General Wave Properties

(a) describe what is meant by wave motion as illustrated by vibrations in ropes and springs and by waves in a ripple tank

(b) show understanding that waves transfer energy without transferring matter

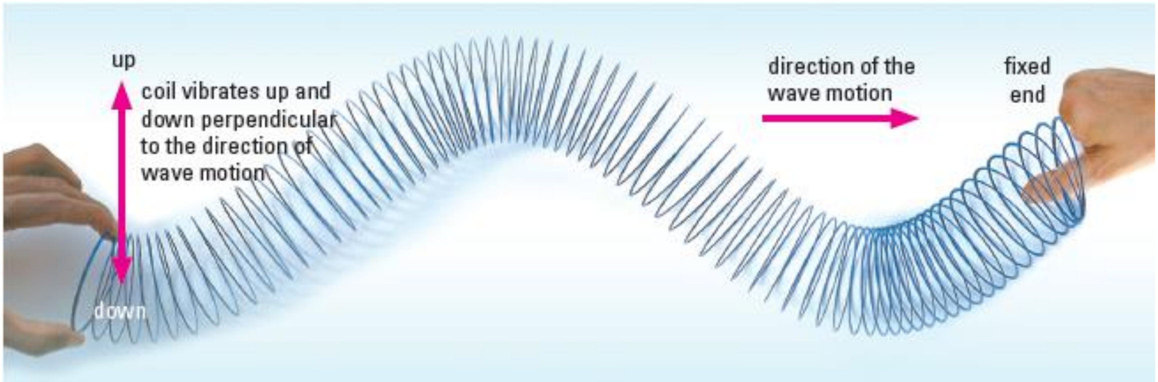
(c) define *speed, frequency, wavelength, period* and *amplitude*

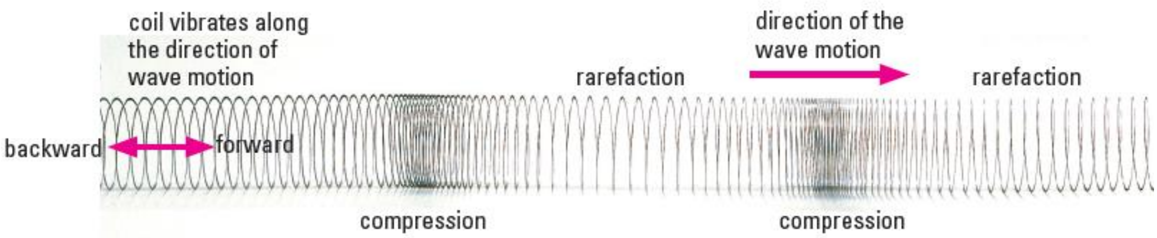
(d) state what is meant by the term *wavefront*

(e) recall and apply the relationship *velocity* = *frequency* × *wavelength* to new situations or to solve related problems

(f) compare transverse and longitudinal waves and give suitable examples of each

(a) Wave motion

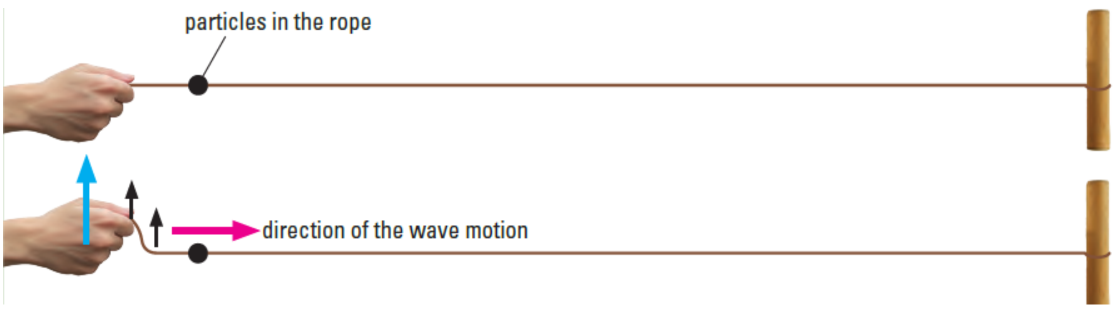


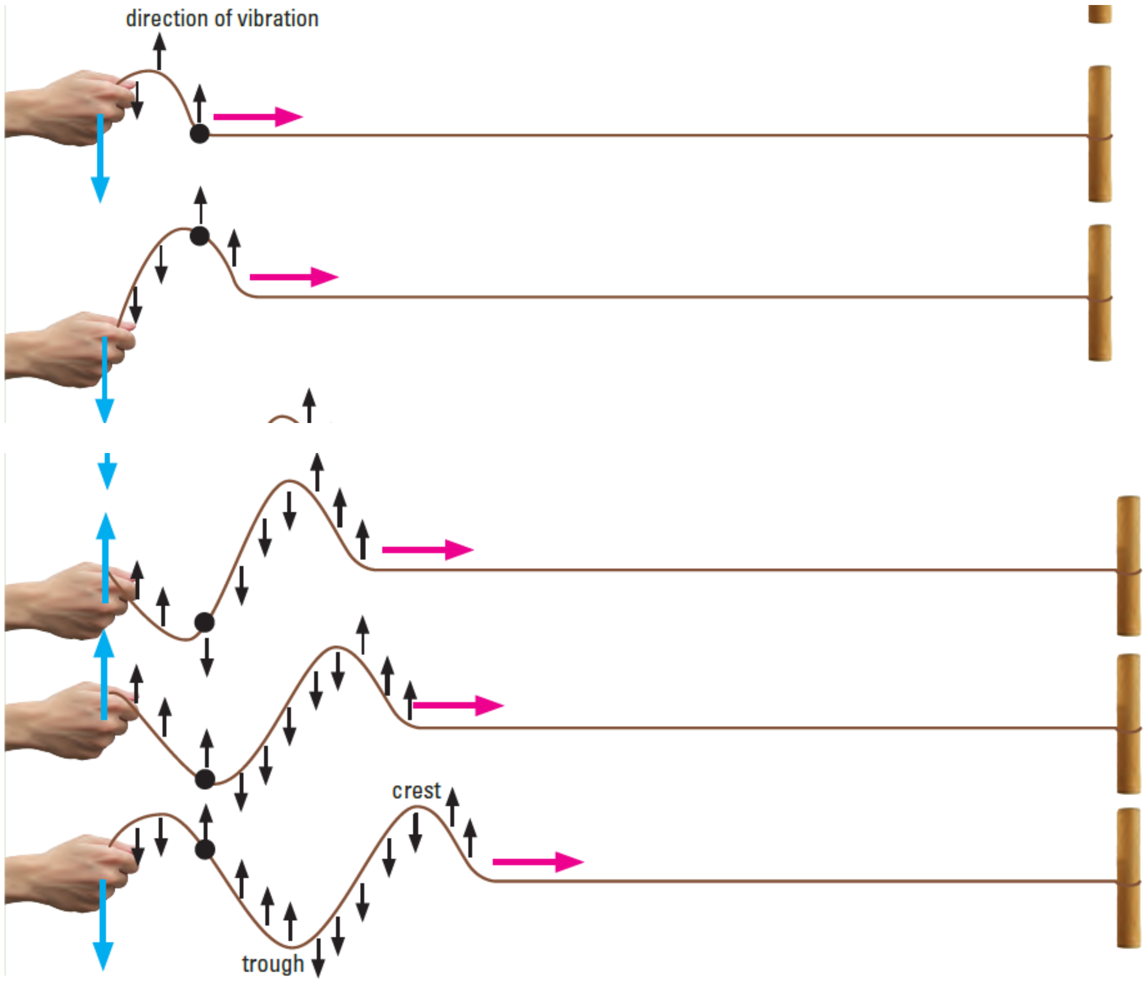


- Periodic oscillations (vibrations) that results in a transfer of energy
- Waves can be mechanical e.g. sound and earthquakes which require a material through which to travel, or **electromagnetic** e.g. light that can travel across empty space (vacuum)

(b) Transfer of energy

- A wave is a disturbance that **transfers energy** through **vibrations** from one place to another **without transferring matter or the medium**. E.g. a wave travelling along a rope carries energy away from the wave source but the rope **does not have a net movement** in the direction of energy transfer.



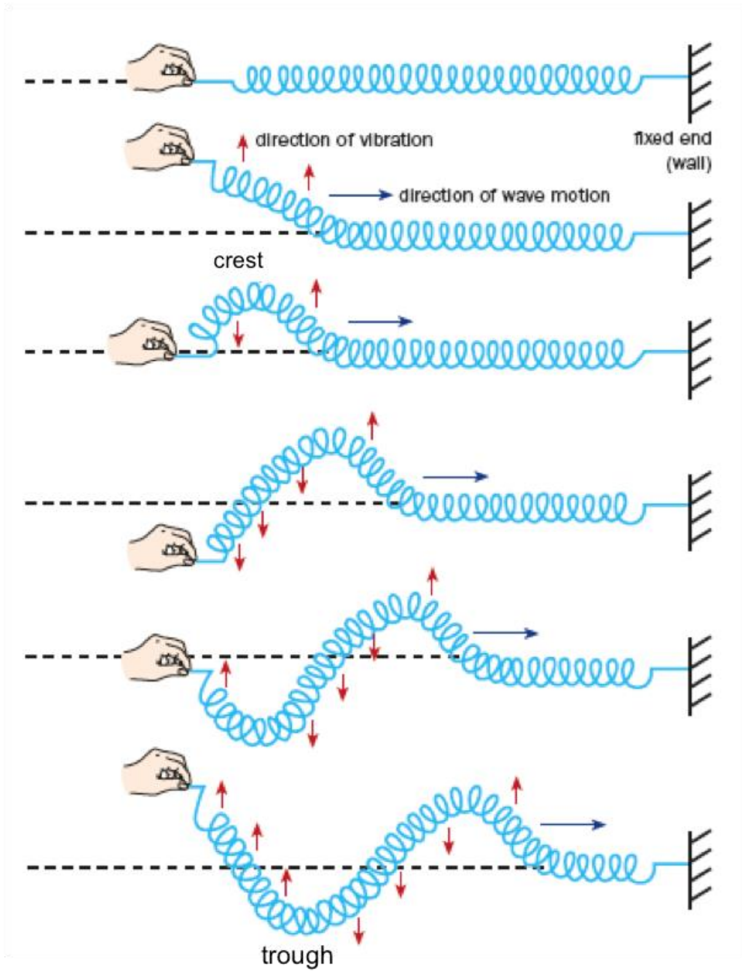


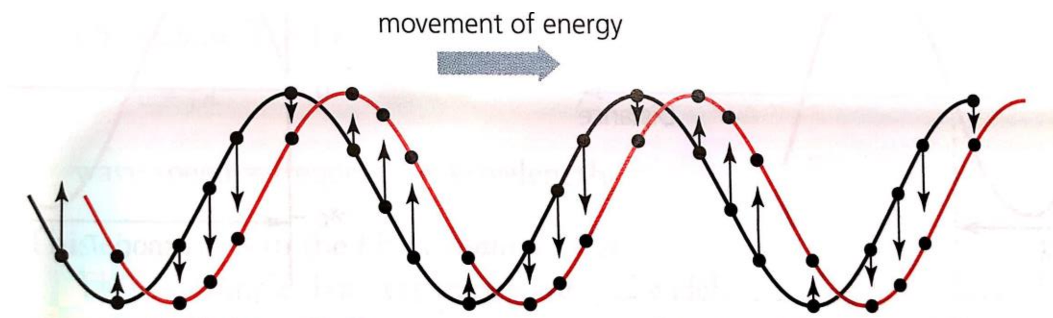
- Individual rope particles **do not** move with the wave, they **vibrate vertically about fixed positions**

Wave terminology

Term	Definition	Unit
Wavelength λ	The wavelength, λ of a wave is the shortest distance between two points moving **in phase**	m
Frequency f	This is the number of complete waves **f** that pass a given point per second.	Hz
Period T	*The **period**, T, is the time it takes for one complete wave to pass a given point*	*s*
	$f = \frac{1}{T}$	
Speed v	Distance travelled by a wave per second	m/s
	$speed = \frac{distance}{time} = \frac{\lambda}{T} = f\lambda$ $v = f\lambda$	
Amplitude	*The **amplitude**, a, is the **maximum displacement** from the rest position or equilibrium position.*	*m*
Transverse wave	*The **direction of vibration** of the medium is **perpendicular** to the direction in which the wave is transferring **energy***	
Longitudinal wave	*The **direction of vibration** of the medium is **parallel** to the direction in which the wave is transferring **energy***	

Transverse wave

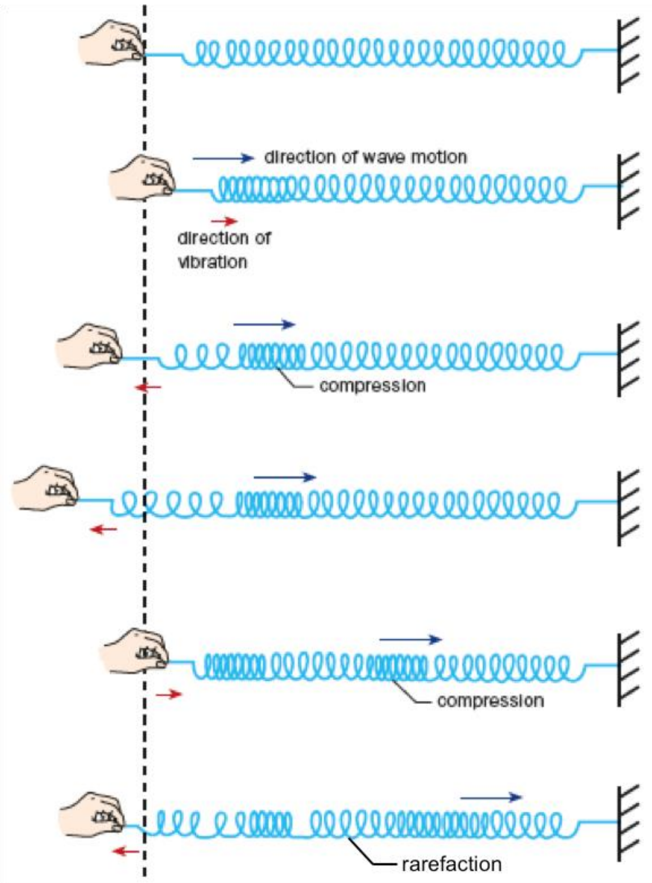




- Each part of the wave is oscillating with the **same frequency and amplitude** but they are **not all in phase** with one another. (i.e. some points are moving up, some down and some are stationary)
- Examples include: water waves, secondary earthquake waves (S waves) and light
- The **highest** point on a transverse wave is a **crest** and the **lowest** point a **trough**.
- One **wavelength** is the distance between **adjacent crests or troughs**.

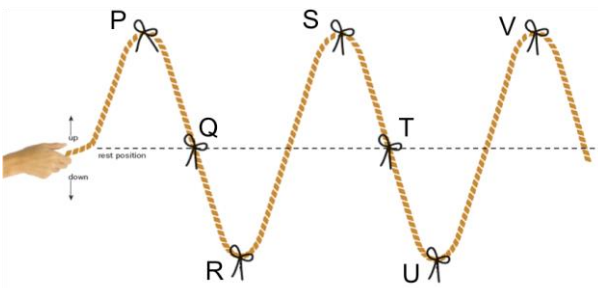
Longitudinal wave

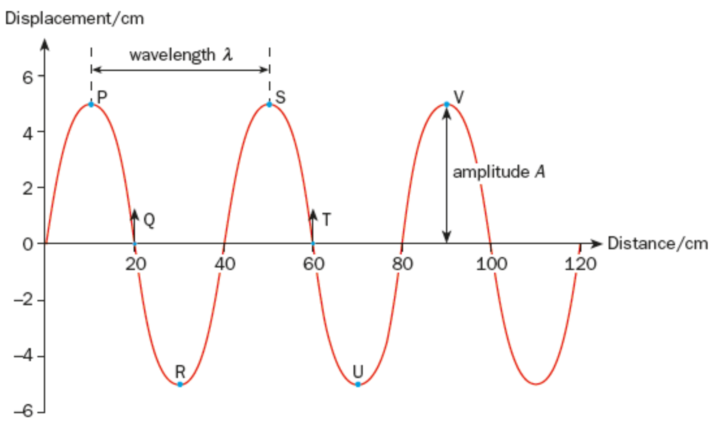
- When a longitudinal wave transfers energy through a medium, the medium itself has **no net movement**; it vibrates about a fixed position.
- Examples: sound and primary earthquake waves (P waves)

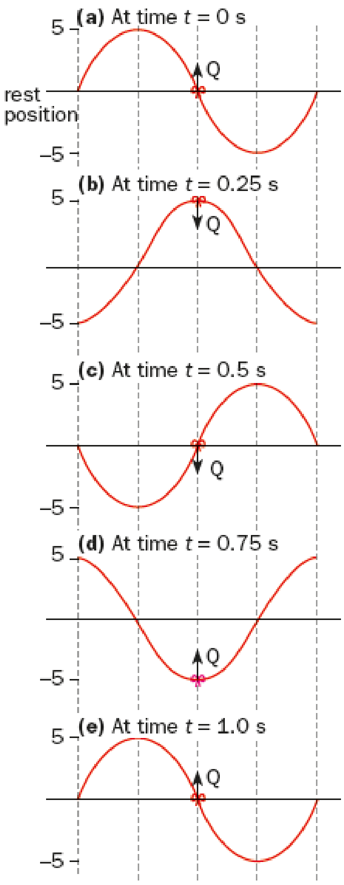


- One **wavelength** is the distance between **adjacent compressions or rarefactions**

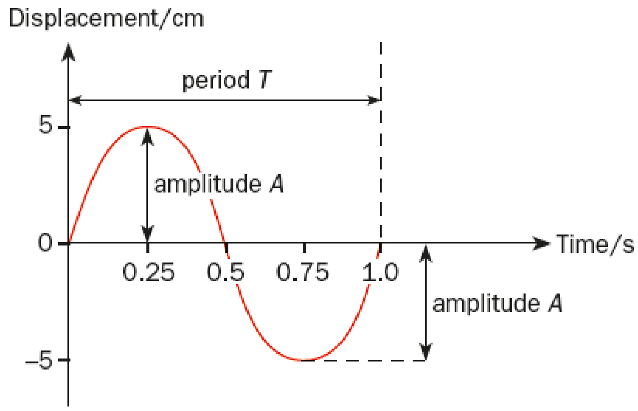
Graphical representation of waves



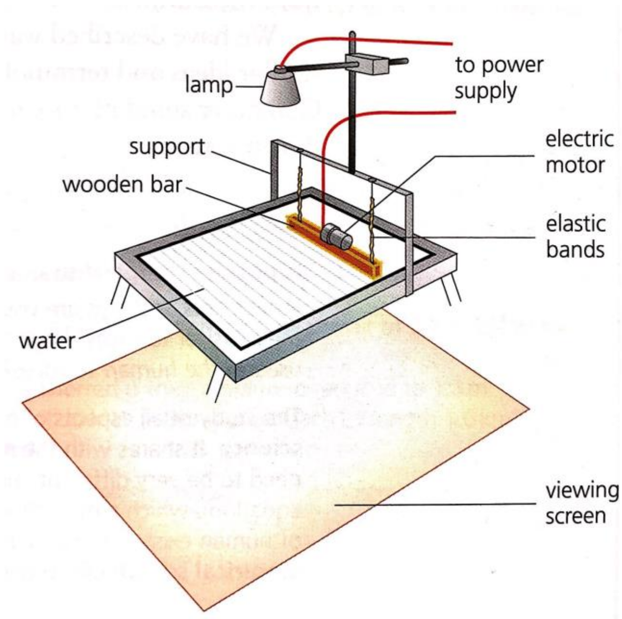




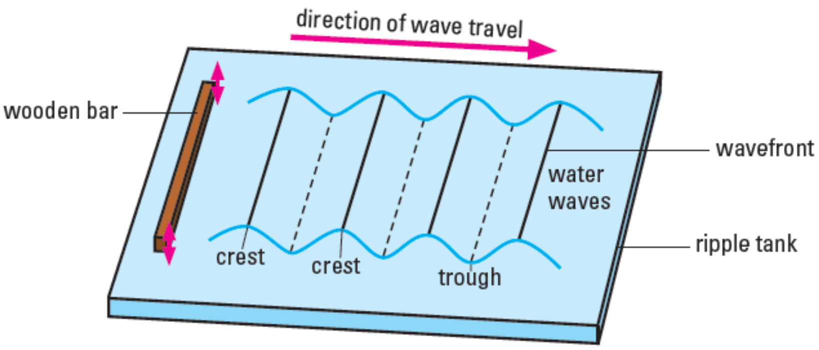
The graph below shows the **vertical displacement of point Q with time**



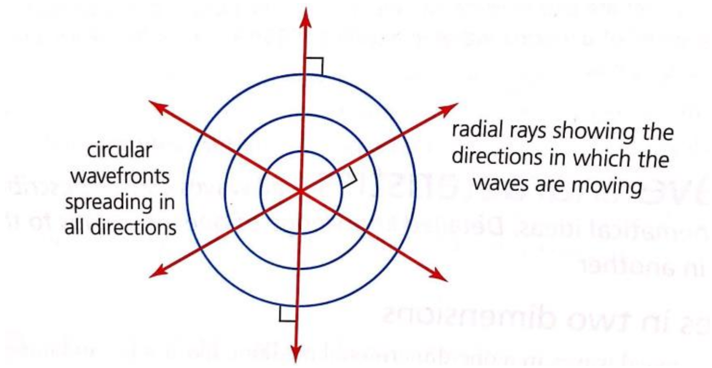
Wavefront

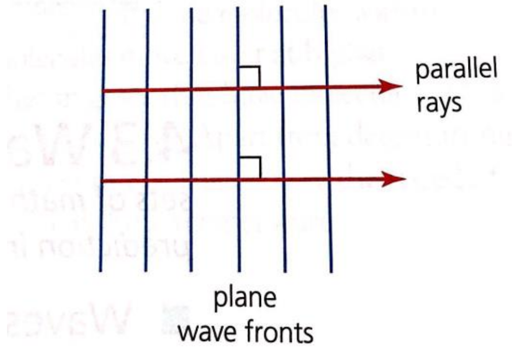


Waves on a ripple tank are produced continuously by a motor that vibrates a small dipper or beam suspended on the water surface. It can be used to study wave behavior.



A **wavefront** is an imaginary line joining adjacent points moving in phase. (e.g. a line joining crests). The distance between adjacent wavefronts is one wavelength

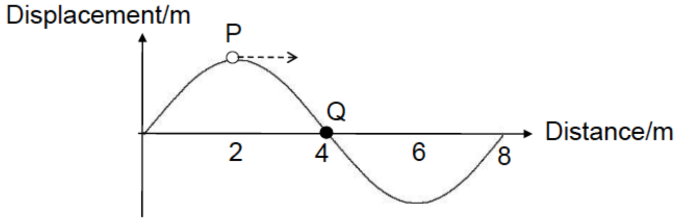




Compare transverse and longitudinal waves

	Transverse		**Longitudinal**
Production	Medium vibrates perpendicular to the direction of energy transfer (mechanical)	Electric and magnetic fields vibrating perpendicular to each other (electromagnetic)	Medium vibrates parallel to the direction of energy transfer (mechanical)
Medium	Yes	No	Yes
Transmission	Transfer energy	Transfer energy	Transfer energy
Examples	Water Earthquake S waves	Light	Sound Earthquake P waves

A wave in a string is travelling to the right at 2.0 m/s. The diagram below shows its displacement-distance graph at t = 0 s.



(a) Sketch a displacement distance graph to show how the wave appears at 3.0 s.

(b) Mark and label the position of P and Q on the wave drawn in (a)

Describe how the speed, frequency and wavelength of a water wave change when it enters shallower water.

Characteristics	**Deep water to shallow water**
Speed	
Wavelength	
frequency	

5 A wave travels along a rope from left to right. Two points on the rope A and B have vertical displacements d_A and d_B. The variation of d_A and of d_B over the same interval in time t is shown in Fig. 5.1.

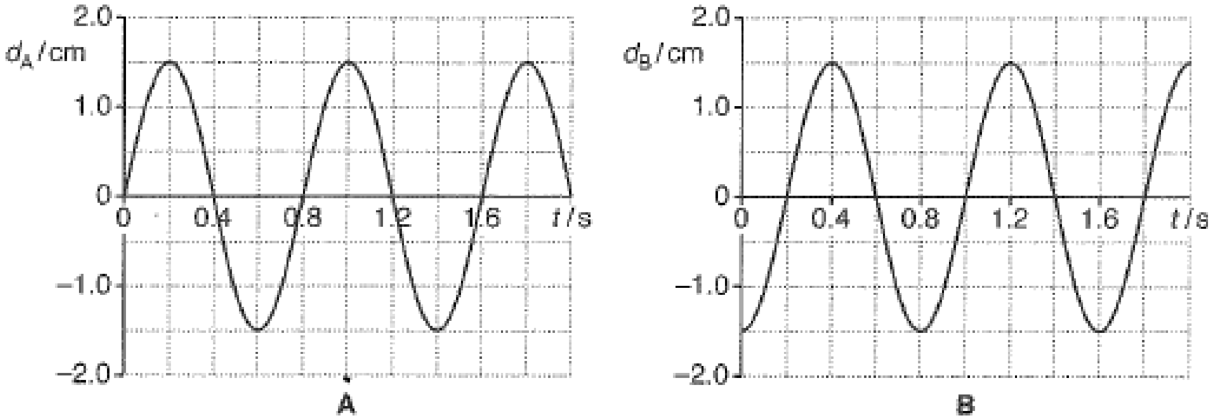


Fig. 5.1

(a) State the amplitude of the wave.

amplitude = ...[1]

(b) (i) Define *frequency* of a wave.

....

....[1]

(ii) Determine the frequency of the wave shown in Fig. 5.1.

frequency = ...[1]

(c) Point B is 38 cm to the right of point A.

(i) There are several possible values for the speed of the wave on the rope.

Show that one possible value for the speed of the wave is about 200 cm/s. Show your working clearly.

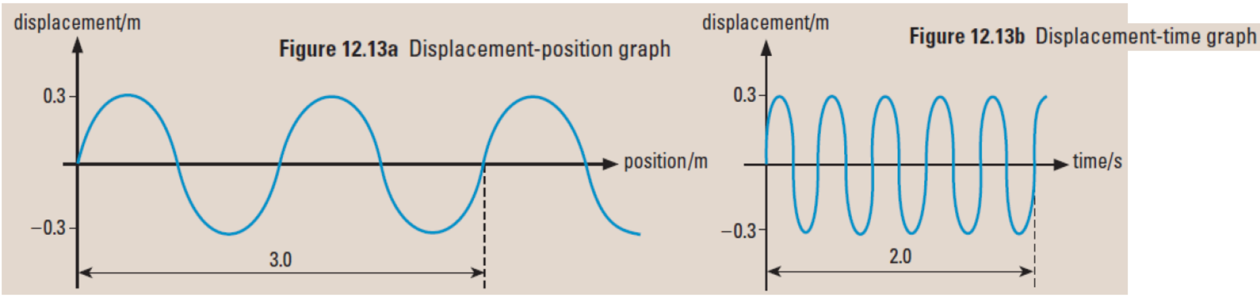
[2]

(ii) Explain why there are other possible values for the speed of the wave.

....

....[1]

Figures 12.13a and 12.13b show the displacement-position and displacement-time graph of a wave travelling along a length of rope respectively.



Determine

(a) Amplitude a;

(b) Wavelength λ;

(c) Period T;

(d) Frequency f;

(e) Speed of the wave v.