudspeakers and headphones, and the 'magnadur' magnets used in school labs. [Note that, although the card suggests that is the magnet in a loudspeaker which moves, in fact it is usually fixed; it pushes and pulls on a coil, which moves the cone back and forth.]

Points for discussion:

Where are the north and south poles on this magnet? How could you find them? [The poles are on the flat surfaces; use a compass to find them.]

What uses might there be for a magnetic plastic material like this? [On display boards etc.]

Will it stay stuck to a fridge forever, or will it run down / run out of energy? [No energy is used up as nothing is changing; no work is being done.]

Try making a loudspeaker: Wind a coil of fine wire around a former (e.g. a plastic coffee cup). Connect its ends to a signal generator or the headphone socket of a radio. Stand the coil on the magnetic card and switch on. [Several published teaching schemes show how to do this.]

Personal stereo headphones use modern high-strength 'rare-earth' magnets, which include elements such as samarium. Look for these on the periodic Table.

Attraction

For Teachers:

This card is linked to a TV advertisement showing a male sex symbol getting ready for a date.

How it Works:

A ‘scratch and sniff’ card is covered in tiny beads containing a volatile scent. When the card is scratched, the scent is released into the air. The ‘scent’ used in this card is known as ‘gorilla’s armpit’.

Points for Discussion:

Nasty smells warn us that food may be bad. Name an animal, which produces a nasty smell to warn us off. [Skunk.]

Just a few molecules up the nose can be enough to stimulate the nerves. Some moths can detect just two or three molecules of a sex pheromone.

What smells might be attractive to another person? What smells repel?

What would you call the smell released by this card? [The manufacturers have named this smell ‘gorilla’s armpit’.]

How little of the card smell can you detect? Devise a test. [One approach: Scratch a tiny part of the card in a controlled way. At what range can you detect the smell?]

What animals do you know for which smell is an important sense? [For dogs, cats and many other animals, the sense of smell is as important as sight.]

Many animals release chemical attractants (pheromones), some of which are used in perfumes (e.g. musk). What other natural perfumes do you know of? [Lavender etc.]

Humans also release pheromones, but at such low levels that we are not conscious of them. Why should this be? [No-one knows!]

Laughter

For Teachers:

This card is linked to a TV advertisement showing a female pop star failing to tell a joke successfully.

How it Works:

The red gel is contained within a welded PVC sachet. It consists of fine solid particles suspended in a clear liquid. A gel is an example of a colloid, a mixture of materials in two different states. Blood is made of red blood cells in clear serum, with other cells including leucocytes (white blood cells).

Points for Discussion:

What things make you laugh? [Jokes, embarrassment, other people's discomfort…]

Are you more likely to laugh with others, or on your own? [A survey showed that we laugh thirty times as often when other people are present.]

Laughing and smiling helps to release serotonin in the brain. This is a neurotransmitter chemical; if it is absorbed too rapidly, we may become depressed.

Blood is a gel, a mixture of a solid and a liquid. What do we call a mixture of a liquid and a gas? [A foam.]

Give some more examples of such mixtures. [Jelly, hair gel, shampoo foam etc.]

Why must blood be able to flow? [It must pass through arteries and veins, pumped by the heart, a large muscle.]

It's In The Net

For Teachers:

This card is linked to a TV advertisement showing Dennis Wise failing to score a goal with a swerving shot. He gives the ball spin so that it curves through the air.

How it Works:

This card is made of a hexagonal-celled polymeric material, to represent the netting of a football goal.

Points for discussion:

How does a footballer kick a ball so that it spins? What determines which way the ball spins? [Kick the ball off-centre.]

How does a football move if it is kicked low down, close to where it touches the ground? [It curves upwards into the air, because it has been given reverse spin.]

In what other sports can a ball be made to curve like this? [Baseball, bowls, cricket etc.]

Hold a piece of paper by two corners, horizontally. Blow gently across the top of the paper, which way does it move? [The paper rises. Fast-moving air gives lower pressure, and there is an upward force on the paper. This is the Bernoulli effect, the basis of lift in aircraft.]

Feelin' Hot

For Teachers:

No advert is linked to this card.

How it Works:

The red point on this card is heat reactive (thermochromic). Its composition can be adjusted to that it turns white at a specified temperature.

Points for Discussion:

What would happen to this card on a very hot summer's day? [It would change to white above the critical temperature.]

How could you find the precise temperature at which this paint turns white? [Put the card in a warm oven with a thermometer. Watch as it cools down. Record the temperature at which it regains its colour.]

When you touch the card and it changes colour, what is transferred from your fingers to the card? [Heat energy.]

Is this reaction reversible or irreversible? [Reversible – a physical change.]

Suggest some uses for heat reactive paint. [Warning signs on hot equipment; making a thermometer for monitoring an ill patient's temperature, etc.]

Snakes are sensitive to infra-red radiation coming from warm-blooded creatures – they can see to hunt in the dark.

Lights Out

For Teachers:

No advert is linked with this card.

How it Works:

This card is printed with ‘glow-in-the-dark’ ink. This contains a phosphorescent material, which absorbs and stores the energy of light. The stored energy is released over a long period of time – several hours.

Note: This is not a radioactive material, although many phosphorescent materials contain radioactive elements. Although the card is described as being like a rechargeable ‘light battery’, a better electrical analogy would be a capacitor – most students will be unfamiliar with these. (The output voltage of a battery remains high, and then drops suddenly. The voltage across a capacitor decreases exponentially, like the brightness of the card.) Light is absorbed by atomic electrons, which move to higher energy levels. These levels are metastable; it takes a long time for the electrons to drop back to their earlier level.

Points for Discussion:

Where have you seen glow-in-the-dark materials? [Some toys, plastic stars etc.]

Leave the card in bright light to ‘charge it’. Put it in the dark and it gradually fades. How could you test how long it takes to fade? [Use an electronic light sensor to monitor the light, or use a photographic technique.]

What is the pattern of its fading? [Brightness decreases rapidly at first, then more and more slowly – like radioactive decay.]

The card glows in the light, too – but you can’t see it.

Most sources of light are hot – this is cold. What other cold sources of light do you know of? [Glow worms, deep-sea fishes, some chemical reactions etc.]

Perspex

For Teachers:

No advert is linked to this card.

How it Works:

The Perspex contains a fluorescent chemical; this absorbs ultraviolet light and re-emits it as visible light. (Optical brighteners in detergents work like this.)

The light travels through the Perspex; most bounces around inside, reflected by total internal reflection. Roughly equal amounts emerge from each of the six faces of the Perspex; this is why the shortest edge seems brightest. Students often use this material in Design and Technology lessons.

Points for Discussion:

Where have you seen plastic like this? [Some toys, eg Lego]

Does this plastic glow in the dark? [No – it must have light shining on it.]

Grip the plastic between finger and thumb. The light that was previously reflected now passes out of the plastic and is absorbed. You can see the edges becoming dimmer.

Scratch the surface and some of the light will escape – the scratch will ‘glow’.

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