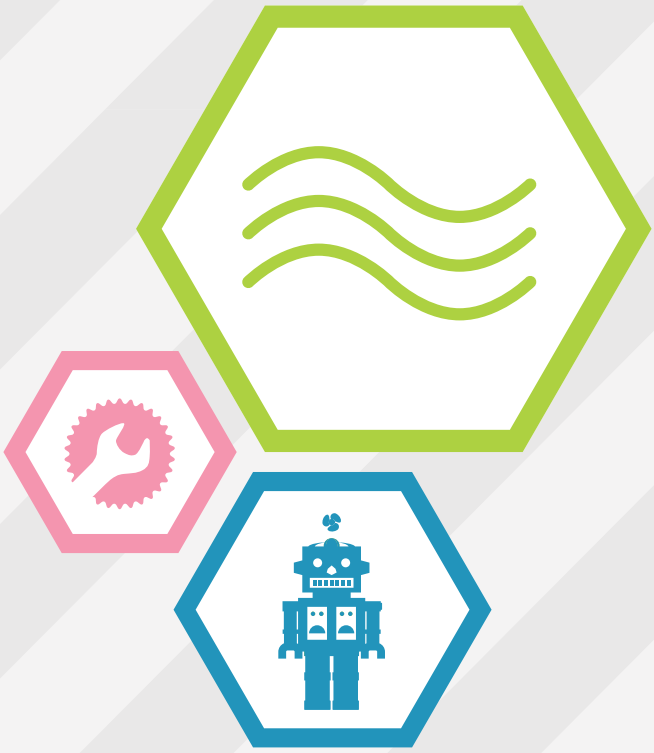
The Edge

MAKEIT

WORKSHOP PLAN



national science week 2015

WAVES OF LIGHT

Many forms of energy travel through space in waves, and light is one of them. When waves collide, interesting things happen!

AGE GROUP
6+

METHOD
Group activity
(14:1 participant to facilitator ratio recommended)

LEVEL
Introductory

DURATION
30 minutes

KEY LEARNINGS
Energy transfer through different mediums can be explained using wave and particle models. (Yr9:ACSSU182)
Use knowledge of scientific concepts to draw conclusions that are consistent with evidence. (Yr9:ACSIS170)

Version 1.1
12 November 2015

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WAVES OF LIGHT

INCLUDED IN THIS WORKSHOP PLAN

> Materials and equipment list
> Preparation suggestions
> Recommendations: General advice, post workshop suggestions and opportunities for further learning
> Full 30 minute workshop outline

APPENDIX

> Materials Suppliers List

MATERIALS AND EQUIPMENT

- ☐ 2 x 150mm squares of clear acrylic plastic
- ☐ 1 x A4 sheet of black paper
- ☐ Clean, new pencils (2 per participant)
- ☐ 150mm square of fly screen mesh (2 per participant)
- ☐ 3D glasses (1 per pair)
- ☐ 100mm square acrylic mirror (1 per pair)
- ☐ Sticky tape
- ☐ Candle or other point source of light (a single bulb, not a tube)
- ☐ MATERIALS SUPPLIERS LIST (appendix)

Required, but not included in pre-packed kits:

- *Sticky tape*
- *Candle/source of light*

PREPARATION

> The facilitator could prepare for this workshop by using the instructions and materials provided to observe the desired effects. Note critical stages (such as preparing the thin slit, and finding an appropriate viewing angle and light source), and advise the participants accordingly.

> Have a rubbish bin ready for any waste that will be generated.

RECOMMENDATIONS

GENERAL ADVICE

> Since this activity consists of some quick demonstrations, and a single simple construction activity, consider the sequence of events. Participants may become bored with too much explanation, and it will be necessary to move on to the hands-on work relatively quickly.

> This topic is also conceptually complex, and therefore it is not important to achieve deep understanding, especially with younger groups. Refer interested participants to online explanations rather than frustrating too many group members with details.

WORKSHOP OUTLINE

00:00 INTRODUCTION

Introduce yourself, welcome participants and cover any housekeeping.

Ask participants if they know about waves and where they have seen them (water waves are a good analogy).

Explain that the waves they see are caused by energy moving *through* the medium (wind acting on water), rather than the movement *of* the medium (does every wave at the beach wash into the shore, or are they just lifted up and down?).

When the energy reaches the edge of the medium, it can be absorbed (like a wave on the beach) or reflected (like a wave in the bath or a swimming pool).

The experiments following will show what happens when light waves interact.

00:05 WHEN WAVES ARE SQUEEZED BETWEEN TWO SURFACES

Acrylic sheets can be prepared in advance.

Prepare the acrylic sheets by removing the protective covering, cleaning them with some methylated spirits, and taping them together around the edges.

Cut out a piece of black paper the same size as the acrylic, and tape it to the back.

Hold the plates together under a light with the black paper underneath, and squeeze with your thumbs. The variance in pressure will produce different moving and shifting swirling coloured patterns.

Continued...

Explanation: The coloured areas appear where light waves reflecting from the surface of the acrylic interact with waves that have passed through the plastic and have been reflected from the bottom sheet.

Different colours of light have their peaks at different distances apart, so when the gap varies slightly, different colours are affected.

If the gap between the sheets is just right (half a wavelength – less than a thousandth of a millimetre), the waves bouncing from the bottom have their peaks where the waves bouncing from the top have their troughs, and they cancel out. This colour is removed from the light you see, and only the remaining colours of light are visible (so the red areas have lost their blue light).

00:10 WHEN WAVES ARE SQUEEZED THROUGH A SLIT

Wrap a single layer of sticky tape around one of the pencils, about 1cm – 2 cm from the end.

If you hold the pencils horizontally, the line should become vertical.

Stand about half a metre from the light, hold the pencils vertically, squeezing them together and hold them about 2.5cm from your eye.

Now look at the light through the slit, just below the sticky tape, and you should see a line of light perpendicular to the slit.

Looking closely, you can see that this line of light is made up of dots of light that will move apart as you squeeze the pencil harder. You might see that they have coloured edges.

Explanation: This effect is caused by waves of light cancelling each other out (to make the black areas) just like in the first example, or doubling up to make bright spots. As the waves pass through the narrow slit, they bend around the edge of the slit and fan out. How much they bend varies with the colour of the light (or the distance between the peaks of the waves). The different amount of bending explains the coloured areas you might see.

00:20 WHEN WAVES ARE FILTERED THROUGH A MESH

A piece of paper will do.

Rubbing works.

Hold the two pieces of fly screen mesh together and look through them onto a white surface.

Move the top sheet of mesh gently from side to side, or rotate it, and notice the patterns of wavy lines that appear. Try flexing one of the pieces too.

You can use one piece of mesh, if working in pairs, by holding the screen and shining a bright light through it. Ask your partner to hold a piece of white paper or card behind it.

Start with the paper touching the screen, and slowly move it away, maybe changing the angle. You should see the same sort of patterns as the screen interacts with its shadow on the paper.

Explanation: What you are seeing is called Moire patterns. The black lines of the top screen overlap either black or clear areas in the screen underneath and your eye sees the whole effect as a single pattern. Changing the relationship between the black and white areas even slightly will make a new pattern.

These patterns can be seen anywhere that a mesh or repeating pattern of lines interacts with itself, or its shadow, in screens, open weave fabrics and even wire fences.

00:25 SIFTING WAVES THROUGH A FILTER

Ask the group how many have been to a modern 3D movie, and if the recall having to wear special glasses to see the effect.

Explain that the glasses work by sending a slightly displaced image to each eye, which your brain combines to make things look 3D. Unlike old fashioned 3D glasses, which used different coloured filters to separate the images, modern technology uses polarising filters to separate the images.

Continued...

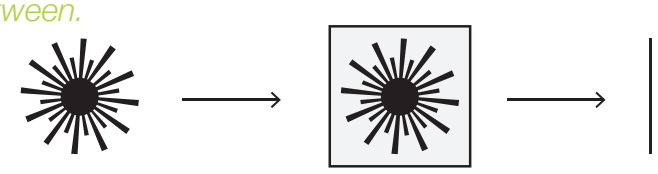
Hand out the 3D glasses, and ask how their vision changes when they put them on. Things get dimmer because the glasses only let part of the available light through (see explanation below).

A reduction in brightness will be observed.

They should see that one lens of the glasses is dark, and through the other lens they will see the closed eye.

Hand out the mirrors, and ask participants to close one eye while they observe their reflection.

Explanation: Coloured filters sift out light according to the wavelength (the distance between the peaks of the waves). Polarised filters sort out light according to the direction of the wave, as shown in the diagram below. In natural light the waves wiggle at all angles – up and down, side to side, and every way between.



A beam of light viewed head-on, showing waves coming at a variety of angles

Polarising filter

Filtered light beam, with wave in one direction

Polarising filters reduce the total incoming light (hence the reduction in intensity), because they only let light through that is wiggling in one direction. (Cinema 3D glasses actually use a more complicated phenomenon, called circular polarisation, which you can read about this on Wikipedia here and here.)

When you look at your eyes in the mirror through the glasses, you see the light that has gone from your face, through the glasses and then onto the mirror. This light is reflected from the mirror, and must travel back through the glasses to get into your eye and be seen. The light travelling from your face near the open eye has gone through a filter, but when it is reflected from the mirror, the angle of the wave is changed. When this light gets back to the glasses, it will no longer pass through the lens in front of the open eye, so this lens appears black in the image. The light travelling from your face near the closed eye is twisted in the opposite direction, and will now pass through the lens over your open eye, so you can see what is beneath this lens: your closed eye.

00:30 THE END

APPENDIX

MATERIALS SUPPLIERS LIST

LIGHT COMES IN WAVES MATERIALS SUPPLIERS

MATERIAL	QTY	SUPPLIER	COST	LINK
A4 black paper (1 per kit)	100	Officeworks	$8.73 + $5.95 shipping	http://www.officeworks.com.au/shop/officeworks/c/paper/coloured-paper/a4-coloured-paper
150x150 mm clear 2mm acrylic (4 per kit)	A4 (210 x 297) cut to size	Acrylics Online	$7.50 ea + $15	http://www.acrylicsonline.com.au/shop-product/acrylic-sheet/a4-size-acrylic-clear-sheet-210-x-297-pack
Pencils (30 per kit)	60 pk	Officeworks	$19.00 + $5.95 < $55	http://www.officeworks.com.au/shop/officeworks/p/columbia-cadet-hb-hexagonal-lead-pencils-60-pack-es6156hhb?searchTerm=pencils
Flyscreen mesh (16 300mm pieces per kit)	50m roll (610 width)	Tradewarehouse	$73.90 + $9.00	http://www.tradewarehouse.com.au/flyscreen-mesh/rolls/flyscreen-fibreglass.html
	610 wide per metre	Bunnings	$8.50 +	http://www.bunnings.com.au/cyclone-insect-screen-aluminium-610mm-555701-p-m_p4111607
3D glasses (8 per kit)	5	Ebay	$5.25 + $1.00	http://www.ebay.com.au/itm/5-pairs-3D-Glasses-for-3D-Passive-Panasonic-Sony-LG-Samsung-TVs-Monitor-Cinema-/261713138343?pt=LHDefaultDomain_15&hash=item3cef5192a7
100mm square acrylic mirror (8 per kit)	A3 (400 x 297) cut to size	Acrylics online	$7.50 + $15 shipping	http://www.acrylicsonline.com.au/shop-product/acrylic-sheet/acrylic-perspex-silver-mirror-1220-2440-2mm-cast-sheet-supply-cut--to--size
Candle	100	Target	$6.00 + $5.00 <$40	http://www.target.com.au/p/1-pack-unscented-tealight-candles/54786387

ABOUT THIS LIST

We've put this list of suppliers together to help make the planning and preparation process a little easier. We don't receive any kick-backs or benefits from sharing this list with you.

If you've downloaded this workshop plan from edgeqld.org.au then you'll require all the materials and equipment listed at the beginning of this document (and above).

If you've received this workshop plan through the National Science Week kits distributed by your public library, then all the above materials are supplied in the kit.

The Edge

Author/Developer

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The Edge, State Library of Queensland
for National Science Week 2015
www.scienceweek.net.au

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This Inspiring Australia initiative is supported by the Australian Government as part of National Science Week.

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