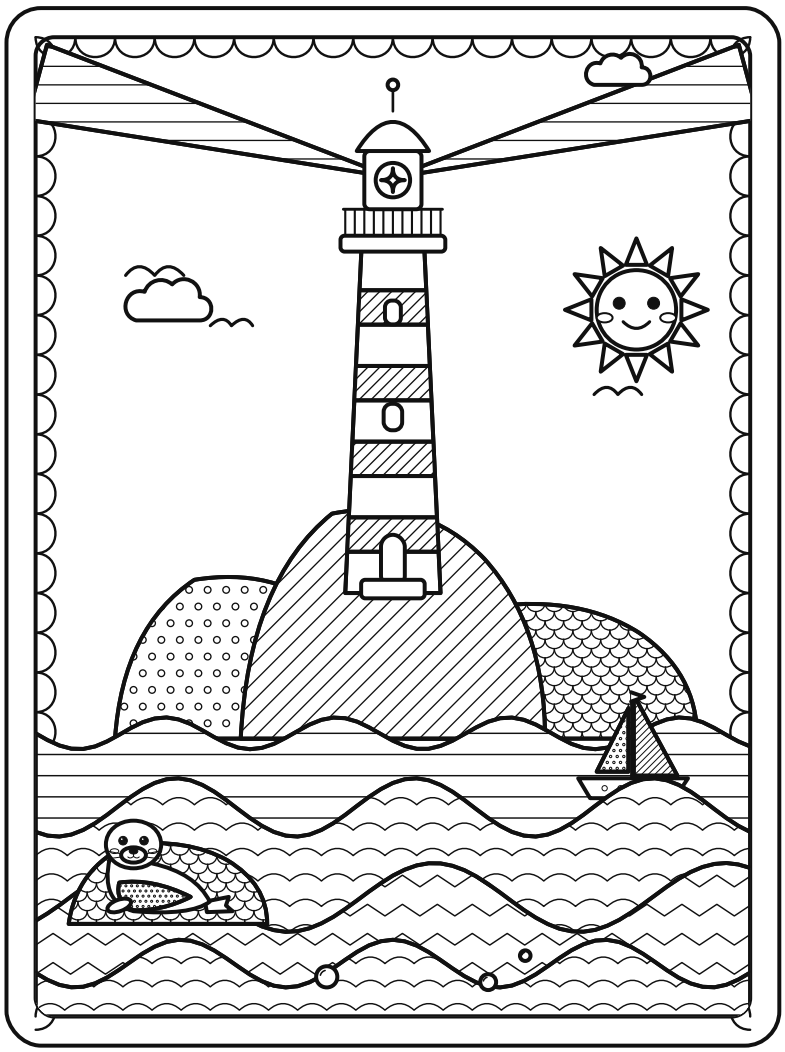
REAL-LIFE PHYSICS

Waves and Radiation

Workbook for National 4 Physics

Unit: Waves and Radiation



C. Blewis

Blewis LEARNING

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How to use this book

This book is about waves and radiation: how waves carry energy, how we hear and use sound, the family of electromagnetic waves, and nuclear radiation. Each topic follows the same pattern, so you always know what comes next.

EACH TOPIC HAS

Opener	the story for the topic, what you will learn and the key words
Learn pages	short explanations with diagrams, and questions to try
Practical	You plan the investigation yourself, carry it out safely, take repeat readings, draw a graph and evaluate your method.
Brain break	a calm puzzle or colouring page
Check-up	a few questions to show what you know, and a checklist

PRACTICAL WORK: STAY SAFE

- Only start a practical when an adult says it is OK.
- Read the whole method and the Stay safe table first.
- Tell your teacher about anything that might affect you, like asthma or an allergy.
- Stop and tell an adult if you feel unwell or something goes wrong.

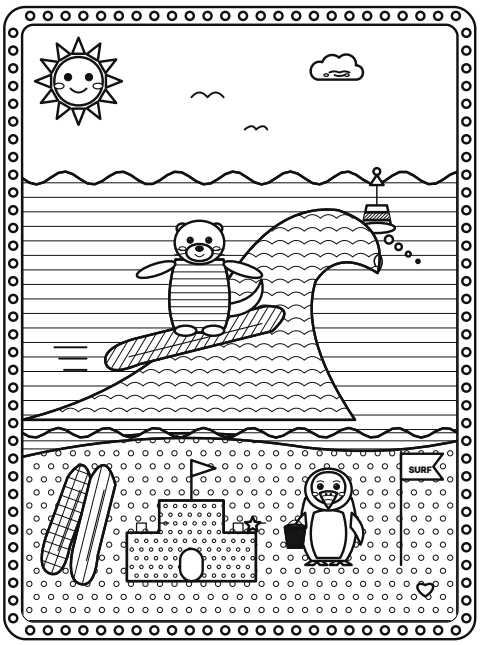
NO LAB TODAY?

Every practical has a set of example results. If you could not do the experiment, use these to finish the results, graph and conclusion.

DOODLE CORNERS

Some pages have a doodle corner. Colour it or doodle in it when you need a short break.

What is a wave?



A surfer rides a wave all the way to the beach, but the water itself does not travel across the sea. So what does a wave actually carry?

Theme: the coast. Port Arrin is a small town on the coast. The surf school, the lifeboat crew and the harbour all depend on the waves. Isla is spending the summer helping at the surf school, and wants to understand how waves work.

IN THIS TOPIC YOU WILL LEARN TO

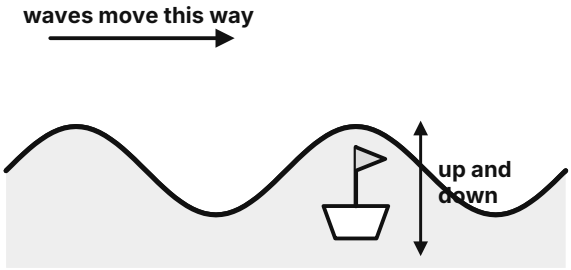
Skill 1	describe a wave as a way of carrying energy, and compare transverse and longitudinal waves
Skill 2	label the crest, trough, amplitude and wavelength of a wave and measure them
Skill 3	use f = N / t to calculate the frequency of a wave

KEY WORDS

Wave	a way of carrying energy from place to place without carrying matter
Transverse	the particles move at right angles to the direction the wave travels
Longitudinal	the particles move back and forth in the same direction the wave travels
Amplitude	the height of a wave from the middle line to a crest
Wavelength (λ)	the length of one complete wave, crest to crest; in metres (m)
Frequency	the number of waves each second; measured in hertz (Hz)

❶ Waves carry energy

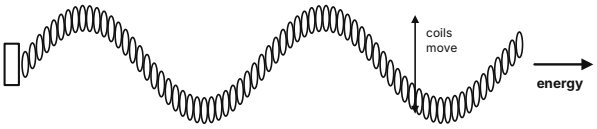
A **wave** carries **energy** from one place to another. The material the wave travels through does **not** move along with it. A buoy on the sea bobs **up and down** as waves pass, but it stays in the same place. Light, sound, water waves and radio signals all travel as waves.



Two kinds of wave

TRANSVERSE

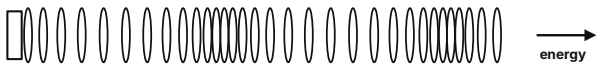
The coils move **up and down**, at **right angles** to the direction the energy travels.



Examples: water waves, light, radio waves, all electromagnetic waves.

LONGITUDINAL

The coils move **back and forth**, in the **same direction** the energy travels.



Example: **sound**. Tight-packed parts are **compressions**; spread-out parts are **rarefactions**.

1 What does a wave carry from one place to another?

Answer:

2 Isla watches a seagull floating on the sea as waves pass. Describe how the seagull moves.

Answer:

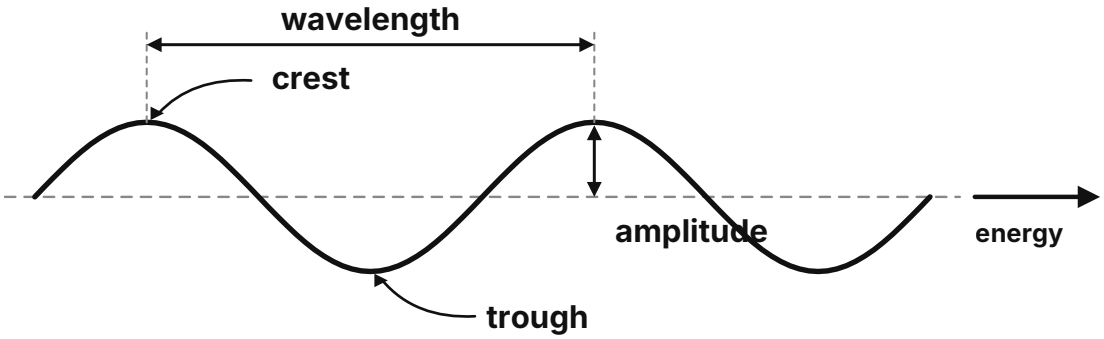
3 Circle the correct word in each sentence.

Sound is a (transverse) (longitudinal) wave. Light is a (transverse) (longitudinal) wave.

In a transverse wave the particles move at (right angles to) (the same direction as) the energy.

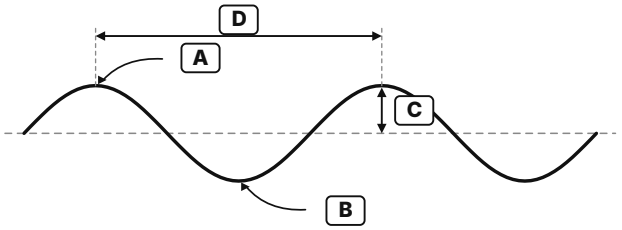
❷ Parts of a wave

We describe a transverse wave using its **crests** (tops), **troughs** (bottoms), **amplitude** and **wavelength**.



Amplitude	measured from the **middle line** to the top of a crest (or the bottom of a trough). A bigger amplitude means the wave carries **more energy**.
Wavelength	the distance from one crest to the next crest (or trough to trough). Its symbol is **λ** (lambda). It is measured in **metres (m)**.

1 Label the wave. Write the correct word next to each letter.



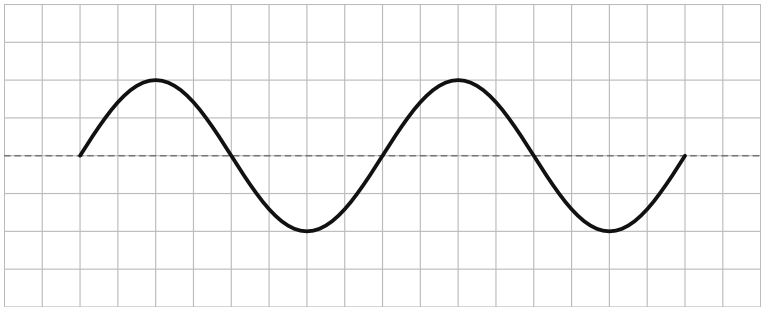
A .....

B .....

C .....

D .....

2 This wave is drawn on squared paper. Each square is **1 cm**. Find the amplitude and the wavelength.



Amplitude = ... cm

Wavelength = ...

cm

3 Kai says the amplitude is measured from the top of a crest to the bottom of a trough. Explain his mistake.

Answer: .....

PRACTICAL 1

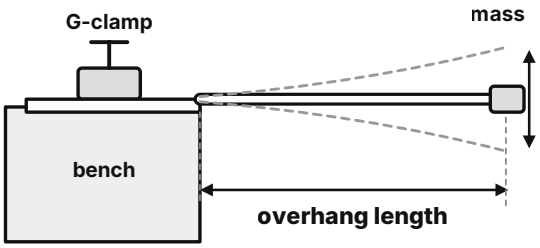
Plan it: how fast does a ruler vibrate?

AIM To find out how the **OVERHANG LENGTH** of a vibrating metre stick affects its **FREQUENCY**.

1 Variables

I will change the independent variable	
I will measure the dependent variable	
I will keep the same controlled variables (give two)	

2 Prediction

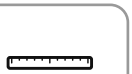


I think that .....

because .....

3 Equipment

Tick the equipment you need. Not everything here is useful.


☐ Metre stick


☐ G-clamp


☐ Mass, tape


☐ Stopwatch


☐ Phone


☐ Thermometer


☐ Loudspeaker

4 Stay safe

The first row is done for you. Add two more hazards.

Hazard What could cause harm?	**Risk** What could happen?	**Control** How will I stay safe?
The mass flies off the end of the vibrating stick	It hits someone	Tape the mass on firmly. Do not pull the stick down more than about 5 cm. Stand to the side.

Method and results

5 Write your method

Write clear steps someone else could follow.

1. How will you clamp the stick and set the overhang length? How will you measure it?

2. How will you start the stick vibrating so every test is the same?

3. How will you count the vibrations, and for how long? (Tip: film it in slow motion.)

4. How many times will you repeat each length? How will you work out the frequency?

6 Results

Complete the headings, including units. Then fill in your results.

				Average number	Frequency

WORKING OUT THE FREQUENCY

Counts of 30, 32 and 31 vibrations in 10 s. Average = $\frac{30 + 32 + 31}{3} = \frac{93}{3} = 31$.

Then $\mathbf{f = \frac{N}{t}} = \frac{31}{10} = \mathbf{3.1\ Hz}$.

NO LAB TODAY? USE THESE RESULTS

Overhang (cm)	Count 1	Count 2	Count 3	Average number	Frequency (Hz)
40	52	50	51		
50	37	38	36		
60	28	27	29		
70	22	21	22		
80	17	17	18		

Vibrations counted in 10 s from a slow-motion video, with a 100 g mass taped to the end. Work out the averages and frequencies yourself.

Analyse and evaluate

7 Draw a line graph

Choose your own scales. Label both axes with units. Plot the frequencies and draw a smooth curve.



8 Conclusion

As the overhang length increased,

9 Use your graph

a Predict the frequency for an overhang of 45 cm.

Answer:

10 Evaluate

a Why is it better to count the vibrations for 10 s rather than 2 s?

Answer:

b Give one other improvement to your method and explain how it would make the results more reliable or accurate.

Answer:

FREE SAMPLE

Waves and Radiation (N4 Physics)

This sample shows a few pages. The full printed workbook is available from Amazon.

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