Wave Parameters & Behaviours

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Frequency, Number of Waves & Time

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1. A boy counts 24 water waves hitting the entrance to a harbour in 4 minutes.
   Calculate the frequency of the waves.

$f = ?$
$N = 24$
$t = 4 \text{ mins}$
$= 240 \text{ s}$

$$f = \frac{N}{t}$$
$$= \frac{24}{240}$$
$$= 0.1 \text{ Hz}$$

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2. A loudspeaker vibrates at a frequency of 256 Hz to produce a note called middle C.
   Calculate the number of sound waves produced by the loudspeaker in 3 seconds.

$N = ?$
$f = 256 \text{ Hz}$
$t = 3 \text{ s}$

$$f = \frac{N}{t}$$
$$N = ft$$
$$= 256 \times 3$$
$$= 768$$

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3. A swimmer at a pool calculates the frequency of waves in the water to be 3 Hz. Calculate the time taken for 27 waves to pass the swimmer.

$t = ?$
$N = 27$
$f = 3\ \text{Hz}$

$$f = \frac{N}{t}$$

$$t = \frac{N}{f}$$

$$= \frac{27}{3}$$

$$= 9\ \text{s}$$

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Frequency & Period

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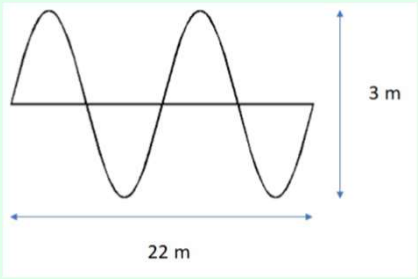
1. Two waves are produced in 5 seconds.



Determine the:

(a) wavelength $\lambda = \frac{22}{2} = 11 \text{ m}$

(b) amplitude $\text{Amplitude} = \frac{3}{2} = 1.5 \text{ m}$

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(c) frequency

$f = ?$
$N = 2$
$t = 5 \text{ s}$

$$f = \frac{N}{t} = \frac{2}{5} = 0.4 \text{ Hz}$$

(d) period

$T = ?$
$f = 0.4 \text{ Hz}$

$$T = \frac{1}{f} = \frac{1}{0.4} = 2.5 \text{ s}$$

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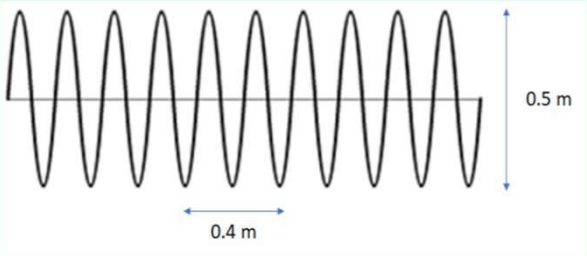
2. A total of 125 waves pass a point in 20 seconds. Some of these waves are shown in the diagram below.



Determine the:

(a) wavelength $\lambda = \frac{0.4}{2} = 0.2 \text{ m}$

(b) amplitude $\text{Amplitude} = \frac{0.5}{2} = 0.25 \text{ m}$

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(c) frequency

$f = ?$
$N = 125$
$t = 20 \text{ s}$

$$f = \frac{N}{t} = \frac{125}{20} = \underline{\underline{6.25 \text{ Hz}}}$$

(d) period

$T = ?$
$f = 6.25 \text{ Hz}$

$$T = \frac{1}{f} = \frac{1}{6.25} = \underline{\underline{0.16 \text{ s}}}$$

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3. A total of 50 waves pass a point in 10 seconds.

Calculate the:

(a) frequency of the wave

$f = ?$
$N = 50$
$t = 10\ s$

$$f = \frac{N}{t}$$
$$= \frac{50}{10}$$
$$= 5\ Hz$$

(b) period of the wave

$T = ?$
$f = 5\ Hz$

$$T = \frac{1}{f}$$
$$= \frac{1}{5}$$
$$= 0.2\ s$$

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Distance, Speed & Time

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1. A sound wave travels a distance of 150 m through water in 0.12 s.
   Calculate the speed of the sound in the water.

$v = ?$
$d = 150\ m$
$t = 0.12\ s$

$d = vt$

$v = \frac{d}{t}$

$= \frac{150}{0.12}$

$= \underline{\underline{1250\ ms^{-1}}}$

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2. When tourists near Edinburgh Castle watch the 1 o'clock gun being fired they see the puff of smoke 5 s before they hear the bang.

   Calculate how far the tourists are from the castle.

$d = ?$
$v = 340\ ms^{-1}$
$t = 5\ s$

$d = vt$

$= 340 \times 5$

$= \underline{\underline{1700\ m}}$

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3. Calculate the time taken for sound to travel 1.5 km in water.

$t = ?$

$v = 1500\ ms^{-1}$

$d = 1.5\ km$

$= 1.5 \times 10^3\ m$

$d = vt$

$t = \frac{d}{v}$

$= \frac{1.5 \times 10^3}{1500}$

$= 1\ s$

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4. A girl standing on a ship shouts towards a cliff. The ship is 595 m from the cliff. Calculate the time taken for the girl's echo to return.

$t = ?$

$v = 340\ ms^{-1}$

$d = 595\ m$

$d = vt$

$t = \frac{d}{v}$

$= \frac{595}{340}$

$= 1.75\ s \times 2$ since it is an echo

$= 3.5\ s$

*Note: we could have multiplied the distance by 2 instead!

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Speed, Frequency & Wavelength

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1. A sound wave has a frequency of 28.3 Hz and a wavelength of 12 m.
   Calculate the speed of the sound wave.

$v = ?$
$f = 28.3\ \text{Hz}$
$\lambda = 12\ \text{m}$

$v = f\lambda$
$= 28.3 \times 12$
$= 340\ \text{ms}^{-1}$

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2. A wave generator in a pool creates waves with a wavelength of 0.2 m. The speed of the waves is 1.5 ms^{-1}. Calculate the frequency of the waves.

$f = ?$

$v = 1.5\ ms^{-1}$

$\lambda = 0.2\ m$

$v = f\lambda$

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

$= \frac{1.5}{0.2}$

$= \underline{\underline{7.5\ Hz}}$

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3. A source produces waves with a frequency of 4 x 10^6 Hz and a speed of 2 x 10^4 ms^{-1}. Calculate the wavelength of the waves.

$\lambda = ?$

$v = 2 \times 10^4\ ms^{-1}$

$f = 4 \times 10^6\ Hz$

$v = f\lambda$

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

$= \frac{2 \times 10^4}{4 \times 10^6}$

$= \underline{\underline{5 \times 10^{-3}\ m}}$

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Diffraction & Wavelength

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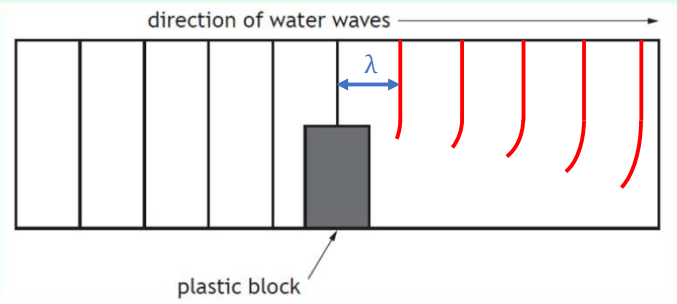
1. A plastic block is placed in a ripple tank, as shown below.
   Complete the diagram to show the pattern of the water waves beyond the plastic block.



Note: diagram should show consistent wavelengths before and after plastic block.

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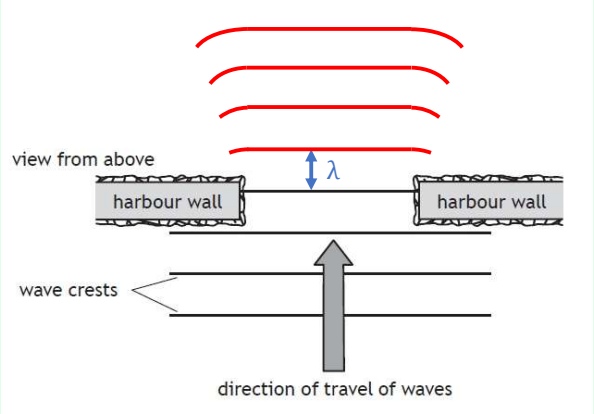
2. Waves travel towards the entrance of a harbour, as shown below.
Complete the diagram to show the pattern of wave crests inside the harbour.



Note: diagram should show consistent wavelengths before and after plastic block.

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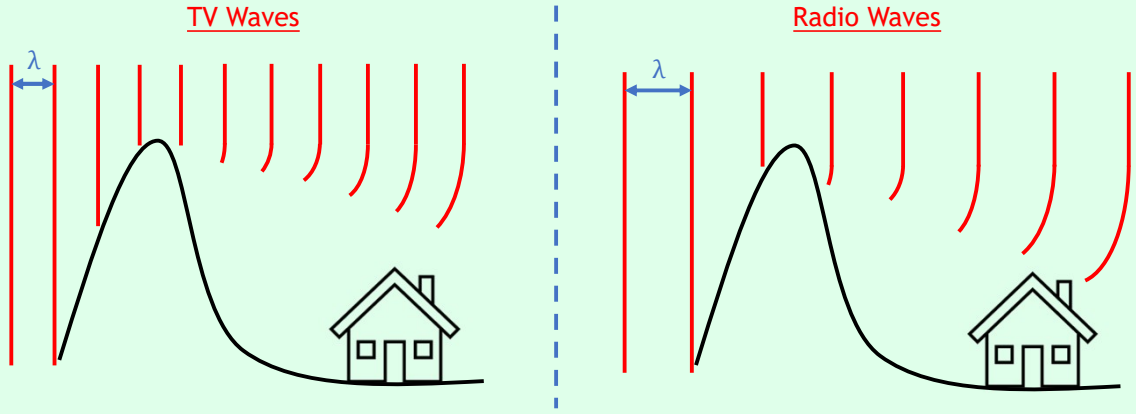
3. Explain why a house located behind a hill might receive a better radio signal than TV signal.
Justify your answer using a labelled diagram.



Radio waves have a (slightly) longer wavelength than TV waves.
Longer wavelengths diffract more than shorter wavelengths.

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