IGCSE Co-ordinated Sciences 0654
Unit 21: P9 Waves, P10 Light and Sound, P11 Making Use of Waves

Recommended Prior Knowledge
Some familiarity with setting up ray boxes would be useful.

Context
The three topics in this unit link together to form a cohesive area of physics.

Outline
Basic ideas about wave forms establish a foundation for study of the behaviour and uses of light and sound. Other parts of the electromagnetic spectrum, and their uses, are also studied.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
AB	Understand that a wave is a means of transferring energy without transferring matter. Understand that energy is transferred in the direction in which the wave travels.	Long springs (often called 'slinkies') can be used to demonstrate the basic properties of wave motion. In the absence of these, long rubber tubing filled with sand, or even a heavy rope, make a suitable substitute.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 8. *IGCSE Study Guide for Physics* by Mike Folland, Topic 3. Interactive wave lesson, click on Waves 1 http://lgfl.skoool.co.uk/
A	Know the meaning of the term wavefront.	These ideas can best be introduced using diagrams on the board or projected onto a screen.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 8.
A	Know the meaning of the terms wavelength, amplitude, frequency and wave speed.		*IGCSE Study Guide for Physics* by Mike Folland, Topic 3.
A	Know and be able to use the equation wave speed = wavelength x	Students aiming for higher grades should practice calculations using this formula.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 8.

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	frequency in simple applications.		*IGCSE Study Guide for Physics* by Mike Folland, Topic 3.
A	Be able to distinguish between transverse and longitudinal waves and appreciate the circumstances in which either or both might occur.	The difference between transverse and longitudinal waves can be demonstrated using springs. The website can be used to show students this difference.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 8. *IGCSE Study Guide for Physics* by Mike Folland, Topic 3. This site has clear demonstrations of transverse and longitudinal waves: http://members.aol.com
ABC	Appreciate the way a wave can be reflected off a plane barrier. Appreciate the way in which a wave can change direction as its speed changes.	Water waves in a ripple tank should be used to demonstrate the properties of refraction and reflection off plane barriers. If enough ripple tanks area available students can do the experiments for themselves. A set of ripple tank projection slides may be used to reinforce the ripple tank work and focus on more detailed discussion.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 8. *IGCSE Study Guide for Physics* by Mike Folland Topic 3. *Teaching and Assessing Practical Skills in Science* by Dave Hayward
ABC	Understand the basic properties of reflection and refraction as they apply to light and sound.	Students can investigate the way light can be uniformly reflected from a mirror and refracted when passing into another, transparent, medium such as glass or Perspex. Students can use instructions from the website to make a simple periscope. Students can carry out simple experiments with optical pins to find the position of the image in a plane mirror. A ray box can be uses to investigate the relationship between angle of incidence and angle of reflection. Students can use rectangular transparent blocks (Perspex or glass) with optical pins or ray boxes to investigate refraction.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 2,3,4,5. *IGCSE Study Guide for Physics* by Mike Folland Topic 3. *Teaching and Assessing Practical Skills in Science* by Dave Hayward How to make a simple periscope. http://www.opticsforkids.com/resources/5_Making_Periscope.pdf

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		Semicircular transparent block can be used to investigate critical angle and total internal reflection.	Total internal reflection, click on Waves 1 http://lgfl.skoool.co.uk More details on further experiments related to total internal reflection and much more http://www.colorado.edu/ click on 8thgrade Physical Science Sol Activities then PS.9 to find total internal reflection
ABC	Understand how the refraction of light by a lens can lead to the formation of real images.	Students can first explore the behaviour of a pinhole camera with one, then many, pinholes. The multiple overlapping pinhole pictures can be collected into one by placing a lens in front of the camera to show how the lens collects together all the light rays falling on it from an object and bends them so that they pass through another place where the image is.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 1,5,6,7. *IGCSE Study Guide for Physics* by Mike Folland, Topic 3.
ABC	Appreciate how reflection and refraction properties can be applied to understand the transmission of light down an optical fibre.	The passage of light down an optical fibre can be shown experimentally.	*Teaching and Assessing Practical Skills in Science* by Dave Hayward. There is a large amount of information and teaching on this site" http://www.physicsclassroom.com
ABC	Appreciate how sound levels can be measured and appreciate the desirability of reducing noise levels yet recognise the problems involved in doing this.	The reflection and refraction of sound is harder to demonstrate experimentally, although a balloon filled with carbon dioxide gas can be made to act as a 'sound lens'. Students who live in urban areas will undoubtedly understand noise as an increasing environmental problem - something that can be usefully investigated. Students can use sound meters to measure the noise level in various locations.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 10 and 11. *Teaching and Assessing Practical Skills in Science* by Dave Hayward. Noise pollution information:

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		Students can plan and carry out investigations to find the best ways to reduce sound levels using appropriate models and different types of insulation.	http://www.infoplease.com
AB	Know that there is limited range of frequencies over which hearing takes place.	The frequency of sound from a signal generator can be fed to a speaker. The frequency of the sound can be changed slowly whilst students listen. Each student (and the teacher) raises a hand when they can no longer hear the sound. This can easily demonstrate the range of frequencies for human hearing, and the facts that this varies from person to person, and changes with age!	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 10 and 11. Good presentation of electromagnetic waves showing the link between wavelength and uses: http://www.colorado.edu/ click on Science Trek click on Electromagnetic Waves
AB	Appreciate the importance of communication systems in the modern world.	Experimental work with optical fibres (see above) can lead to some introductory work on communications.	
A	Be able to state the approximate frequencies over which human hearing takes place.	See above experimental work.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 10.
A	Understand that wave motion is a useful way of describing and explaining the behaviour of light and sound.	Students can compare the behaviour of light and sound and how this can be explained by considering both as wave motions.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 8. *IGCSE Study Guide for Physics* by Mike Folland, Topic 3.
AB	Understand that diffraction and the speed of light in glass, in relation to that in air, are some evidence for the wave nature of light.	There is an opportunity for 'model building' in this area of physics. The wave nature of light and sound can only be established by critically comparing their properties as waves.	*IGCSE Physics* by Tom Duncan & Heather Kennett Chapter 8 and 10.
AB	Understand how a prism can be used to split white light into its component colours.	A simple class experiment, or demonstration, can be used to show that white light from a ray box or slide projector is dispersed by a prism. A single slit can be cut from a piece of stiff card and inserted in	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 4.

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		the slide carrier of the projector to produce a ray that can be shone through the prism on to a screen.	*IGCSE Study Guide for Physics* by Mike Folland, Topic 3. For prism work: http://en.wikipedia.org/
AB	Appreciate how energy can be transferred from waves and how it is possible to be selective in making that transfer.	The selective transfer of energy by waves ('resonance') is a topic of everyday importance in radio and television. It is easily demonstrated using a dynamics trolley held in place by springs attached to each end. The trolley can be set in motion by a wave sent down a long piece of sand-filled rubber tubing, attached to the trolley, but only if the wave frequency is equal to the natural frequency of the spring-coupled trolley.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 11.
AB	Appreciate the nature of colour vision in terms of primary and secondary colours. Be able to identify wavelength with colour in light.	Primary and secondary colours are ways of describing how we see colours and many interesting experiments are possible if a well-darkened room is available.	Interactive colour mixing (no need for a colour mixing kit or blackout) http://www.phy.ntnu.edu.tw/java/shadow/shadow.html Wavelength and colour relationship: http://en.wikipedia.org/wiki/color
AB	Appreciate that light is a part of a wide band of wavelengths called the electromagnetic spectrum.	Include plenty of examples to show students that they already have much general knowledge regarding the uses of electromagnetic waves.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 9. *IGCSE Study Guide for Physics* by Mike Folland, Topic 3.
AB	Be able to associate the terms radio, microwave, infra-red, ultraviolet and X-rays with the appropriate parts of the electromagnetic spectrum and	The electromagnetic spectrum is important for the wealth of applications that it provides. As many as possible of these applications should be within the students' experience. A brain storming exercise can be used to generate ideas that can be collected onto the board. Each student could prepare a short talk on one use of a part of the	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 9. *IGCSE Study Guide for Physics* by Mike Folland, Topic 3.

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	know some of the uses to which these parts of the spectrum are put.	electromagnetic spectrum. .	Electromagnetic spectrum: http://lgfl.shoool.co.uk/ .
AB	Know how sound can be transmitted through air as a wave.	A variety of musical instruments can be used to introduce this section. A signal generator and loudspeaker can be used to investigate the range of audible frequencies. A bell in a bell jar that can be evacuated can be used to show that a medium is required for the transmission of sound (at the same time showing that light travels through a vacuum).	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 10 and 11. *IGCSE Study Guide for Physics* by Mike Folland, Topic 3. This site about sound waves is informative and includes audio! http://library.thinkquest.org/
AB	Be able to relate the loudness and pitch of a sound to the amplitude and frequency of the sound wave.	A c.r.o. (cathode ray oscilloscope) and microphone can be used to give a visual picture of amplitude and frequency.	IGCSE Physics by Tom Duncan & Heather Kennett Chapter 10 and 11.
AB	Appreciate that earthquakes involve the passage of waves through the Earth.	Students can collect newspaper and/or magazine clippings about Earthquakes. Discussion can lead to the idea that the damage Earthquakes can do often depends on resonance between building and wave. This will be a matter of real experience of students in many parts of the world.	*IGCSE Physics* by Tom Duncan & Heather Kennett, Chapter 11.