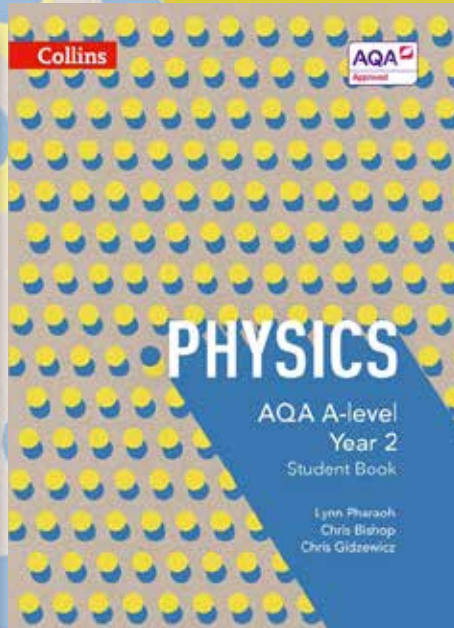
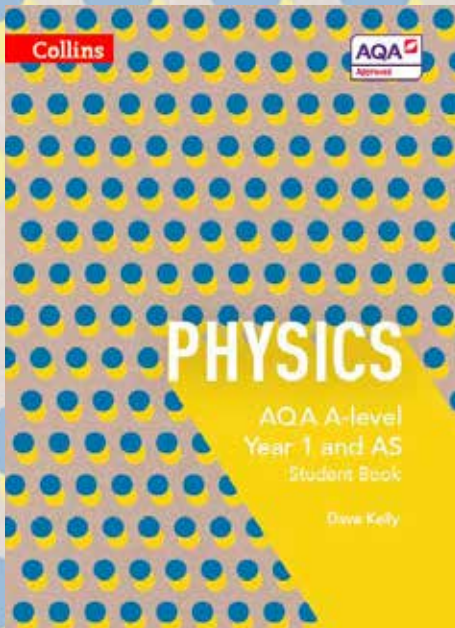


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PHYSICS

AQA A-level Physics



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Chris Bishop and
Chris Gidzewicz

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PHYSICS

Teaching A level Physics, how the resources support you:

Linear assessment

Terminal assessment in the form of three 2 hour papers at A-level and two 1.5 hour papers on the first four topics at AS Level



- Extensive practice questions embedded throughout help build synoptic understanding
- Prior knowledge section at the start of each chapter consolidates knowledge from GCSE
- Key ideas summaries in every topic allow students to check progress easily and revise effectively

Practicals

Assessment of practical skills will be by written exam only. Practical-based questions will form 15% of the total assessment



Comprehensive Required Practical sections advise students on apparatus, techniques and how best to avoid common errors

Maths

40% of assessment marks require the use of Level 2 mathematical skills



Test and build mathematical skills with signposted Assignments throughout

Standalone AS qualification

The AS becomes a separate qualification, which doesn't contribute to the A-level grade



AS and Year 1 content is fully co-teachable using Student Book 1

Comprehensive Student Books

- Help students build knowledge, application and evaluation skills through clear explanations set in real-life contexts supported by skills-focused assignments
- Prepare for the new practical assessment with comprehensive Required Practical sections that advise on apparatus, techniques and best practice to help develop students' theoretical understanding
- Build confidence across the linear course with extensive practice questions integrated throughout to check knowledge, test skills and consolidate learning
- Extend students' understanding and prepare them for further study and scientific careers with plenty of stretch and challenge questions that develop higher-order thinking skills
- Develop students' confidence in tackling the maths requirements of the specification with step-by-step worked examples and plenty of maths practice questions

Stretch and challenge questions and activities encourage stronger students to move beyond the specification

Stretch and challenge

8. The graph in Figure 12 shows how, at an instant in time, the displacement of particles from their equilibrium position varies with distance along a longitudinal wave.

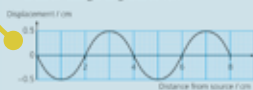


Figure 12

- Copy the diagram and mark with dots the positions of the particles that are at their equilibrium positions.
- Positive displacement is in the direction of travel of the wave. Which of the particles you have marked are at compressions? Which are at rarefactions? Mark them C and R.
- Mark with an X the particle whose equilibrium position is 1 cm from the source of the disturbance.
- Which way is particle X moving?

KEY IDEAS

- Progressive waves transfer energy, without causing any permanent displacement of the medium.
- In a transverse wave the oscillations are at right angles to the direction that the wave travels.
- In a longitudinal wave the particles oscillate in the same direction as the wave travels.
- Surface water waves, waves on a string and electromagnetic waves are transverse waves.
- Sound waves are longitudinal waves.
- Electromagnetic waves do not need a medium to travel through. They all travel at the same speed in a vacuum.

LOOKING IN DETAIL AT WAVES

Displacement-distance graphs, wavelength and phase
Progressive waves can be described as they would look at one instant in time (as in Figure 5). Such a

'snapshot' shows how the displacement of the particles depends on their distance from the wave source at a certain time.

The displacement is measured from the equilibrium position and may be either positive or negative. The maximum displacement caused by the wave is known as the **amplitude**. A wave (Figure 15) that carries energy depends on its amplitude.

The distance between any two consecutive positions, aware that have identical displacement and velocity is referred to as the **wavelength** (Figure 17). The wavelength is measured in metres.

If we observed two positions on the wave that are exactly one wavelength apart (such as A and B in Figure 18), we would see that they oscillate in step with each other. These points are said to be **in phase**. Points on the wave that are half a wavelength apart reach the opposite extremes of their oscillation at the same time, like points C and D in Figure 18. These points are **antiphase** (i.e. completely out of phase with each other). Other points on the wave, like E and F, have a phase difference that depends on what fraction of a wavelength lies between them.



Figure 15 A snapshot versus distance graph shows a wave at a certain time.

QUESTIONS

10. Two seagulls are 150 m apart on the surface of the sea. They are bobbing up and down as waves pass them. When one of the seagulls is at the crest of a wave, the other is in a trough. When this happens there is one wave crest between the seagulls. What is the wavelength of the waves?

Boost understanding and mathematical skills with **worked maths examples**

5 WAVES

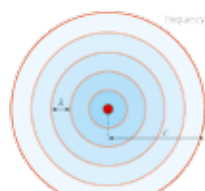


Figure 19 At the second there are 2.2 waves and the first wave will have travelled a distance of 100 m.

Worked Example

A wind-driven ocean wave has a frequency of around 0.1 Hz and a wavelength of around 100 m. This gives a wave speed of

$$c = 100 \text{ m} \times 0.1 \text{ Hz} = 10 \text{ m s}^{-1}$$

Compare this with the speed of a tsunami, which has a low frequency of $2.2 \times 10^{-2} \text{ Hz}$ but a long wavelength of up to 500 km in the open sea. This gives a wave speed for the tsunami of

$$c = 2.2 \times 10^{-2} \text{ Hz} \times 500\,000 \text{ m} = 11\,000 \text{ m s}^{-1} \text{ (about } 3\,000 \text{ km h}^{-1}\text{)}$$

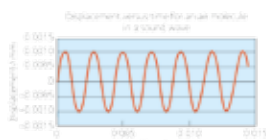
QUESTIONS

- The speed of sound in air is about 350 m s^{-1} . Calculate the wavelength of a sound wave that has a frequency of 256 Hz.
- The BBC transmits Radio 4 on the long-wave band at a wavelength of 1500 m. The speed of radio waves in air is approximately $3 \times 10^8 \text{ m s}^{-1}$. Calculate the frequency of these radio waves.
- The graph in Figure 20 shows how the displacement of a molecule in the air varies with time as a sound wave passes by.
 - Calculate the frequency of the sound wave.
 - Use the graph to plot a velocity versus time graph for the air molecule.

KEY IDEAS

- The wavelength, λ , of a progressive wave is the distance between any two consecutive points on a wave that have identical displacement and velocity.
- Two points on a wave that are any whole number of wavelengths apart will have exactly the same displacement and velocity. These points are said to be **in phase**.
- The phase difference between two waves at any given point, or between two points on a wave, can be expressed as a fraction of a cycle, or as an angle in degrees or radians.
- The frequency f of a wave source is the number of waves per second, measured in hertz (Hz).
- The time taken for one complete wave to pass a point is the period T , in seconds, $T = \frac{1}{f}$.
- The wave speed, c , is equal to the wavelength multiplied by the frequency, $c = f\lambda$.

Figure 20



Signposted assignments throughout build confidence in Maths skills, practical skills, extended writing, AO2 and AO3

Required practicals pages provide comprehensive guidance on apparatus, experimental techniques and how best to avoid common errors

5 WAVES

REQUIRED PRACTICAL: APPARATUS AND TECHNIQUES

Investigation into the variation of the frequency of stationary waves on a string
The aim of this practical is to verify the relationship

$$f = \frac{v}{\lambda}$$

The practical gives you the opportunity to show that you can:

- use appropriate analogue apparatus to record a range of measurements and to interpolate between scale markings
- use appropriate digital instruments to obtain a range of measurements
- use methods to increase accuracy of measurements
- use a signal generator
- generate and measure waves using a vibration transducer

Apparatus

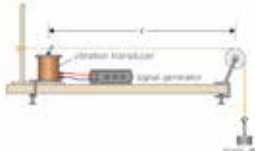


Figure P1 The experimental setup

- The standard experiment for investigating stationary waves on a string uses a vibration transducer to vibrate the end of the string. A vibration transducer is similar to a loudspeaker: it has a metal post in place of a paper cone.
- One end of the string is connected to the post of the vibration transducer and the other end has a loop so that masses can be hung from it via a pulley (see Figure P1). The tension in the string can be varied by changing the mass.
- A signal generator is connected to the vibration transducer so that the frequency of oscillations can be controlled. The signal generator sometimes has a digital readout of frequency, although this can be

inaccurate. Often, the frequency has two controls: one determines the range of frequencies and the other is a fine control. The scale of the fine control is sometimes logarithmic, rather than linear, so that a small movement of the control can make a large change to the output frequency (see Figure P2).



Figure P2 Digital signal generator

- An alternative means of measuring the frequency is useful, for example an oscilloscope, a frequency meter or a strobeoscope with a digital display. Using a strobeoscope has the advantage that the waves are observed easily, but care has to be taken as flashing lights can cause problems for some people.

Techniques

The frequency of the first harmonic for a wave on a string (Figure P5) is given by $f = \frac{v}{\lambda}$. Since only one variable should be changed at a time, several separate experiments are necessary.

- To investigate the effect of tension, T :

The tension is varied by changing the mass, m , at the end of the string, $T = mg$, ensuring that the pulley is frictionless. The length, L , of the string and its mass per unit length, μ , must be kept constant.

Polarisation

PRACTICAL SKILLS ASSIGNMENT 5: DEMONSTRATING POLARISATION

Your task is to prepare a short, say 10–15 minute, lesson for a small group of younger students about polarisation. You should plan to include at least some of the demonstrations listed in Experiment 1, or Experiment 2, to help you explain what polarisation is.

- Begin to write a plan for your lesson. Think about how you will start. For example, it will help if you can find out what the students already understand about waves. What questions could you ask?
- It would be possible to give an initial demonstration of the idea of polarisation using a long spring or even a piece of thick rubber tubing. How would you do this?
- Which experiment (1 or 2) will you use? Read through the details given here and make your decision about what to show. What apparatus will you need? Write down clear steps for yourself of the order in which you will do things, so that your lesson goes smoothly. Include any safety precautions you will need to take. You will need to try out the demonstrations first.
- What will you need to explain to the students? Are there any diagrams that might be useful to draw and show, perhaps using presentation software?
- If you get a chance to give your lesson, take feedback from your audience and then write an evaluation of how you did and how you might improve on this another time.

Experiment 1. Light polarisation

This experiment consists of a series of demonstrations involving polarised light. Most can be carried out using very simple apparatus, for example two Polaroid filters (a pair of old Polaroid sunglasses would do), a bright torch, a light meter and a sunny day.

- It is important to consider safety. Students should be reminded that looking directly at the Sun for any length of time can damage eyes.
- One polarising filter, or Polaroid sunglasses, can be used to examine the polarisation of light from different parts of the sky.

- A beam of polarised light can be produced by shining a torch, or a ray box, through a Polaroid filter.
- The intensity of light can be measured using a light meter. It may be possible to find a suitable app for a smartphone or tablet.
- A second Polaroid filter can be placed between the detector and the light source. The intensity transmitted through the two Polaroid filters will depend on the relative orientation of the filters. Varying this angle will alter the amount of light transmitted.
- Observing reflected light through a Polaroid filter will reveal that the intensity of light transmitted depends on the angle of the filter. This is because reflected light is partly polarised.
- If a Perspex set square is placed between two polarising filters orientated at right angles, it should be possible to see stress patterns in the Perspex.

Experiment 2. Microwave polarisation

A microwave receiver and transmitter can be used to demonstrate polarisation of microwaves (Figure A1). The microwave transmitters used in schools transmit polarised waves, which can be detected by a receiver linked to an amplifier. The amplified signal is used to generate an audio output. A louder sound means that more microwave power is being received.

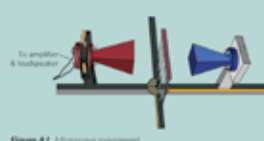


Figure A1 Microwave experiment

The microwave power emitted by school apparatus is very low and presents no danger. However, it is sensible to warn students that microwave energy can be dangerous and it is good practice to limit their exposure, for example by turning the transmitter off when not in use.

Planning support

To support you in your planning, a free scheme of work for each subject is available. These editable schemes of work cover learning outcomes, number of hours' teaching, specification references, the skills covered, and where the practicals fit in, and are designed to help you get the most from our AQA-approved student books.

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