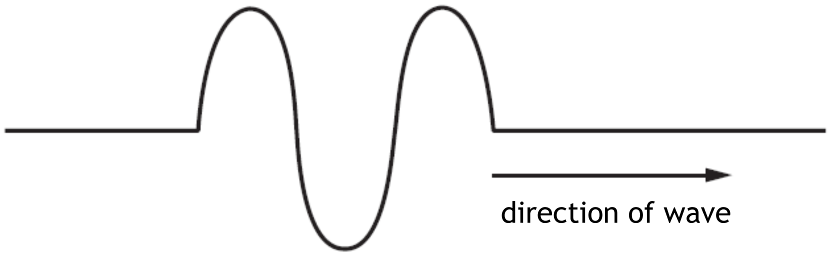
Homework – Waves

1. A transverse wave travels along a string as shown below.



The equation representing the travelling wave on the string is

$$y = 8.6 \times 10^{-2} sin 2\pi(2.4t - 2.0x)$$

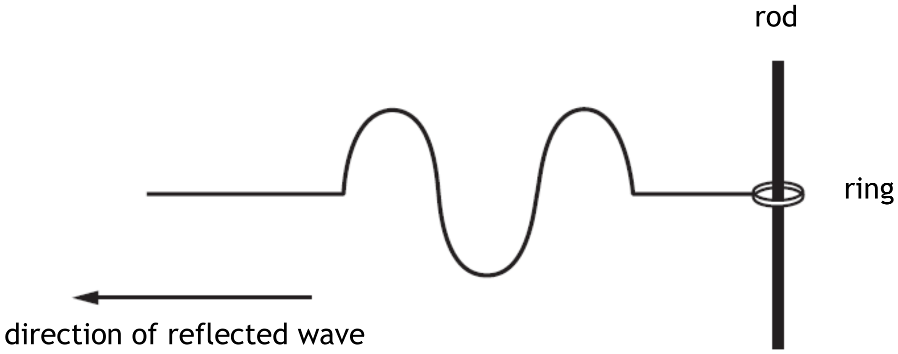
where x and y are in metres and t is in seconds.

(a) State the frequency of the wave.

(b) Calculate the velocity of the wave.

Attached to the end of the string is a very light ring. The ring is free to move up and down a fixed vertical rod.

The diagram below shows the string after the wave reflects from the vertical rod.



When the wave reflects, its energy falls to one quarter of its original value. The frequency and wavelength remained constant.

(c) Create an expression that represents this reflected wave.

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2. A water wave travelling from right to left has a frequency of 30 Hz, velocity 0·050 ms^{-1} and initial amplitude 0·040 m.

    (a) Create an expression for the displacement y of a point on the water surface in terms of x and time t.

    After some time the amplitude of the wave has fallen to 0·020 m.

    (b) Calculate the factor by which the energy of the wave has fallen.

    When a continuous sound wave of constant frequency is reflected from a wall, a stationary wave is produced.

    (c) Explain how nodes and anti-nodes are formed along the stationary wave.

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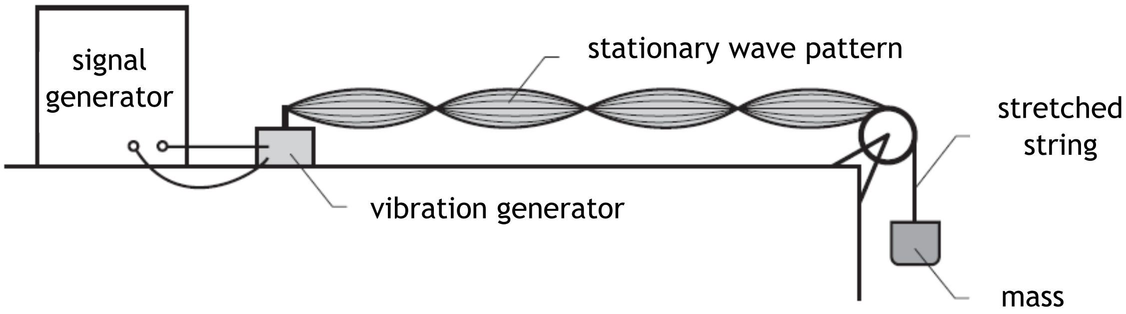
3. The apparatus shown below is set up to measure the speed of transverse waves on a stretched string.



The following data set is obtained.

distance between adjacent nodes	($0{\cdot}150 \pm 0{\cdot}005$) m
frequency of signal generator	(250 ± 10) Hz

(a) Show that the wave speed is 75 ms^{-1}.

(b) Calculate the absolute uncertainty in this value for the wave speed.
You must express your final answer in the form (75 $\pm$) ms^{-1}.

(c) In an attempt to reduce the absolute uncertainty, the frequency of the signal generator is increased to (500 ± 10) Hz.

(i) Explain why this will not result in a reduced absolute uncertainty.

(ii) State one way in which the absolute uncertainty in the wave speed could be reduced.

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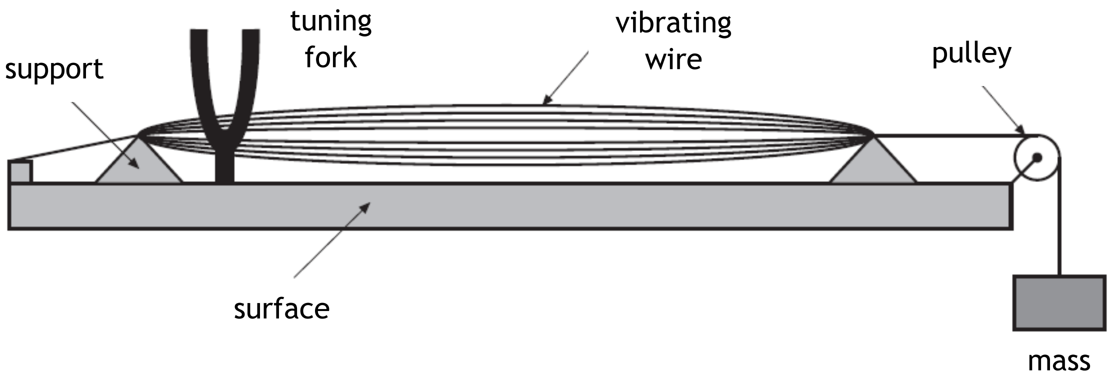
4. A stretched wire, supported near its ends, is made to vibrate by touching a tuning fork of unknown frequency to the supporting surface. One of the supports is moved until a stationary wave pattern appears as shown in diagram below.



(a) Explain how waves on this wire produce a stationary wave pattern.

(b) The formula for the frequency of the note from a stretched wire is given by:

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$$

where l is the distance between the supports
T is the stretching force
μ is the mass per unit length of the wire

The results of the experiment are given below

mass per unit length of the wire	$1{\cdot}92 \times 10^{-4}$ kg m^{-1}
distance between the supports	0·780 m
mass the of load on the wire	4·02 kg

The table below gives information about the note produced by tuning forks of different frequency. Identify the note most likely to correspond to the tuning fork used in the experiment.

note	A	B	C	D	E	F	G
frequency (Hz)	220	245	262	294	330	349	392

(c) A second tuning fork produces the pattern shown below. Suggest a **frequency** for this tuning fork.