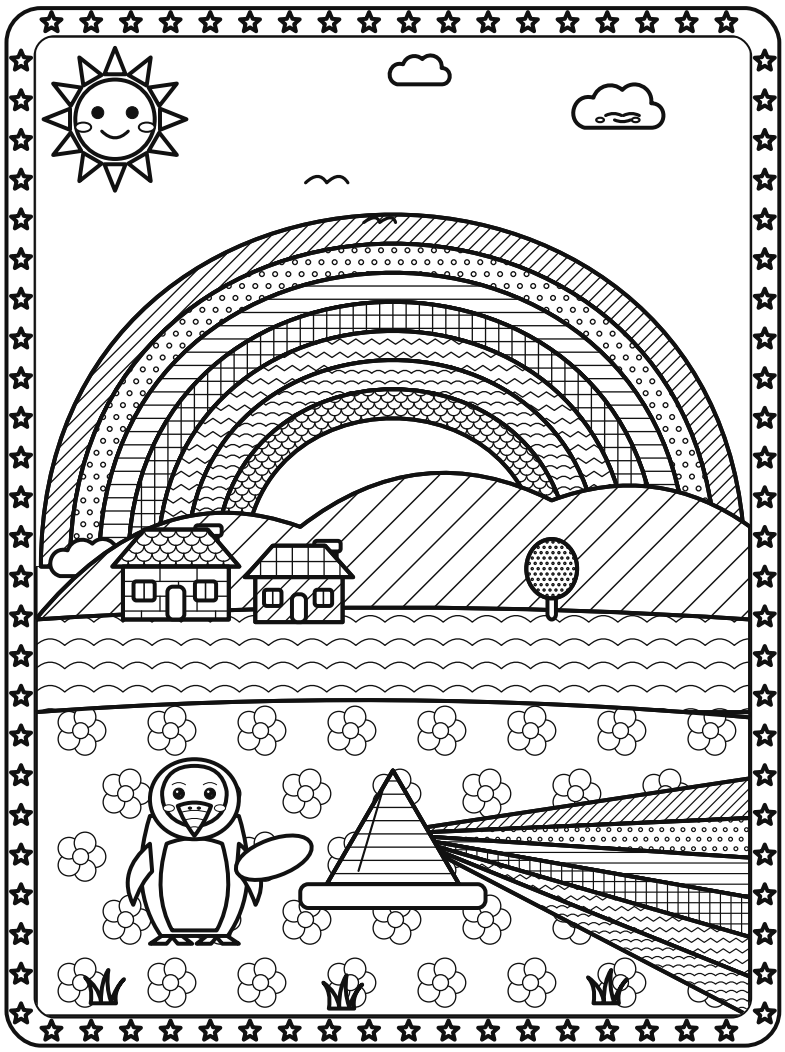
REAL-LIFE PHYSICS

Waves and Radiation

Workbook for National 5 Physics

Unit: Waves and Radiation



C. Blewis

Blewis LEARNING

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How to use this book

This book covers Waves and Radiation for National 5 Physics: wave properties and diffraction, the electromagnetic spectrum, refraction, nuclear radiation and dose, and half-life, fission and fusion. 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?

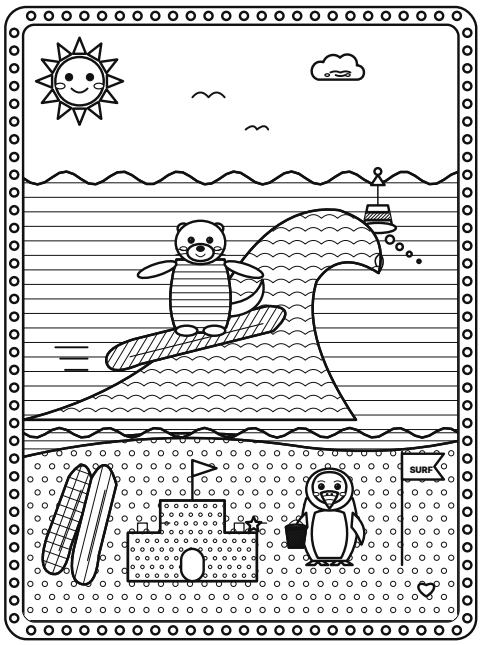
Every practical has a set of example results. If you could not do the experiment, use these to finish the results, graph and conclusion.

DOODLE CORNERS

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

Blewis LEARNING

Wave properties and diffraction



Out at sea the waves march past the harbour wall in straight lines. Inside the harbour they spread out in curves. What happened at the gap?

Theme: the coast. The Port Arrin surf school and the harbour master both watch the waves closely. Isla and Kai are measuring the waves for a school project on how the new harbour wall changes the sea inside it.

IN THIS TOPIC YOU WILL LEARN TO

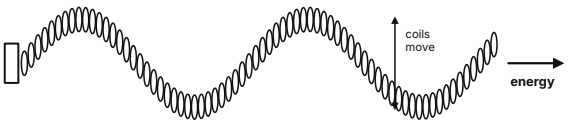
Skill 1	describe waves using frequency, period, wavelength, amplitude and wave speed, for transverse and longitudinal waves
Skill 2	use $v = f\lambda$, $f = 1 / T$ and $v = d / t$ to solve problems
Skill 3	describe and draw diffraction, and compare long and short wavelengths

KEY WORDS

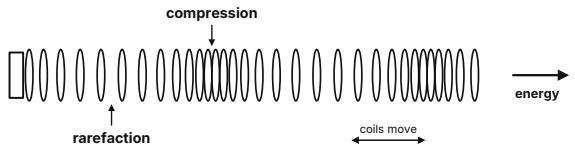
Period (T)	the time for one complete wave to pass a point; in seconds (s)
Frequency (f)	the number of waves passing a point each second; in hertz (Hz)
Wavelength (λ)	the distance from one crest to the next crest; in metres (m)
Wave speed (v)	the distance a wave travels each second; in m/s
Diffraction	the spreading of a wave as it passes through a gap or round an obstacle
Wavefront	a line joining points on the same part of a wave, e.g. along a crest

❶ Describing waves

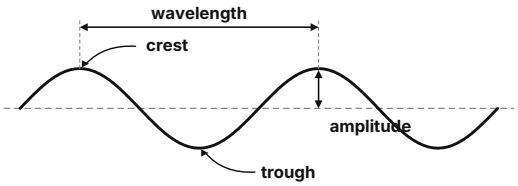
A wave **transfers energy** without transferring matter. In a **transverse** wave the particles vibrate at right angles to the direction the wave travels (water waves, light and all electromagnetic waves). In a **longitudinal** wave they vibrate along the direction of travel (sound).



transverse



longitudinal



Quantity	Meaning	Unit
Frequency, f	waves passing a point each second	Hz
Period, T	time for one complete wave	s
Wavelength, λ	crest to next crest	m
Amplitude	rest position to crest	m
Wave speed, v	distance travelled each second	m/s

1 Give **one** example of a transverse wave and **one** example of a longitudinal wave.

Answer:

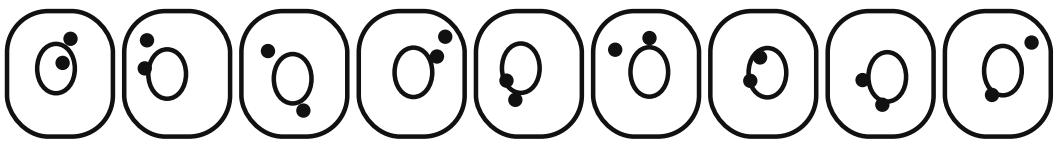
2 A wave has a bigger amplitude than another wave. What does this tell you about the energy it carries?

Answer:

3 On a scale drawing, one wavelength measures 3.2 cm, and 1 cm on the drawing is 0.50 m. Calculate the real wavelength.

Answer:

DOODLE CORNER



2 Wave calculations

RELATIONSHIP

$$v = f\lambda$$

v	wave speed in metres per second (m/s)
f	frequency in hertz (Hz)
λ	wavelength in metres (m)

ALSO USE

- $f = \frac{1}{T}$ (T = period in s)
- $v = \frac{d}{t}$ (d = distance in m, t = time in s)
- $f = \frac{N}{t}$ (N = number of waves)

WORKED EXAMPLE 1

A water wave has a frequency of 0.40 Hz and a wavelength of 6.5 m. Calculate its speed.

Relationship v = f λ

Substitute v = 0.40 × 6.5

Answer **v = 2.6 m/s**

Example: a buoy rises and falls once every 2.5 s, so $f = \frac{1}{2.5}$ = **0.40 Hz**.

1 A sound wave in air has a frequency of 850 Hz and travels at 340 m/s. Calculate its wavelength.

Relationship

Substitute

Answer

2 A wave machine in the Port Arrin pool sends 18 waves along the pool in 45 s. Calculate the period of the waves.

Relationship

Substitute

Answer

3 A wave travels 96 m across the harbour in 32 s. Its wavelength is 7.5 m. Calculate its frequency.

Relationship

Substitute

Answer

PRACTICAL 1

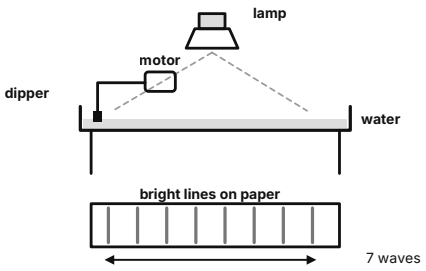
Plan it: frequency and wavelength in a ripple tank

AIM To find out how the **FREQUENCY** of water waves affects their **WAVELENGTH**, and to find the **SPEED** of the waves.

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.

- ☐ Ripple tank
- ☐ Power supply
- ☐ Ruler
- ☐ Phone camera
- ☐ Lamp
- ☐ Thermometer
- ☐ Balance

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?
Water spilled near the low-voltage lamp and power supply	Electric shock	Keep the water level low, mop spills at once and keep mains plugs away from the tank.

Method and results

5 Write your method

Write clear steps someone else could follow.

1. How will you set and read the frequency of the dipper?

2. How will you measure the wavelength? Why measure across several waves?

3. How many repeat measurements will you take at each frequency?

4. How will you work out the mean wavelength, its uncertainty and the wave speed?

6 Results

Complete the headings, including units.

				Mean λ	Speed

UNCERTAINTY

At 10 Hz one wavelength was 2.50, 2.55 and 2.45 cm. Mean = 2.50 cm. Random uncertainty = (max − min) ÷ number of readings = $\frac{0.10}{3}$ = 0.03 cm, so λ = (2.50 ± 0.03) cm.

NO LAB TODAY? USE THESE RESULTS

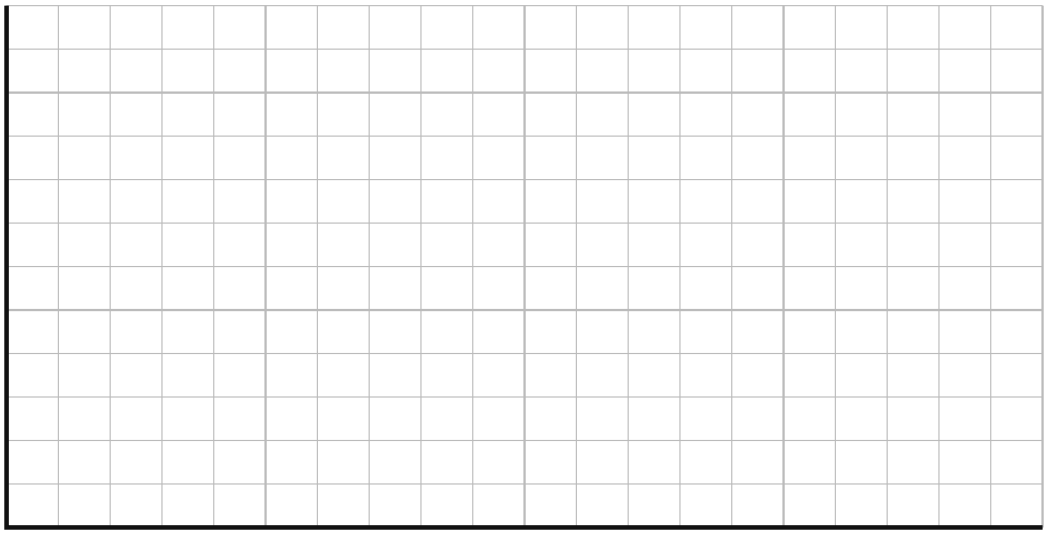
Frequency (Hz)	10λ, 1st (cm)	10λ, 2nd (cm)	10λ, 3rd (cm)	Mean λ (cm)	Speed (m/s)
5	50.5	49.0	50.0		
8	31.5	30.5	31.0		
10	25.0	25.5	24.5		
12	21.0	20.5	21.5		
15	16.5	17.0	16.5		

Ten wavelengths measured on a still photo, with a ruler laid in the tank.

Analyse and evaluate

7 Draw a line graph

Plot mean wavelength against frequency. Choose your own scales, label both axes with units and draw a smooth curve of best fit.



8 Conclusion

As the frequency increased,

9 Wave speed

a Use v = f λ to find the speed at each frequency. What do you notice?

Answer:

10 Evaluate

a Why is it better to measure ten wavelengths and divide by ten than to measure one?

Answer:

b Suggest one way to make the wavelength readings more precise.

Answer:

> **ASSIGNMENT LINK**
> In a report you would compare your wave speed with a value from a book or website for water of the same depth, and give the reference.

FREE SAMPLE

Waves and Radiation (N5 Physics)

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

blewislearning.co.uk

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