The House on the Hill (KS 2)

SUPPORT NOTES

This interactive show explores the wonders of sound and light through a story of suspense and surprise. The audience will be able to play with rainbows, make thunder, mix beautiful colours, and have their shadow stolen.

Purpose of these notes

These notes are intended to provide teachers with a brief overview of the main demonstrations and concepts presented in the show, and to suggest some topics for discussion or follow-up after the show. We also hope that the show will encourage teachers to integrate some of the ideas and techniques that they find useful into their own teaching. If you would like any more information about any of these topics please get in touch with us.

safety information

Although each demonstration presented in the show only involves everyday equipment, each activity has been subject to the normal risk assessments. It is important to emphasise that if any of the demonstrations are to be used or adapted for classrooms they should, of course, be thoroughly assessed by each teacher in advance. *Pupils repeating the experiments at home should be encouraged to involve their parents or carers for reasons of both safety and education.*

Format of the show

This show uses a story and exciting demonstrations to reveal the beauty and wonder of science.

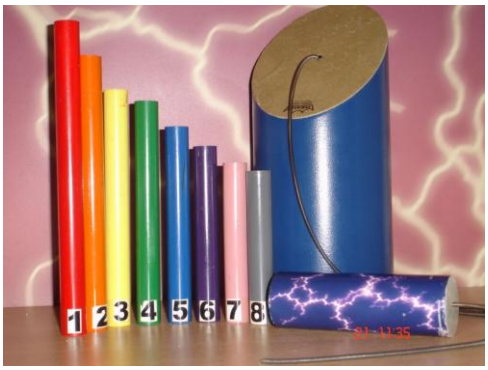
As well as being about the science of light and sound, this story is all about the different ways in which we learn – the different ways we are smart. Sometimes when we think of what being "smart" or "intelligent" means we think of being good at reading, writing and maths. But there are many different ways of being smart. The demonstrations and activities developed for the show were designed to involve all of these multiple intelligences. The activities involve a wide range of skills - problem-solving; logical thinking; working out information from visual images; physical demonstrations involving your body; sensing music to set moods; listening skills and developing imagination through storytelling; working with others.

A selection of the demonstrations outlined below will be used in the show. The exact activities used in each show will depend on the length of the show, the performing conditions, the age and background of the audience, and any particular topics requested by the teachers.

Curriculum connections

Our shows are designed to support and enrich the science strand of the revised NI curriculum learning area *The World Around Us* for Key Stage 2.

The topics covered in the show are concerned with movement and energy – how sounds are produced and how they travel; sources of light; importance of light in our everyday lives. The way that the activities are explored also develops the abilities of pupils to ask questions and test out their ideas.



sound as vibrations

key ideas:

- All sounds are made by something vibrating or shaking.
- Often these vibrations are so small or so fast that we cannot see them.
- The vibrating object sends a series of invisible squashes and stretches through the molecules of the gas (or liquid or solid) that surrounds it.

Asking the pupils to imagine they are molecules of the air and getting them act out how a sound wave would make they move helps to them to visualise how sound travels. They can also visualise why sound cannot travel in space where they are no molecules to transmit the sound.

thunder drums

key ideas:

- Sounds can be loud or soft. The volume of the sound depends on the amount of energy that the sound waves carry – when the molecules are pushed forwards and backwards violently a loud sound is heard, and when they are pushed gently a quiet sound is heard.
- Sounds can be high pitched (like the voice of a girl) or low pitched (like the deep voice of a man).
- The pitch (or frequency) of a sound depends on how many times the vibrating object shakes backwards and forwards in one second. Objects that vibrate very quickly produce high-pitched sounds, and objects vibrating slowly make low notes.
- We can only hear sounds that are made by objects that vibrate between 20 and 20,000 times a second. As we get older our ears get less sensitive to high-pitched notes.

Shaking the metal spring vibrates the drum skin, which cause the air inside the drum to vibrate. The large thunder drum can move more air so it sounds louder than the small drum – like shouting compared to humming with your lips closed. Large amounts of air tend not to vibrate as fast as smaller volumes of air – so the large drum has quite a deep, low-pitched sound compared to the tinny, high-pitched sound from the small drum.

the human loudspeaker

key ideas:

- Sounds travel fastest in solids, then liquids, and slowest in gases. The molecules in a solid or liquid are closer together than in a gas, so they can transmit the pulse of sound energy more quickly when they are compressed. Sounds travel at about 340 metres per second through the air. Sounds can travel nearly 5 times faster in water than air, and almost 20 times faster in solids like steel.
- Sounds travel further in solids and liquids than they do in gases - the sound wave loses energy to its surroundings more slowly in solids and liquids. For example, some male whales sing "songs" that can carry for hundreds of kilometres through the oceans to attract mates.

We asked the human loudspeaker to hold the wooden dowel between her teeth with a coil of copper wire wound tightly around the other end. When we brought a magnet close to this end, the electrical signal from the radio in the copper wires causes the dowel to vibrate slightly. Sounds travel very well through solids, so her teeth and skull vibrate to transmit the sound to her eardrum. We can amplify this sound by using the signal to vibrate a larger object – like the thunder drum.

the palm pipe band

key ideas

- Music is really just "organised sound" – playing a sequence of notes each with a pitch, volume and timbre (quality of the sound) to create tunes and rhythms that sound pleasing to our brains.
- The larger the object the slower it tends to vibrate and so the deeper the sound it produces. Smaller objects can vibrate faster and make higher pitched sounds.
- The 3 main types of musical instrument produce their sounds in different ways – stringed instruments are bowed or plucked (eg violin, guitar); wind instruments are blown (eg trumpet, recorder); and percussion instruments are hit (eg drums).

Slapping the pipe into your hand vibrates the column of air inside, producing a sound of a particular pitch. The longer the pipes, the more air there is to vibrate, and deeper the note it makes. This musical scale can be used to play simple tunes.

Sources of light

Key ideas:

- Some objects make their own light – sources of light eg fire; torch, glow stick, Sun.
- Most objects do not make their own light and we only see them because the light from sources reflects off them towards our eyes eg trees, the Moon.
- Light travels very fast through the air – a million of times faster than sound travels. This is why we usually see the flash of lightning slightly before the clap of thunder, even though they are both made at exactly the same time.
- Light does not need molecules to travel through a region, unlike sound.

Ghostly images

key ideas:

- Light travels in straight lines from the source to our eyes.
- This light is detected by the rods and cones on the retina at the back of our eyes.

When you stare hard at a mostly black picture your rods get used to looking at darkness and they get very sensitive to light – like walking out of a dark cinema into bright light. When you then look at the blank screen immediately afterwards, the back of your eyeball gets flooded by light where there was darkness before, so you should see a whiter-than-white "after-image" of the ghost. If you move your gaze around the room you will the see the ghost follow, because the image is temporarily imprinted on the back of your eyeball. Optical illusions like this fool our eyes and our brains – they look very real.

The mysterious glowing room

key ideas:

- There are some forms of light that our eyes cannot see eg ultraviolet light.
- There is ultraviolet radiation in sunlight.
- Some objects can absorb this invisible light and then give out a glowing light that we can see.

Ultraviolet light is invisible to our eyes, but it gives us a tan and it can also cause skin cancer if we absorb too much of it. The purplish glow that appears once the ultraviolet (UV) or black light is turned on is not UV light. When UV light is absorbed by some surfaces they give out another form of light that we can see - a strange glow. The chemicals in our washing powder and toothpaste make them glow or fluoresce in UV light so that they look "whiter than white" in sunlight.

Stealing your shadow

key ideas:

- Light always travels in straight lines.
- When an object blocks out some light rays from a light source it leaves a dark outline of the object on a screen behind it – a shadow.
- When the object is moved closer to the light source the shadow gets larger; and as the object is moved away from the light the shadow gets smaller.
- Some objects contain chemicals that can absorb lots of light and then give out this light slowly when the light source is removed. Objects that "glow-in-the-dark" like this are called phosphorescent.

The bright flash of light is absorbed by the glow-in-the-dark paper inside the *shadow capture machine*, but the part of the paper blocked out by the volunteer (their shadow) does not get 'charged up' by the light. So when we take away the light, only part of the paper starts to glow, and it looks as if we have "frozen" their shadow. As more light hits all of the paper, the shadow fades.

Coloured shadows and colour mixing

key ideas:

- The primary (or basic) colours of light are red, blue and green.
- You can make any other colour by mixing these three primary colours in different amounts (colour addition).
- White light is made from an equal mix of each of these three colours.

By mixing the red and green light you can make yellow; red and blue combine to give magenta (purple-pink colour); and blue and green produce cyan.

When you overlap the light from the red, blue and green spotlights on the screen, a whitish light is produced. White light is made of these primary colours.

Putting your hand in front of the spotlights reveals many different colours. This is because the spotlights are in slightly different places and your hand makes different colours depending on how many lights are blocked out at that part of the screen:

- if you block out all three lights (like my arm) you get the 'normal' black shadow;
- if you block two of the three lights you get a shadow of the third colour – red, blue and green;
- if you only block out one of the three lights you get a shadow that is a mixture of the other two colours – yellow, magenta, and cyan.

The magic sunglasses

key ideas:

- Any surface can reflect, absorb or transmit the light rays that hit it.
- When an object mixes up or scatters light as it passes through it – so that everything looks a bit darker and more blurred – we call it translucent.
- If an object reflects or absorbs all the light that hits it and does not transmit any we call it opaque – we cannot see through it all.
- An object that lets all of the light pass through it is called transparent – completely see-through like a window.

When light rays hit something they bounce off (reflected), are soaked up (absorbed), or pass through (transmitted).

The lenses from high-quality sunglasses – called Polaroid filters – only let light through that is vibrating in one direction. The filter is then translucent. This is how they help to cut down on the glare entering our eyes.

If you put another filter on top of the first, so that it only lets light through in a direction at right angles to the first, then none of the light will be transmitted and it will look opaque.

The strips of sellotape on the transparent sheet, mean that there are different thicknesses of plastic for the light to travel through – this reveals all the different colours that make up the white light from the projector.

Placing the transparent CD case between the filters reveals the 'hidden' stresses inside the material – where there are strong bands of colour close together this means the plastic is under a lot of strain at these points.

The end of the rainbow

key ideas:

- Sunlight (white light) is made up of "all the colours of the rainbow".
- In the sky, when the sunlight shines through each raindrop, it gets spilt up into six main colours that we can see – red, orange, yellow, green, blue, and violet – making a beautiful rainbow.

In this demonstration the light from the projector represents the Sun, and the water in the glass splits this white light into a rainbow that surrounds the room. An actual rainbow is a complete circle but from the ground we normally only see an arc of colours. There is no end of the rainbow.

Our eyes can make out a million different shades of colour. There are, however, other kinds of light above and below these visible colours that our eyes cannot see eg microwaves and ultraviolet radiation.

follow-up ideas

1) Try making your own palm pipes – cut some PVC piping from any DIY store into the correct lengths to produce the appropriate notes:

1	2	3	4	5	6	7	8
C1	D	E	F	G	A	B	C2
32.7cm	29.4	26.0	24.6	22.1	19.8	17.8	16.7

The tune used for "Twinkle, twinkle little star" was:

1155665
4433221
5544332
5544332
1155665
4433221

There are several web sites with instructions on how to make these pipes eg
http://www.cpo.com/powerpoint/Palm%20pipes.doc

2) If you can find some old, high-quality sunglasses that nobody wants any more you can allow the pupils to design their own polarised work of art with strips of sellotape on acetate sheets, and then discover what they look like between the Polaroid filters.

3) Encourage your pupils to write another account of the story from the point of view of the old lady in the house. Can they describe some of the demonstrations that she used or took part in? How did the demonstrations work? How did she feel when she saw the demonstrations?

4) You could challenge your pupils to remember one example from the show when they had to use each type of intelligence.

- **Learning through logic and numbers** – science itself as a way of thinking – looking for rational explanations for what you see and hear; using maths to work out distance to house;
- **Learning through words** – listening to the story; listening to sounds throughout show; talking about the problem amongst themselves;
- **Learning through pictures** – observing closely; visual experiments throughout show;
- **Learning through action** – molecule role-play for sound transmission;
- **Learning through music** – listening to high/low and loud/soft notes; making a tune at the end;
- **Learning together -** everyone had to work together to make the music at the end; the children were able to understand some of the emotions the old woman was going through; children in the story had to work together to help each other**.**
- **Learning by yourself -** each pupil will have their own strengths and weaknesses in how they learn – it is important for us all to find out how we learn best so that we can use our strengths to the full, and work on our weaker ways of learning.