Qualification Accredited

OCR
Oxford Cambridge and RSA

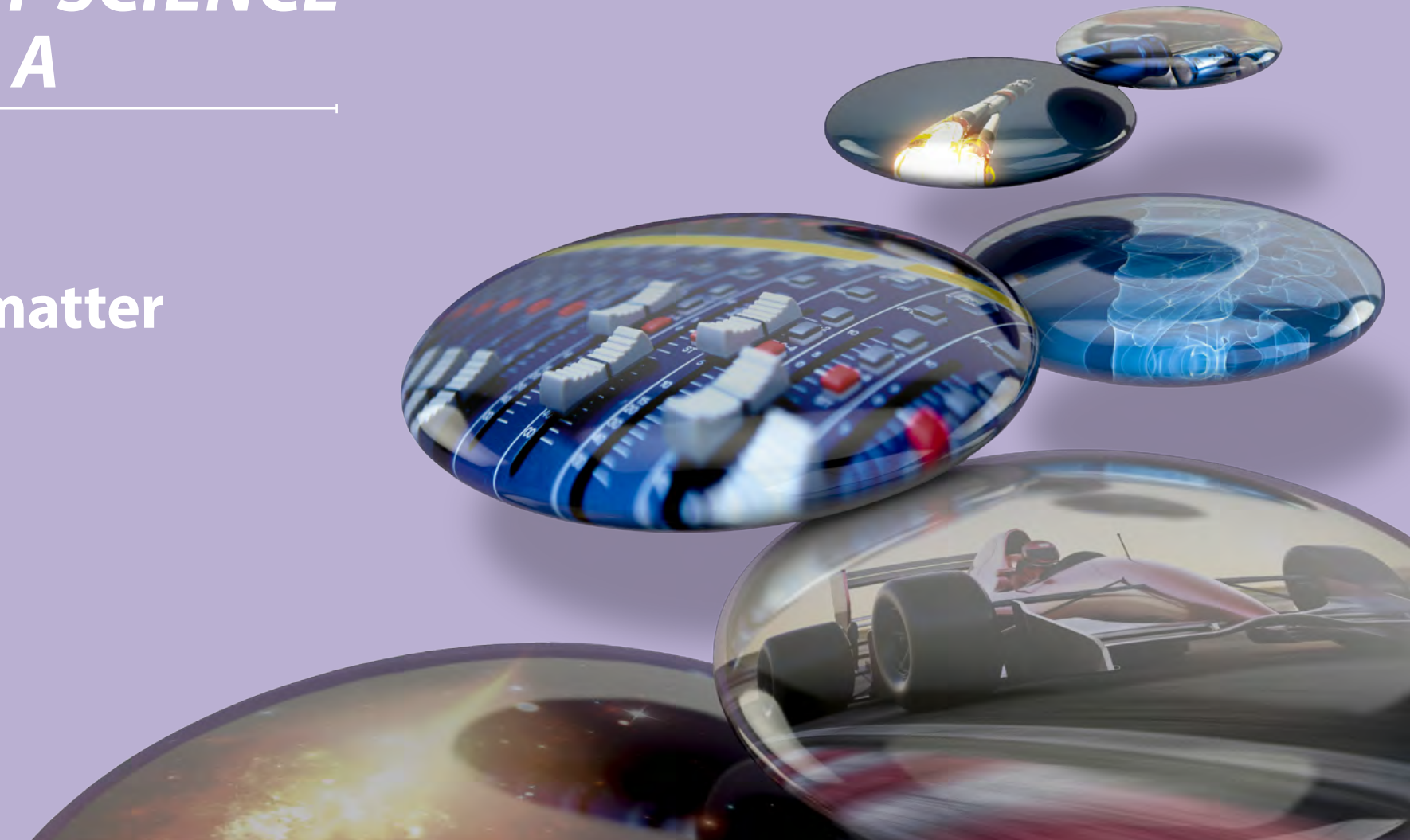
GCSE (9–1)
Transition Guide

GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

Waves in matter

Version 1



www.ocr.org.uk/physics

GCSE (9–1)

GATEWAY SCIENCE PHYSICS A

Key Stage 3 to 4 Transition guides focus on how a particular topic is covered at the different key stages and provide information on:

- Differences in the demand and approach at the different levels;
- Useful ways to think about the content at Key Stage 3 which will help prepare students for progression to Key Stage 4;
- Common student misconceptions in this topic.

Transition guides also contain links to a range of teaching activities that can be used to deliver the content at Key Stage 3 and 4 and are designed to be of use to teachers of both key stages. Central to the transition guide is a Checkpoint task which is specifically designed to help teachers determine whether students have developed deep conceptual understanding of the topic at Key Stage 3 and assess their 'readiness for progression' to Key Stage 4 content on this topic. This checkpoint task can be used as a summative assessment at the end of Key Stage 3 teaching of the topic or by Key Stage 4 teachers to establish their students' conceptual starting point.

Key Stage 3 to 4 Transition Guides are written by experts with experience of teaching at both key stages.

Mapping KS3 to KS4 Page 3

Possible Teaching Activities (KS3 focus) Page 5

Checkpoint tasks (KS3 focus) Page 6

Possible Teaching Activities (KS4 focus) Page 7

Possible Extension Activities (KS4 focus) Page 8

Resources, links and support Page 9

Key Stage 3 Content

Learners will be required to:

Observed waves

- waves on water as undulations which travel through water with transverse motion; these waves can be reflected, and add or cancel – superposition.

Sound waves

- frequencies of sound waves, measured in hertz (Hz); echoes, reflection and absorption of sound
- sound needs a medium to travel, the speed of sound in air, in water, in solids
- sound produced by vibrations of objects, in loud speakers, detected by their effects on microphone diaphragm and the ear drum; sound waves are longitudinal
- auditory range of humans and animals. Energy and waves
- pressure waves transferring energy; use for cleaning and physiotherapy by ultra-sound; waves transferring information for conversion to electrical signals by microphone.

Light waves

- the similarities and differences between light waves and waves in matter: light waves travelling through a vacuum; speed of light
- the transmission of light through materials: absorption, diffuse scattering and specular reflection at a surface Science – key stage 3 12
- use of ray model to explain imaging in mirrors, the pinhole camera, the refraction of light and action of convex lens in focusing (qualitative); the human eye
- light transferring energy from source to absorber leading to chemical and electrical effects; photo-sensitive material in the retina and in cameras
- colours and the different frequencies of light, white light and prisms (qualitative only); differential colour effects in absorption and diffuse reflection.

Key Stage 4 Content

Learners will be required to:

- Describe wave motion in terms of amplitude, wavelength, frequency and period
- Recall and apply: wave speed (m/s) = frequency (Hz) x wavelength (m)
- Describe differences between transverse and longitudinal waves
- Describe the effects of reflection, transmission, and absorption of waves at material interfaces (to include examples such as ultrasound and sonar)
- Describe how ripples on water surfaces are examples of transverse waves whilst sound waves in air are longitudinal waves, and how the speed of each may be measured
- Use ray diagrams to illustrate reflection, refraction and the similarities and differences between convex and concave lenses (qualitative only)
- Construct two-dimensional ray diagrams to illustrate reflection and refraction.
- Explain how colour is related to differential absorption, transmission and reflection (to include reflection to include specular and scattering)

Comment

This transition guide is designed to encourage learners to secure the connections between the concepts and equations they are learning and physical phenomena that can be observed and measured, as well as hinting at some of the more fundamental differences between light and sound which will be developed at later stages.

While many aspects of waves ought to be familiar by now, some learners may still experience a degree of difficulty remembering which way the relationships go – which things to multiply and which ones to divide, and which things increase as others decrease. The idea of the repetition of similar calculations is not just to reinforce the relevant relationships but also to cement the idea of which end of the spectrum is which in terms of observable phenomena; colours and pitches and so on. When calculating quantities in real life pheomena, learners will increasingly encounter answers that make them wrestle with very different scales, and it is important that they are also comfortable manipulating quantities of very different sizes, using orders of magnitude and common unit names and translating between them, and so on.

The first checkpoint task encourages learners to visualise the different scales involved when dealing with light and sound waves and cement their ability to manipulate basic equations involving speed, frequency and wavelength, while the second takes a more qualitative approach and asks learners to connect the properties of light and sound waves with real phenomena that can be tested using resources available in the classroom and observed in ordinary life.

As the subject matter becomes more complicated in later stages of education, learners may find that they are performing increasingly complicated calculations, and that memorising all the different formulae becomes difficult. In these cases, particularly when dealing with quantities that relate to observable phenomena, it is important to try and retain, wherever possible, a connection between the observable implications of the results of the relevant calculations and the numerical and algebraic relationships that describe them. Thus, the relative scales of light- and sound-related phenomena are explicity related here to the scales of the wavelengths.

During coverage of this topic at the lower key stage, care should be taken not to oversimplify the phenomena. Many learners will have heard of photons, or at least of particles of light, and, while it is tempting to avoid dealing with the concept of wave-particle duality, more able learners can be told that we now know that it is not only light that behaves like both waves and particles, but matter as well; that all particles are also waves, and that modern physics depends on treating them as such. Those who are more easily put off by complicated ideas can still be told about wave-particle duality, but perhaps with a more reassuring emphasis on the fact that the difference only matters on very very tiny scales.

If there is any opportunity during the lower key stage to remind learners of the sinusoidal shape of most basic waves, this might be helpful, especially if they have learned to connect sine waves with circular motion in maths.

Activities

Three sound frequency diagrams

Resources: http://www.themusicespionage.co.uk/frequencies-fundamentals-and-harmonics-explained/

http://misclab.umeoce.maine.edu/boss/classes/SMS_491_2003/sound/Dusen9_3.jpg

http://www.oestex.com/tubes/spectrum.jpg

One web page and two images showing, in two cases, the range of frequencies of various musical instruments, and, in the other, the hearing range of various animals.

Colour

Resources: http://physics.info/color/

A webpage featuring various bits of obscure information about colour, including some details on colour vision and perception.

Electromagnetic Spectrum

Resources: http://hyperphysics.phy-astr.gsu.edu/hbase/ems1.html

A helpful précis of the various parts of the EM spectrum, with clickable links to the various areas (eg. Visible light) and a useful "cheat" section where you can fill in the frequency and the wavelength will be filled in for you, or vice versa.

The checkpoint task requires learners to be familiar and comfortable with manipulating basic equations concerning frequency, wavelength and speed, and asks them to consider the relationships between these quantities and observable phenomena. Activity 1 deals with audible sound waves, and asks learners to calculate the wavelengths of various audible pitches, with results that might surprise them, while Activity 2 compares these with visible light (with connected calculations relating to visual perception) and the extension task assesses the differences between light- and sound-based phenomena and how the scales of the waves affect them. Learners are encouraged throughout to bring in examples of the principles underlying the phenomena being described, and to consider how our ability to measure and experiment on the wave nature of light and sound differ.

In all tasks, there is an emphasis on translating the quantities being manipulated in learned equations into scales that can be understood intuitively, which can help to reinforce the essential connection between physics, even when describing quite abstractly mathematical relationships, and real observable phenomena. For learners who are going on to study the subject at higher levels, there is some encouragement to consider the deeper differences between light and sound in the attached resources, where ideas of diffraction, interference and diffusion are introduced along with the more familiar emission, absorption, reflection and refraction.

Link to checkpoint task

Activities

Sounds Amazing | AS A Level Physics Waves Revision
http://www.acoustics.salford.ac.uk/feschools/

A very useful website featuring a large number of simple explanations and examples, with a few basic interactives and short videos, of various wave phenomena and their applications in acoustics.

Sound propagation
http://hyperphysics.phy-astr.gsu.edu/hbase/sound/sprop.html

Another subsection of a website featuring various pages of explanations and examples of wave phenomena. In this case, the clickable "bubbles" on the left of the featured diagram, labelled "reflection", "interference", "refraction" and "diffraction" are probably most useful to learners in the context of the checkpoint task.

Propagation of Light
http://hyperphysics.phy-astr.gsu.edu/hbase/geoopt/cspeed.html

The companion to the above, in terms of light, with clickable hyperlinks in blue.

Wave Interference - Electric Field, Interference, Diffraction
https://phet.colorado.edu/en/simulation/legacy/wave-interference

A fairly simple interactive in which the phenomena of interference and diffraction are usefully demonstrated.

Activities

Molecules and Light - Molecules, Light, Photons
https://phet.colorado.edu/en/simulation/molecules-and-light

A simulation of the effect of light at different intensities and frequencies on various simple chemicals in the atmosphere.

Photoelectric Effect - Light, Quantum Mechanics, Photons
https://phet.colorado.edu/en/simulation/photoelectric

An interactive in which the principles of an effect that was influential in the development of quantum theory are demonstrated.

The first ever photograph of light as both a particle and wave
https://www.youtube.com/watch?v=v-1zjdUTu0o

A basic video showing a standard demonstration of the photoelectric effect, with a brief explanation of its significance.

Photoelectric Effect Demonstration
http://phys.org/news/2015-03-particle.html

A short article about a recent development in imaging light. Learners can be encouraged to speculate about its meaning with reference to the photoelectric effect.

Wave-Particle Duality
http://hyperphysics.phy-astr.gsu.edu/hbase/mod1.html

A webpage featuring a set of short explanationsof phenomena associated with the discovery of the wave-particle duality of light.

Resources, links and support

Science Spotlight – Our termly update Science Spotlight provides useful information and helps to support our Science teaching community. Science Spotlight is designed to keep you up-to-date with Science here at OCR, as well as to share information, news and resources. Each issue is packed full with a series of exciting articles across the whole range of our Science qualifications: www.ocr.org.uk/qualifications/by-subject/science/science-spotlight/

Find resources and qualification information through our science page: www.ocr.org.uk/qualifications/bysubject/science/

Contact the team: science@ocr.org.uk

Continue the discussion on the science community forum: http://social.ocr.org.uk/

and follow us on Twitter, @ocr_science

To find out more about GCSE and A Level reform please visit: http://www.ocr.org.uk/qualifications/gcse-and-a-level-reform

The small print

We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

If you do not currently offer this OCR qualification but would like to do so, please complete the Expression of Interest Form which can be found here: www.ocr.org.uk/expression-of-interest

Looking for a resource?

There is now a quick and easy search tool to help find **free** resources for your qualification:

www.ocr.org.uk/i-want-to/find-resources/

www.ocr.org.uk/gcsereform

OCR Customer Contact Centre

General qualifications

Telephone 01223 553998
Facsimile 01223 552627
Email general.qualifications@ocr.org.uk

OCR is part of Cambridge Assessment, a department of the University of Cambridge. *For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored.*

A DIVISION OF CAMBRIDGE ASSESSMENT

LLOYD'S REGISTER · LRQA ISO 9001 001

UKAS MANAGEMENT SYSTEMS