# Physics PAG 4: Measuring waves

# Combined Science PAG P4: Waves

# Suggested Activity 2: Tsunami

## 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 depth of water impacts the speed of a wave in the context of Tsunamis.

### 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; 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 the time taken for a wave to move a set distance

To make observations of waves in fluids.

To calculate the speed of a wave

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.

### Method

Learners use a tray of set depth of water, they lift it a height of a few cm at one end and drop the tray onto the desk. Learners measure the time taken for the wave to travel a set number of lengths of the tray (for example 4). From measurements of time taken, and distance travelled, the wave speed can be calculated using speed = distance/time. Learners then vary the depth of the water in the tray to see how wave speed is related to depth of water in the tray.

### 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.

The extension is provided to allow students to access P5.1d and PM5.1i (Suite A), and P1.3.6 (Suite B). These are not covered by the main method, but calculations are considered in the quiz section.

### Technician Notes

### For this practical the teacher will require:

* 15 x Plastic trays
* 15 x Metre rulers
* 15 x Stopwatch
* Access to water

### Answers for quiz questions

**1**. A tsunami is caused by an earthquake at sea, with a wavelength of 100km, and a speed of 250 m/s.

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| **(a) (i)** Using this information and the equation; speed = distance / time, to work out how long does it take for the tsunami to reach land 400 km away? **[3 marks]** |
| Speed = distance/time  Rearrange to give time = distance/speed ✓  Time = 400 000 / 250 ✓  Time = 1600 s ✓  = 27 minutes |
|  |
| **(a)(ii)** It actually takes longer for the wave to reach land. Use ideas from your investigation to explain why. **[3 marks]** |
| The speed of the wave changes with depth. ✓  From experiment, shallower water = slower wave ✓  As the wave comes to shore the wave slows down ✓ |
|  |
| 1. What is the frequency of the wave in Hz? **[4 marks]** |
| wave speed = frequency x wavelength ✓  Rearrange to give frequency = wave speed ÷ wavelength ✓  Frequency = 250m/s ÷ 100 000 m ✓  = 0.0025 Hz ✓ |
|  |
| 1. Seismographs are used to detect the shockwaves produced by earthquakes. There are two types of waves produced P waves (longitudinal) and S waves (transverse).   **(a)** How are longitudinal and transverse waves different? You may wish to use a diagram. **[2 marks]** |
| Longitudinal waves vibrate in the direction of wave motion ✓  Transverse waves vibrate at right angles to the direction of wave motion ✓  Well labelled diagrams can give the 2 marks |
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| **(b)(i)** Give another example of a longitudinal wave. **[1 mark]** |
| Sound ✓ |
|  |
| **(b)(i)** Give another example of a transverse wave. **[1 mark]** |
| Light/any electromagnetic wave ✓ |
|  |

**OCR Resources**: *the small print*This formative assessment resource has been produced as part of our free GCSE teaching and learning support package. All the GCSE teaching and learning resources, including delivery guides, topic exploration packs, lesson elements and more are available on the qualification webpages.

If you are looking for examination practice materials, you can find Sample Assessment Materials (SAMs) on the qualification webpages: [here](http://www.ocr.org.uk/qualifications/by-type/gcse/physics/)

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# Physics PAG 4: Measuring waves

# Combined Science PAG P4: Waves

# Suggested Activity 2: Tsunami

## Learner Activity

### Introduction

In this experiment pupils will be investigating how depth of water impacts the speed of a wave in the context of Tsunamis.

### Aims

To use appropriate apparatus to measure the time taken for a wave to move a set distance

To make observations of waves in fluids.

To calculate the speed of a wave

To evaluate methods and suggest improvements

### Intended class time

50-60 minutes

### Equipment (per group)

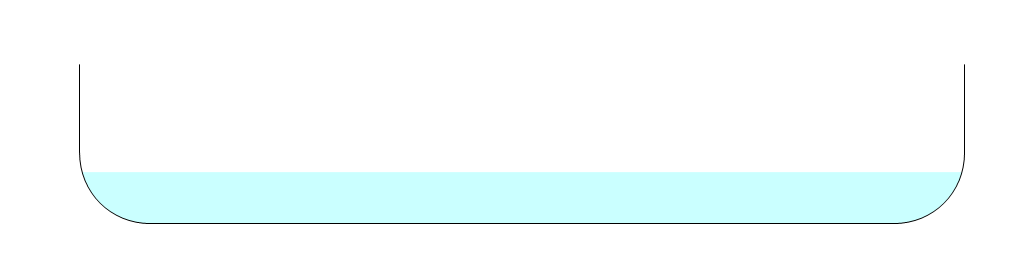
* Plastic tray
* Metre ruler
* Stopwatch
* Access to water

### 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.

### Method

1. Fill a tray with water to a depth of 0.5 cm
2. Lift one end of the tray to a set height as shown in the diagram below



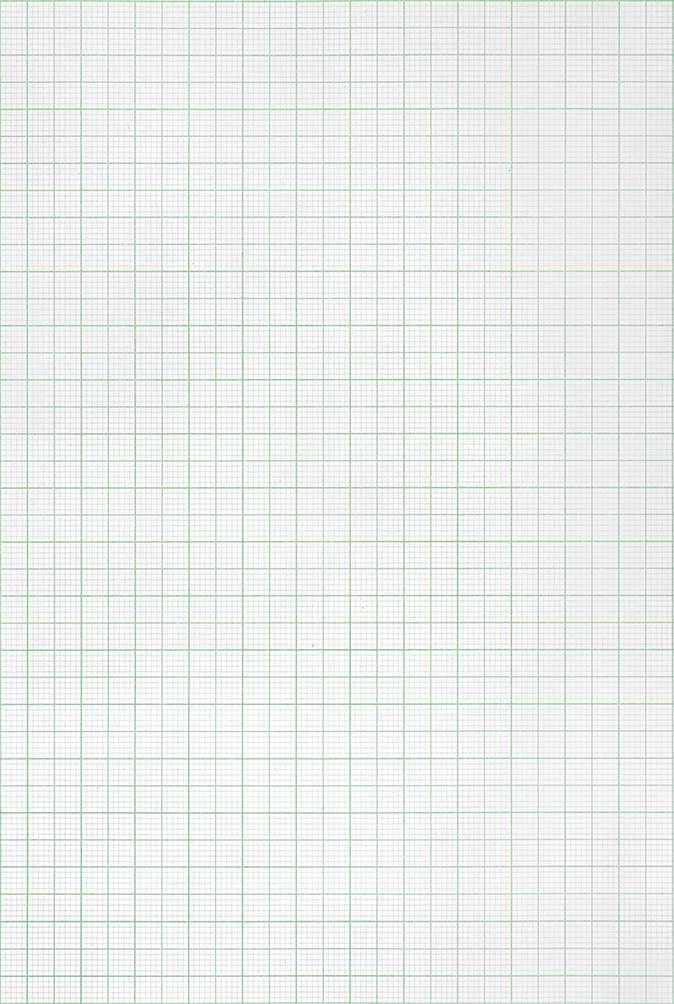
1. Gently drop the lifted end onto the desk. As the tray hits the desk start the stopwatch
2. Measure the time taken for the wave generated to travel 3 lengths of the tray. Record results in the table below
3. Repeat 3 times
4. Repeat steps 2 to 5 with increasing depths of 0.5 cm of water up to 6.5 cm.
5. Record the length of the tray
6. Plot an appropriate graph to find the relationship between water depth and wave speed

### Results

Length of tray = cm

Total distance travelled by the wave = cm = m

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| --- | --- | --- | --- | --- | --- |
| **Water depth (cm)** | **Time taken to travel 3 lengths the tray (s)** | | | | **Wave speed (m/s)** |
| **1** | **2** | **3** | **Mean** |
| **0.5** |  |  |  |  |  |
| **1.0** |  |  |  |  |  |
| **1.5** |  |  |  |  |  |
| **2.0** |  |  |  |  |  |
| **2.5** |  |  |  |  |  |



### Analysis

What conclusions can you draw from your results?

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### Evaluation

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| How precise do you think your results are? Justify your answer if possible. |
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| Why does this method only produce an ‘estimated’ wave speed? |
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| Write down the good and bad points of the method used. How could the accuracy of the measurements have been improved? Can you think of any other improvements you could make to your method? |
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### Extension

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| Describe how you could use this set up to measure the wavelength of the wave and hence calculate the frequency of the waves |

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If you have time, carry out this test and record you results and observations below

### Quiz - test your knowledge and understanding

**1**. A tsunami is caused by an earthquake at sea, with a wavelength of 100km, and a speed of 250 m/s.

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| --- |
| **(a) (i)** Using this information and the equation; speed = distance / time, to work out how long does it take for the tsunami to reach land 400 km away? **[3 marks]** |
|  |
|  |
| **(a)(ii)** It actually takes longer for the wave to reach land. Use ideas from your investigation to explain why. **[3 mark]** |
|  |
|  |
| **(b)** What is the frequency of the wave in Hz? **[4 marks]** |
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| --- |
| 1. Seismographs are used to detect the shockwaves produced by earthquakes. There are two types of waves produced P waves (longitudinal) and S waves (transverse).   **(a)** How are longitudinal and transverse waves different? You may wish to use a diagram. **[2 marks]** |
|  |
|  |
| **(b)(i)** Give another example of a longitudinal wave. **[1 mark]** |
|  |
|  |
| **(b)(i)** Give another example of a transverse wave. **[1 mark]** |
|  |
|  |

### 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-iii (ext) |  | *1-i* | *1-iv* | *16a-i* | *16a-iii* (ext) |
| 8-i |  |  |  |  |  |  |  |  |