

GCSE

Edexcel GCSE in Science

Now You See It, Now You Don't (Concept approach)

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Support material

Edexcel GCSE in Science
Now You See It, Now You Don't
(Concept approach)

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Scheme of work for Topic 11: Now you see it, now you don't

LESSON 1: Features of a wave							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P2b 11.14 P2b 11.12	8K Light. 8L Sound and hearing.	Use the correct scientific terms to describe features of waves. Comparing longitudinal and transverse waves.	<p>Starter</p> <p>Ask students to mind map all their existing knowledge about waves. Demonstrate longitudinal waves, transverse waves, amplitude, frequency and wavelength using a slinky.</p> <p>Main</p> <p>Students label a diagram of a wave. Emphasise symbols and units. Demonstrate different wavelengths and frequencies using a signal generator, oscilloscope and loudspeaker. Ensure students understand the link between pitch and frequency, and loudness and amplitude. Students draw a set of waves: the first loud and high pitched, the second the same loudness but low- pitched, the third quiet and high- pitched, the fourth quiet and low-pitched.</p> <p>Plenary</p> <p>Show animations, video clips and examples of different waves. Students decide if each wave is longitudinal or transverse and discuss different features of the wave such as speed and frequency.</p>	<p>Slinky. Loudspeaker, signal generator and oscilloscope. Physics for You, Chapter 29. Longman Foundation/Higher Physics 2 worksheet L6.</p> <p>Crocodile Physics CD ROM. BBC Bitesize. www.echalk.co.uk www.practicalphysics.org/ www.darvill.clara.net for interactive simulations.</p>	<p>Explain the terms:</p> <ul style="list-style-type: none"> • amplitude • frequency • wavelength • speed of a wave. <p>Describe the similarities and differences between longitudinal and transverse waves, giving examples of each type, including sound waves, ultrasound, seismic waves and electromagnetic waves.</p>	N 2.2	
<p>Homework: Students should learn the features of a wave, including units of measurement, and find out examples of longitudinal and transverse waves for a test.</p>							

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LESSON 2: Speed of a wave							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.16 P1b 11.5	8K Light. 8L Sound and hearing. 9K Speeding up.	Calculate the speed of a wave ($v=d/t$). Relationship between speed, velocity and wavelength. Changes in optical density cause waves to be reflected. Explain uses of scanning by reflection.	Starter Test on features of waves from last lesson. Students classify a list of waves into a table of longitudinal and transverse waves. Ask students to recall speed=distance/time equation from KS3. Main Demonstration or practical activity: Tap the water surface in a tank of water using a ruler's edge. Time the ripple reaching the other end of the tank. Use speed = distance/time. Extend the idea to calculate the speed of a wave using velocity = frequency x wavelength as you can create several waves at known time intervals (eg one per second, frequency of one hertz) and measure the distance between wave fronts (wavelength). Remind students how waves can be used to study internal structures in the body. Stress that there must be a boundary/change for the wave to change direction. Explain that ultrasound reflects off the different surfaces inside a person and this is used to show the outline of the organs in the body. Ultrasound is considered a safe method of internal investigation because the waves are low energy sound waves (remind students of echoes). Show video on the use of ultrasound in pre-natal checkups. Plenary Quick test on using $v=d/t$ and $v=f\lambda$, ensuring that questions require rearranging the equations and the correct use of units.	Demonstration Water tank, ruler and stopwatches. Similar to: Longman Foundation or Higher Science 2 Teacher's guide worksheet L2.2. Calculate the speed of waves in water (full details in the guide). www.medphys.ucl.ac.uk/ for medical physics video from UCL. www.ob-ultrasound.net/frames.htm Longman Foundation /Higher Science 2 Teacher's guide, worksheets L5.1/6.1. Physics for You. TV and video on waves eg BBC Bitesize revision video.	Use the equation: speed = distance/time to calculate the distance to a reflecting surface if the time for the reflected wave to return is known. Explain how scanning by reflection can be used for the application of scanning a foetus during pregnancy.	N 2.1 2.2 2.3	

Homework: Worksheet on uses of ultrasound (eg Longman Foundation/Higher Science 2 Teacher's guide L5.1) or describe uses of ultrasound using written resources (eg Physics for You, Chapter 29; Physics at Work: Ultrasonic echoes) as a table, poster or presentation. Headings could include: What is ultrasound? Uses in medicine. Uses in industry.

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LESSON 3: Structure of the Earth							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.4 P1b 11.17 P1b 11.13	8K Light. 8L Sound and hearing.	Changes in optical density cause waves to be refracted. Explain the path of seismic waves within the Earth's interior. Understand why earthquakes and tsunamis are hard to predict.	Starter Animation or video showing an earthquake. Discussion about the devastation caused and difficulty in predicting earthquakes. Problems of positioning sensors; large areas and geographical terrain; risk of false alarms; frequency of tremors in many regions. Explain difference between p and s waves. Main Demonstrate how refraction causes light to change direction using a light ray passing through a glass block, or stand glass rods in beakers of different liquids (eg water/glycerol/alcohol) and see the light bend (refract) by a different amount in the different substances. Explain some waves change direction within the Earth because their speed changes – this is refraction. Explain and draw diagrams to show that the Earth's core stops s-waves passing through – proof the core is liquid. Alternatively, do an interactive exercise to plot graphs of velocities of p and s waves against depth below Earth's surface. Draw conclusions about the nature of the Earth at various depths.	Videos eg Short Circuit: 'Earthquakes and seismic waves' Science in Focus: 'Earthquakes – the sound of the Earth'. Ray boxes, power packs, glass blocks or glass rods, beakers containing glycerol, water and alcohol. www.matter.org.uk navigate to A level Physics: Refraction. www.upd8.org.uk www.echalk.co.uk homepage.ntlworld.com/wendy.sadler www.howstuffworks.com www.practicalphysics.org/ Physics for You, Chapter 20; Longman Higher Physics 2 worksheet L5.	Use primary or secondary data to describe how differences in density of materials will cause waves to be reflected/refracted. Use data about seismic waves passing through the Earth to draw conclusions about the types of materials that are found in the planet's interior. Suggest reasons why scientists find it difficult to predict earthquakes and tsunami waves, given appropriate data.	C 2.1 N 2.1 2.2 2.3 ICT 2.1 PS 2.1 2.2 2.3	

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LESSON 3: Structure of the Earth (continued)							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
			<p>Plenary</p> <p>Show an animation/video of tsunami. Ask why the tsunami was so devastating. Explain that the wave behaved differently in deep water, moving fast but as it reached shallow water by the coast the front of the wave slowed down and the back caught up, so a huge body of water surged onshore.</p> <p>Demonstrate how the energy travels along the water's surface but the water is disturbed up/down by using a clear tank with water and dropping a cork on the surface. Repeat in different depths of water to see the wave travelling at different speeds. Explain water is a transverse wave (as are em waves and seismic s-waves). (Students can see the disturbed surface through the side of the tray. Identify wave front, amplitude etc.)</p>	<p>www.matter.org.uk/schools/Content/Seismology/experiment1.html</p> <p>BBC website for information on tsunami.</p>			
<p>Homework: Set questions on structure of the Earth's interior (eg Longman Higher Physics 2 Teacher's guide L5.1; Physics for You, Chapter 20 – questions and selection from further questions on Earth and beyond, Physics for You Support Pack research sheet; 'Ideas about the Earth' or Reactive Science, Chapter 12).</p>							

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LESSON 4: The wave speed equation							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.15 P1b 11.19	8K Light. 8L Sound and hearing.	Calculate the speed of a wave ($v=d/t$). Electromagnetic waves all travel at the same speed.	<p>Starter</p> <p>Recap/quick test on the meanings of frequency (Hz) and wavelength (m). Review the symbol for wavelength.</p> <p>Main</p> <p>To demonstrate the speed of sound: students measure distance greater than 50m from the school wall; clap blocks and calculate speed of sound. Alternatively, do the velocity of sound experiment from UNILAB www.unilab.co.uk/waves.htm.</p> <p>Extend calculations to echo sounding and firing pulse of laser light at the moon. Use animations to show change in wavelength as waves encounter a boundary. Give examples of how to calculate wave speed. Show how to use a triangle to rearrange the equation. Students complete a set of questions to ensure they practise calculating frequency, wavelength and wave speed.</p> <p>Plenary</p> <p>Ask students to describe what they have found out about the speed of electromagnetic waves. They should be able to say that it is always constant, state its value and state its units.</p>	TV and video on waves eg BBC Bitesize revision video.	Use the relationship: speed = frequency \times wavelength. Recall that electromagnetic waves all travel at the same speed in a vacuum.	N 2.1 2.2 2.3 C 2.1	
<p>Homework: More questions on speed=distance/time and speed = frequency \times wavelength (eg use Longman Science 2 K1 and L2). Ensure they include units. Learn the value of the speed of electromagnetic waves in a vacuum and units for a test.</p>							

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LESSON 5: The electromagnetic spectrum — 1							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.18 P1b 11.5	8K Light. 8L Sound and hearing.	Representing similarities and differences of waves in the electromagnetic spectrum. Changes in optical density cause waves to be reflected. Explain uses of scanning by reflection.	<p>Starter</p> <p>Test on speed of electromagnetic waves and their units from last lesson. Show a general video about the electromagnetic spectrum.</p> <p>Main</p> <p>Cut and stick to match jumbled examples of parts/sources/uses of the electromagnetic spectrum to the names of each section. Explain that the electromagnetic spectrum is a group of waves with similar properties eg they travel through a vacuum at the speed of light. The waves have unique properties and uses depending on their frequency. Show a selection of devices to students as a visual aid.</p> <p>Show video on use of ultrasound in pre-natal checkups. A demonstration of light reflecting off a mirror could be appropriate – stress that many types of waves reflect off boundaries, including light as well as sound (light cannot study internal structure as skin is opaque but opticians study the inside of our eyes using light passed through the pupil and reflected off the back of the eyeball).</p> <p>Plenary</p> <p>Class debate on security checks by fingerprints + DNA, leading to iris recognition, as fast but secure methods of identification.</p>	<p>TV and video eg Science in Focus: ‘Electromagnetic spectrum making waves’.</p> <p>Short Circuit: ‘Electromagnetic waves’.</p> <p>Websites: www.darvill.clara.net www.howstuffworks.com</p> <p>Book resources include: Longman Foundation or Higher Science Book 2 worksheets L10, L12. Nelson Thornes Physics for You, Chapter 28. CUP Reactive Science, Chapter 12.</p> <p>Range of devices, materials linked to different parts of the electromagnetic spectrum, eg radio, TV, X-ray negatives, mobile phone, microwave oven/food label/dish, UV light, pictures of sunbeds, heat lamp, security markers, TV remote control.</p> <p>Access to computer suite.</p>	<p>Describe how similarities and differences of waves can be represented in the electromagnetic spectrum.</p> <p>Explain how scanning by reflection can be used for the following application: Optical: iris recognition. Discuss the advantages and disadvantages of such technology.</p>	<p>C</p> <p>2.2</p> <p>ICT</p> <p>2.1</p> <p>2.2</p> <p>2.3</p>	
<p>Homework: Learn order of electromagnetic spectrum for a test next lesson. Worksheet on uses of ultrasound (eg Longman Foundation/Higher Science 2 Teacher’s guide, L5.1). Describe uses of ultrasound using written resources (eg Physics for You, Chapter 29 Physics at Work: Ultrasonic echoes) as a table, poster or presentation. Headings could include: What is ultrasound; Uses in medicine; Uses in industry.</p>							

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LESSON 6: The electromagnetic spectrum — 2							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.6 P1b 11.7	8K Light.	Explain uses of scanning by absorption.	<p>Starter</p> <p>Ask students to write out parts of electromagnetic spectrum in the correct order.</p> <p>Explain that there are some structures in the body that cannot be investigated by ultrasound. More powerful rays are used which pass through soft tissues, but are absorbed by bones. Use OHPs or a data projector to show X-ray negatives of broken bones etc. Use the OHP to cast a shadow of a hand on to a screen showing that the closer it is to the screen the sharper the image (relates to X-rays being shadowgrams).</p> <p>Shine a lamp at a wall through a sheet of card, showing the card's shadow (light is absorbed). Tear the card into pieces and then students piece it together. Discuss why students can now see light shining through the cracks. Students use ideas from KS3 to explain what is happening.</p> <p>Explain that other less energetic waves are absorbed in other situations eg microwaves are absorbed by water/rain and this is why it is difficult to get a mobile phone or satellite TV signal during a monsoon like downpour.</p> <p>Microwaves are used to monitor rain. Surround a mobile phone with various materials then see if it will ring when dialled by second mobile.</p>	<p>Websites www.darvill.clara.net www.howstuffworks.com</p> <p>Longman Foundation or Higher Science Book 2 worksheets L10, L12.</p> <p>Nelson Thornes Physics for You, Chapter 28.</p> <p>CUP: Reactive Science, Chapter 12.</p> <p>Use of images from www.meditherm.com/</p> <p>Access to computer suite. Heat sensor linked to data logger and computer.</p> <p>Physics for You sections on Physics at work (electromagnetic waves), Chapter 28 and Radiation from Chapter 8.</p> <p>Physics through Applications OUP.</p>	<p>Explain how scanning by absorption enables: X-rays to see bone fractures, microwaves to monitor rain and ultraviolet light to detect forged bank notes by fluorescence.</p> <p>Explain how scanning by emission enables the use of infrared sensors to monitor temperature.</p>	<p>C</p> <p>2.2</p> <p>ICT</p> <p>2.1</p> <p>2.2</p> <p>2.3</p>	

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LESSON 6: The electromagnetic spectrum — 2 (continued)							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
			<p>Main</p> <p>Students prepare a presentation based on 'Electromagnetic Waves and Health' (eg X-rays, gamma rays, infrared and UV) or 'Electromagnetic Waves and Communications' (eg microwaves, radio and TV waves) or 'electromagnetic waves in the home' (eg infrared, microwaves, visible, TV and radio).</p> <p>Explain the term fluorescence (certain materials absorb invisible UV, reemitting it as visible purple light). Demonstrate a security marker. Explain how fluorescent materials help to prevent forgeries eg materials used to make bank notes and the use of UV lamps by cashiers.</p> <p>Plenary</p> <p>Use a heat sensor to compare infrared radiation from fans/beakers of cold and hot water.</p> <p>Class discussion on how search and rescue, or police helicopters, can find people in the dark.</p>				
<p>Homework: Foundation tier students prepare a poster to explain how infrared sensors are used to monitor temperature eg satellite images of land us, by fire fighters and the police to look for people, to survey heat losses from houses and factories.</p> <p>Higher tier students present the same information as an article for a scientific journal or video for the Blue Peter TV programme (show the journals <i>New Scientist</i> or <i>Nature</i> when discussing the homework).</p>							

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LESSON 7: Microwaves and mobiles							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.3 P1b 11.1	8K Light.	Wave energy can be a risk to health.	<p>Starter</p> <p>Do Physics for You Support Pack Research sheet 'Are mobile phones safe'.</p> <p>Main</p> <p>In groups, students prepare posters on the possible effects on health of microwaves. The poster should include the name of the radiation and its frequency, a description of the risk it poses and damage it causes (also an estimate of long/short term effects) and ways to minimise the effects of the radiation. Discuss whether the benefits of use outweigh the risks.</p> <p>Plenary</p> <p>Students show their posters to the rest of the class, and these are discussed and improved.</p>	<p>Institute of Physics and Engineering in Medicine www.ipem.ac.uk</p> <p>Longman Foundation or Higher Physics 2 worksheet L13.1 for effects on cells.</p> <p>Physics for You Chapter 28.</p> <p>Reactive Science Chapter 12.</p> <p>Access to computer suite.</p>	<p>Describe the detrimental effects of excessive exposure to microwaves: internal heating of body tissue and explain this in terms of increasing frequency.</p> <p>Discuss the evidence that microwave radiation from mobile phones or masts poses health risks and how this has been reported in the media.</p>	<p>C</p> <p>2.1 2.2 2.3</p> <p>ICT</p> <p>2.1 2.2 2.3</p> <p>WO</p> <p>2.1 2.2 2.3</p>	
<p>Homework: Students research and create posters on mobile phones.</p>							

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LESSON 8: Infrared, X-rays and UV radiation							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.3 P1b 11.2	8K Light.	Wave energy can be a risk to health.	<p>Starter</p> <p>Class discussion about the dangers of sunbathing, reinforcing the idea that waves transfer energy and that this energy can damage cells when absorbed. Explain that the dangers may not show up until later in life, and prevention is better than cure.</p> <p>Main</p> <p>In groups students prepare posters on the possible effects on health of one type of electromagnetic radiation not already covered in previous lessons eg infrared (burns), UV (sunburn, skin cancer), X-rays or gamma rays (mutation or death of cells). Ensure that the class has covered each type of radiation. The poster should include the name of the radiation, its frequency, a description of the risk it poses/damage it causes (also an estimate of long/short term effects) and ways to minimise the effects of the radiation.</p> <p>Plenary</p> <p>At the end of the session, the posters from all the lessons in this topic can be displayed in order of the frequency of the radiation investigated. This should show a progression of increasing dangers with increasing frequency. Discuss whether the benefits of use outweigh the risks.</p>	<p>Institute of Physics and Engineering in Medicine www.ipem.ac.uk</p> <p>Longman Foundation or Higher Physics2 worksheet L13.1 for effects on cells.</p> <p>Physics for You Chapter 28.</p> <p>Reactive Science Chapter 12.</p> <p>Access to computer suite.</p>	<p>Describe the detrimental effects of excessive exposure to the following waves and explain this in terms of increasing frequency:</p> <ul style="list-style-type: none"> - infrared: skin burns - X-rays and gamma-rays :mutation or destruction of cells in the body. <p>Discuss the characteristics of ultraviolet light in terms of amplitude, frequency and wavelength and relate them to the dangers of over-exposure.</p>	<p>C</p> <p>2.1 2.2 2.3</p> <p>ICT</p> <p>2.1 2.2 2.3</p> <p>WO</p> <p>2.1 2.2 2.3</p>	
<p>Homework: Worksheet Longman Foundation or Higher Physics 2 L13.1 (effects on body).</p>							

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LESSON 9: Analogue and digital							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.9 P1b 11.11	8K Light.	Comparing analogue and digital signals. Explain how total internal reflection allows signals to travel through optical fibres.	<p>Starter Play a sound track of an old fashioned record, followed by MP3 of same track. Ask students to comment on differences.</p> <p>Main Explain the differences between analogue and digital signals, and the advantages of digital signals. Students sort a list of devices into analogue and digital. Set of questions on analogue and digital.</p> <p>Plenary Demonstrate/practical 11.9 (Total internal reflection) using semicircular glass block and ray box. Show optical fibre lamp, and discuss uses of optical fibres eg communication and endoscopy.</p>	<p>Record and player, same recording on MP3. Analogue and digital devices to look at.</p> <p>Semicircular glass block, ray box, power pack and optical fibre lamp.</p> <p>Video: Beyond the Square Window (Science in Focus). Longman Foundation/Higher Science 2 plus Teacher's guide worksheet L11.1 or Physics for You, Chapter 36 Physics at work: In your home and Chapter 38 Physics at work: Analogue and digital communications.</p> <p>Reactive Science Chapter 12. Foundation/Higher Science 2 Teacher's worksheet L7.1.</p>	<p>Describe the advantages of sending information in the form of a digital signal compared with analogue.</p> <p>Describe how the property of total internal reflection of light waves allows optical fibres to transfer large amounts of information over long distances.</p>		
<p>Homework: Research medical or communication uses of optical fibres.</p>							

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LESSON 10: Digital music							
Spec. code	Links and concept building from KS3	Learning objectives	Teaching activities	Resources	Learning outcomes	Key skills	Safety issues
P1b 11.10 P1b 11.8	8L Sound and hearing.	Uses of digital signals in music technologies. Benefits and drawbacks of using wave-based technology.	<p>Starter Class survey on types of music players used by students and their families, eg MP3, CD, do they download from the web?</p> <p>Main Students use resources to explain how CD recordings store digital data compared to analogue data stored on records or tapes. Present as a two column table (diagram and explanation per medium) for comparison.</p> <p>Plenary Higher tier students prepare a poster showing a greater variety of benefits and drawbacks of a wave -based technology from a discussion covering previous work. Issues may include benefits of improved knowledge, communication and health care, but threats to health and privacy etc. Foundation tier students discuss the above issues and make a table of benefits/drawbacks.</p>	<p>Use of computer suite is desirable. http://electronics.howstuffworks.com may be helpful. Video: Beyond the Square Window (Science in Focus). Longman Foundation/Higher Science 2 Teacher's guide worksheet L11.1. Physics for You, Chapter 36 Physics at work: In your home and Chapter 38 Physics at work: Analogue and digital communications. Reactive Science Chapter 12. Longman Foundation/Higher Science 2 teacher's guide L7.1.</p>	Discuss how the production of digital signals has created a range of music technologies, including synthesised instruments and altered the way we listen to and distribute music. Discuss the benefits and drawbacks to society of a technology that is based on the properties of waves.	C 2.1 2.3 ICT 2.1 2.2 2.3 WO 2.2	
<p>Homework: Update the mind map from lesson one and prepare for a test.</p>							

Activity 11.1: Uses of electromagnetic waves

Notes for students

What you will learn from this activity

In this activity you will learn about the uses of different parts of the electromagnetic spectrum.

What you will know when you finish this activity

- 1 The main parts of the electromagnetic spectrum.
- 2 The uses of each part of the electromagnetic spectrum.

What you do

- 1 Make a table showing the main parts of the electromagnetic spectrum in order of decreasing wavelength (start with radio waves).
- 2 Work your way around the pieces of equipment and photographs set out in the laboratory.
- 3 For each item decide which part of the electromagnetic spectrum it uses and then add the use to your table of the spectrum.
- 4 Some clues to get you started: broadcasting equipment uses radio waves; equipment giving out heat usually uses infrared radiation; medical uses generally involve X-rays and gamma-rays; equipment involving light uses visible radiation.

Suggestions for further work/homework

Use textbooks or the internet to find further uses of as many parts of the electromagnetic spectrum as you can.

Experiment 11.9: Total internal reflection

Notes for teachers and technicians

Aim

In this activity students will learn about uses of different parts of the electromagnetic spectrum.

Materials required

Label the equipment listed below (this is not an exhaustive list — add further items depending on availability).

Arrange the equipment in a circus around the laboratory.

- 1 Photograph of gamma radiation used to treat cancer.
- 2 Photograph of x-ray machine.
- 3 X-ray negatives.
- 4 Sun tan lotion/sunblock.
- 5 Posters (from Australia) alerting people to the dangers of sunbathing.
- 6 Security markers, UV lamp and fluorescent material.
- 7 Sunglasses.
- 8 Camera.
- 9 TV.
- 10 Model eye.
- 11 CD player.
- 12 Toaster.
- 13 TV remote control.
- 14 Electric fire.
- 15 Heat lamp.
- 16 Microwave oven.
- 17 Food labels for microwave.
- 18 Microwave dish.
- 19 Mobile telephone.
- 20 Poster about radar.
- 21 Meteorology poster about detecting rain.
- 22 Radio.

Health and safety issues

All appliances should be checked and/or plugs removed from equipment that connects to the mains supply.

Activity 11.1: Uses of electromagnetic waves

Delivery strategies

- Class discussion about the visible light spectrum (Key Stage 3).
- Students check each other's work after completing the circus.

Suggestions for further work

Research in depth at least one other use of electromagnetic waves.

Experiment 11.9: Total internal reflection

Notes for students

What you will learn from this demonstration

In this demonstration you will find out how the loudness and pitch of a sound wave can be represented on a diagram.

What you will know after you see this demonstration

- 1 That frequency is measured in Hertz and is represented by the number of waves passing a certain point per second.
- 2 Loudness is represented by the amplitude of a wave on a wave diagram.
- 3 That sound waves can be analysed using a cathode ray oscilloscope.

What you do

- 1 Draw four large boxes all on the same page.
- 2 Divide each box in half and draw a horizontal line across the centre of each box.
- 3 The teacher will show you some waves on the screen of the cathode ray oscilloscope, and you will also be able to listen to the loudness and pitch (frequency) of these waves.
- 4 Try and relate what you hear to what you see.
- 5 Your teacher will draw a loud low-pitched wave for you to copy into the first box and then they will give you a list of other waves to draw in the other boxes.

Questions

What is the unit of frequency?

What is the distance from the peak of a wave to the next peak called?

Demonstration 11.1: Sound waves

Notes for teachers and technicians

Aim

In this demonstration students will find out how the loudness and pitch of a sound wave can be represented on a diagram.

Skills, knowledge and understanding to be gained

This demonstration will enable students to gain the following skills and/or knowledge and understanding:

- 1 Frequency is measured in Hertz and is represented by the number of waves passing a certain point per second.
- 2 Loudness is represented by the amplitude of a wave on a wave diagram.
- 3 That sound waves can be analysed using a cathode ray oscilloscope.

Equipment and chemicals required

- 1 Cathode ray oscilloscope.
- 2 Signal generator.
- 3 Speaker.
- 4 Microphone.
- 5 Connecting leads.

Connect the cathode ray oscilloscope, signal generator and the loudspeaker together prior to the lesson. A camera and data projector are recommended to enable all students to see the display. Picometers are available that plug into a data projector and PC to act as a CRO.

Health and safety issues

Be aware that very high-pitched sounds can make some students feel unwell.

Delivery strategies

- Before using the equipment ask students ‘who wants to see a sound wave?’. Then discuss what they actually see.
- Be sensitive to students with hearing difficulties especially if measuring the upper/lower limit of human hearing.

Links with Key Stage 3 (KS3)

This demonstration builds on the following skills, knowledge and understanding from KS3:

- 8L Sound and hearing.

Resources

- www.bbc.co.uk
- http://www.mathematicshelpcentral.com/graph_paper/files/Form3B-BW.pdf

Experiment 11.9: Total internal reflection

Suggestions for further work

Research the upper limit of hearing for different animals.

Could also look into deafness, and its causes and prevention.

Role play – human waves. Students hold hands, a sound is played through the signal generator and loudspeaker and students have to simulate the loudness and frequency of the sound with their arms.

Experiment 11.9: Total internal reflection

Notes for students

What you will learn from this experiment

In this experiment you will find out how to measure the critical angle for a particular material.

What you will know when you finish this experiment

- 1 Be able to describe an experiment to show total internal reflection.
- 2 That different materials have different critical angles.
- 3 That at a certain angle of incidence, the refracted light travels along the boundary of two materials and that above the critical angle the light is reflected back from the inside surface - it is totally internally reflected.

How you may be assessed

- 1 Your teacher may check the accuracy of your angle drawing and measuring.
- 2 Your teacher may ask you to say what the critical angle of your material is from your measurements.

What you do

- 1 Put a semicircular glass or perspex block flat on an A4 plain piece of paper.
- 2 Draw around it and draw a normal (dotted) line through the centre of the straight edge on your drawing.
- 3 Shine an incident ray at the point where the normal line crosses the straight edge of the block. Make sure you shine the ray through the curved side of the block.
- 4 Move your ray box around (keeping the ray going through the point where the normal line crosses the straight edge of the block.) You will see at some angles the ray passes directly through the block into the air and at other angles it reflects back through the block.
- 5 Make a mark at the angle the ray travels along the boundary.
- 6 Measure this angle between the incident ray and the normal.
- 7 Check with your teacher – they will know the critical angle for the material you are working with.

Suggestions for further work/homework

See Longman Higher/Foundation Science 2 worksheet L7.

Experiment 11.9: Total internal reflection

Notes for teachers and technicians

Aim

In this experiment students will find out how to measure the critical angle for a particular material.

Skills, knowledge and understanding to be gained

- 1 Drawing ray diagrams.
- 2 Measuring angles.
- 3 Correct terminology for ray diagrams, revision of reflection and refraction.

Equipment and chemicals required

- 1 Semicircular glass/perspex blocks.
- 2 A4 plain paper.
- 3 Protractors.
- 4 Ray boxes with single slits.
- 5 Rulers and pencils.

Health and safety issues

Care with bulbs as they may get hot.

Glass blocks may have sharp edges if damaged.

Delivery strategies

- Include a diagram if students are not planning the experiment for themselves.
- Demonstrate how to set up the apparatus and where to draw the normal.
- Suggest a reward for the most accurate diagram with all the correct labels, and correct critical angle.
- If possible have different groups working on blocks of different materials.
- Explain that different materials have a different critical angle.
- Give some applications of where TIR is used and why we need to know the critical angle for a particular material.

Assessment strategies

- Accurate diagrams will produce a correct critical angle.
- Insist that each student produces a labelled diagram if sharing equipment.
- Allocate marks for labels, use of ruler, arrowheads, dotted normals, etc.

Experiment 11.9: Total internal reflection

Links with Key Stage 3 (KS3)

This experiment builds on the following skills, knowledge and understanding from KS3:

- 8K Light.

Resources

- Multimedia science school 11–16.
- Longman Higher/Foundation Science 2 Worksheet L6.

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