# Physics PAG 4: Measuring waves

# Combined Science PAG P4: Waves

# Suggested Activity 1: Investigating water waves

## Instructions and answers for teachers & technicians

These instructions cover the learner activity section which can be found on [page 7](#_PAG_4:_Measuring). This Practical activity supports OCR GCSE Physics.

**When distributing the activity section to the learners either as a printed copy or as a Word file you will need to remove the teacher instructions section.**

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| This is a **suggested** practical activity that can be used as part of teaching the GCSE (9-1) Gateway Science (A) and Twenty First Century Science (B) specifications.These are **not controlled assessment tasks**, and there is **no requirement to use these particular activities**.You may modify these activities to suit your learners and centre. Alternative activities are available from, for example, [Royal Society of Biology](https://www.rsb.org.uk/education/teaching-resources/secondary-schools), [Royal Society of Chemistry](http://www.rsc.org/learn-chemistry), [Institute of Physics](http://www.iop.org/education/teacher/resources/index.html), [CLEAPSS](http://science.cleapss.org.uk/) and [publishing companies](https://global.oup.com/education/content/secondary/key-issues/gcse_science_2016/?region=uk), or of your own devising.Further details are available in the [specifications](http://www.ocr.org.uk/science) (Practical Skills Topics), and in these [videos](https://www.youtube.com/playlist?list=PLBD9B84FF4BD54AA4). |

**OCR recommendations:**

**Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.**

**CLEAPSS resources are useful for carrying out risk-assessments: (**<http://science.cleapss.org.uk>**).**

**Centres should trial experiments in advance of giving them to learners. Centres may choose to make adaptations to this practical activity, but should be aware that this may affect the Apparatus and Techniques covered by the learner.**

### Introduction

In this experiment pupils will be investigating how to measure how to measure the speed, frequency and wavelength of a water wave.

### DfE Apparatus and Techniques covered

The codes used below match the OCR Practical Activity Learner Record Sheet ([**Physics**](http://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) and Trackers ([**Physics**](http://www.ocr.org.uk/Images/323482-gcse-physics-practical-tracker.zip) / [*Combined Science*](http://www.ocr.org.uk/Images/323483-gcse-combined-science-practical-tracker.zip)) available online. **There is no requirement to use these resources.**

**1a***[1]***:** Use of appropriate apparatus to make and record a range of measurements accurately, including: **i**[*i*]) length; **iv**[*iv*]) time

**4a** *[16a]*) Making observations of waves in fluids and solids to identify the suitability of apparatus to measure: i) speed; ii) frequency; iii) wavelength

**8**) Making observations of waves to identify the suitability of apparatus to measure the effects of interactions of waves with matter in: i) fluids

### Aims

To use appropriate apparatus to measure speed, frequency and wavelength.

To make observations of waves in fluids.

To calculate the speed of a wave using the equation:

Wave speed (m/s) = frequency (Hz) x wavelength (m)

To evaluate methods and suggest improvements

### Intended class time

50-60 minutes

### Links to Specifications:

### Gateway Science (Suite A) including Working Scientifically (WS)

P5.1a describe wave motion in terms of amplitude, wavelength, frequency and period

P5.1b define wavelength and frequency

P5.1c describe and apply the relationship between these and the wave velocity

P5.1d apply formulae relating velocity, frequency and wavelength

PM5.1i recall and apply: Wave speed (m/s) = frequency (Hz) x wavelength (m)

WS1.2e Evaluate methods and suggest possible improvements and further investigations

WS1.3e Interpreting observations and other data

WS1.4a Use scientific vocabulary, terminology and definitions

WS1.4b Recognise the importance of scientific quantities and understand how they are determined

WS1.4c Use SI units and IUPAC chemical nomenclature unless inappropriate

WS2a Carry out experiments

WS2c Presenting observations using appropriate methods

### Twenty First Century Science (Suite B) including Ideas about Science (IaS)

P1.3.1 describe wave motion in terms of amplitude, wavelength, frequency and period

P1.3.2 describe evidence that for both ripples on water surface and sound waves in air, it is the wave and not the water it air itself that travels

P1.3.5 define wavelength and frequency

P1.3.6 recall and apply the relationship between speed, frequency and wavelength to waves, including waves on water, sound waves and across the electromagnetic spectrum:

Wave speed (m/s) = frequency (Hz) x wavelength (m)

1.3.7a describe how the speed of ripples on water surfaces and the speed of sound waves in air can be measured

1.3.7b describe how to use a ripple tank to measure speed/frequency and wavelength of a wave

IaS1.2 Suggest appropriate apparatus, materials and techniques, justifying choice with reference to the precision, accuracy and validity of the data that will be collected

IaS1.4 Identify factors that need to be controlled, and the ways in which they could be controlled

IaS2.1 Present observations and other data using appropriate formats

IaS2.2 When processing data use SI units where appropriate (e.g. kg, g, mg, km, m, mm, kJ, J)

### Mathematical Skills covered

M3b Change the subject of an equation

M3c Substitute numerical values into algebraic equations using appropriate units for physical quantities

M3d Solve simple algebraic equations

### Health and Safety

This is a very safe experiment when performed sensibly; spilled water can be a slip hazard so back sure and spills are dealt with quickly. Make sure any electrical supplies are not close to the water. If class members have photo-induced epilepsy than a stroboscope shouldn’t be used.

### Method 1: wavelength

Learners use a ripple tank or tray to work out the wavelength of a water wave. Depending on centres equipment they can either use a ripple tank, motor driven paddle and stroboscope or they can use a tray, ruler and digital camera or camera phone. Learners create ripples on the water and measure the distance between waves 1 times and then work out the mean wavelength.

### Method 2: frequency and wavelength

Learners keep the frequency of the waves created the same as for experiment 1. A stopwatch is used and the number of ripples that pass appoint in a set time is recorded. Learners repeat this and calculate an average. The frequency is then calculated by dividing the average by the time. Using the wave speed equation learners can then use their results from part 1 and 2 to calculate an estimated wave speed.

### Notes

Teachers should trial this activity to be able to modify the learner sheet in the light of the equipment and lesson time available at the centre.

Encourage learners to consider where the inaccuracies in their measurements may be. This is a good opportunity to look at the accuracy of the measuring equipment they are using.

### Technician Notes

### For this practical the teacher will require:

* Ripple tank and accessories (or tray of water if ripple tank not available)
* Motor driven beam with supports to create ripples (or ruler if this is unavailable)
* Hand stroboscope (or digital camera / mobile phone if this isn’t available)
* Metre ruler
* White paper
* Stopwatch

### Answers for quiz questions

**1a [1 mark]**

40 cm = 0.40m ✓

**1b [1 mark]**

120 cm = 1.20 m ✓

**1c [4 marks]**

wave speed = frequency x wavelength ✓

 Rearrange to give frequency = wave speed ÷ wavelength ✓

 Frequency = 25m/s ÷ 1.2m ✓

 = 20.83 Hz ✓

**2a [1 mark]**

Water/light/any EM wave ✓

**1b [1 mark]**

Sound/P wave ✓

**3 [4 marks]**

Equipment needed = stopwatch, meter ruler, wall, person or something to make noise ✓

Place source of noise or person in front of wall, Measure distance to wall from source ✓

Make sound and time how long it takes for echo of sound from wall to be heard ✓

Calculate speed using speed = (2 x distance) x time ✓

### Document updates

 v1 Published on the qualification pages

 v1.1 January 2017 Consolidated labelling and formatting of activities

 v1.2 February 2017 Correction of Combined Science labelling

 v1.3 June 2021 Updated to digital accessibility standards



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# Physics PAG 4: Measuring waves

# Combined Science PAG P4: Waves

# Suggested Activity 1: Investigating water waves

## Learner Activity

### Introduction

In this experiment you will be investigating how to measure the speed, frequency and wavelength of a water wave.

### Aims

To use appropriate apparatus to measure speed, frequency and wavelength.

To make observations of waves in fluids.

To calculate the speed of a wave using the equation:

Wave speed (m/s) = frequency (Hz) x wavelength (m)

To evaluate methods and suggest improvements

### Intended class time

50-60 minutes

### Equipment (per group)

* Ripple tank and accessories (or tray of water if ripple tank not available)
* Motor driven beam with supports to create ripples (or ruler if this is unavailable)
* Hand stroboscope (or digital camera / mobile phone if this isn’t available)
* Metre ruler
* White paper
* Stopwatch

### Health and Safety

This is a very safe experiment when performed sensibly; spilled water can be a slip hazard so make sure that spills are dealt with quickly. Make sure any electrical supplies are not close to the water. If class members have photo-induced epilepsy then a stroboscope shouldn’t be used.

### Method 1

1. Set up apparatus as shown below.



NB alternatively use a tray and create the ripples by hand using a ruler, waves can then be photographed to analyse while stationary

1. Use the motor driven beam or a ruler to create a continuous straight wave, this should be of low frequency for easier measuring
2. Use the stroboscope to freeze the wave pattern, if a stroboscope is not available then a digital image of the wave should be taken with the meter ruler lying alongside the wave fronts
3. Find the wavelength by measuring 10 waves on the paper under the ripple tank and finding the average wavelength. If using the camera technique then do the same thing but from the images produced rather than from the paper

### Results

Wavelengths (m)

| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **Mean** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |

### Evaluation

|  |
| --- |
| Why does this method only produce an ‘estimated’ wavelength? |
|  |
|  |
| Why is it more accurate to produce the ripples using a motor than by hand? |
|  |
|  |

### Method 2 – frequency and wave speed

### Keep the frequency the same as you did for method 1.

### Use the stop watch and count the number of ripples that pass in a given time, say 10 seconds

### Repeat at least 3 times and calculate a mean

### Calculate the number of waves that pass per second (frequency)

### Calculate the wave speed using the equation:

### Wave speed (m/s) = frequency (Hz) x wavelength (m)

### Results

|  | **Number of waves**  |
| --- | --- |
| **Time (s)** | **1** | **2** | **3** | **Mean** |
|  |  |  |  |  |

|  |
| --- |
| Work out the frequency = mean number of waves ÷ time (s) |
| **=…………………..Hz** |
|  |
| Work out the wave speed = frequency (Hz) x wavelength (m) |
| **=…………………..m/s** |
|  |

### Evaluation

|  |
| --- |
| If you doubled the frequency what would happen to the wavelength assuming the wave speed was kept constant? |
|  |
|  |
| Write down the good and bad points of your method. How could the accuracy of the measurements have been improved? Can you think of any other improvements you could make to your method? |
|  |
|  |

###  Quiz - test your knowledge and understanding

**1**. A student is investigating with waves on a skipping rope, below is an image of the wave produce?



|  |
| --- |
| **(a)** What is the amplitude of the wave in meters? **[1 mark]** |
|  |
|  |
| **(b)** What is the wavelength of the wave in meters? **[1 mark]** |
|  |
|  |
| **(c)** The wave travels at a speed of 25m/s. Work out the frequency of the wave. **[4 marks]** |
|  |
|  |

|  |
| --- |
| **2. (a)** Waves on a rope are an example of a transverse wave. Give another example of a transverse wave. **[1 mark]** |
|  |
|  |
|  **(b)** Give an example of a longitudinal wave. **[1 mark]** |
|  |
|  |
| **3**. A student wants to measure the speed of a sound wave using an echo. What apparatus would they need and what measurements should they take? **[4 marks]** |
|  |
|  |

### DfE Apparatus and Techniques covered

If you are using the OCR Practical Activity Learner Record Sheet ([**Physics**](http://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) you may be able to tick off the following skills:

| **Physics** |  | ***Combined Science*** |
| --- | --- | --- |
| 1a-i | 1a-iv | 4a-i | 4a-ii |  | *1-i* | *1-iv* | *16a-i* | *16a-ii* |
| 4a-iii | 8-i |  |  |  | *16a-iii* |  |  |  |