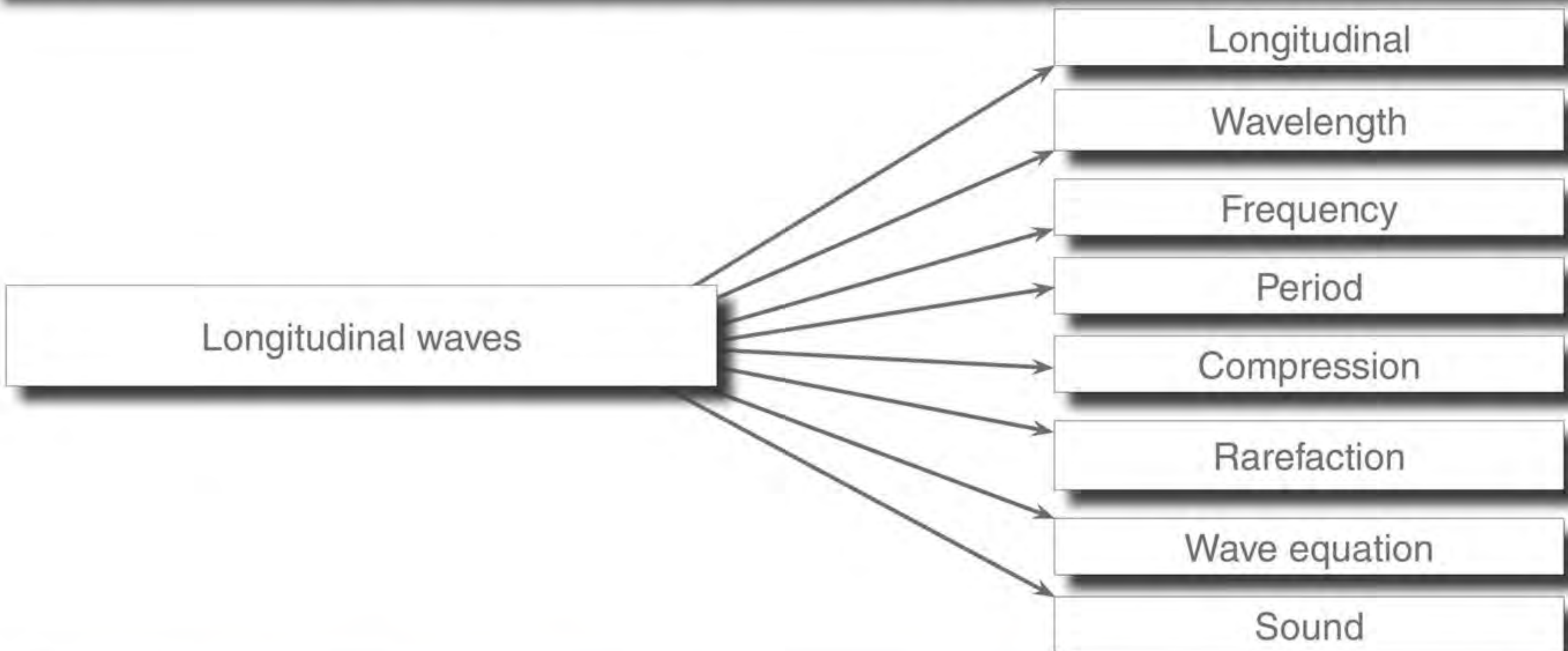
# KNOWLEDGE AREA: WAVES, SOUND AND LIGHT

## UNIT 3 LONGITUDINAL WAVES



## 3.1 Longitudinal waves in a spring

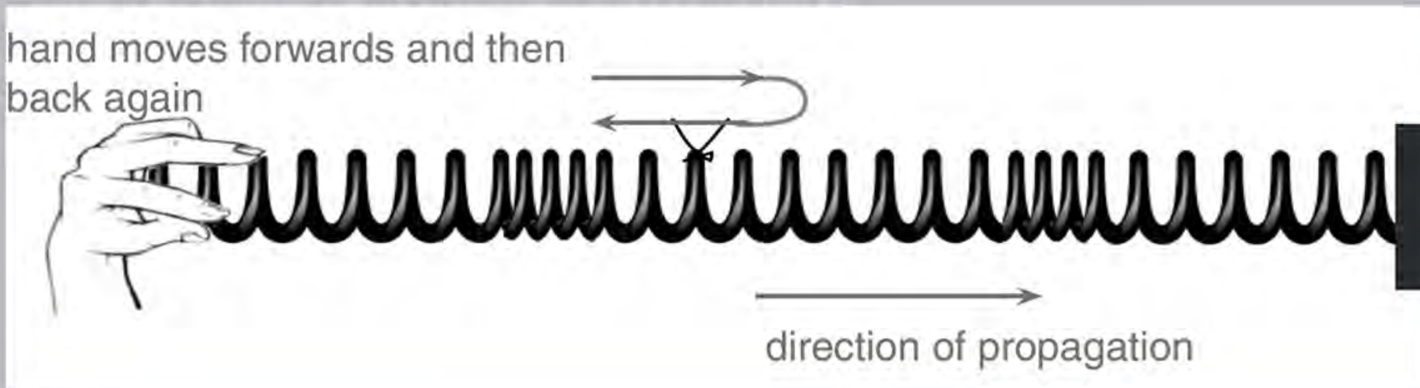
### Practical demonstration: Page 37

**Aim:** To produce a longitudinal wave.

**Apparatus:** Slinky spring

**Method:**
1. Hold one end of the slinky while it is lying on the floor or on a table.
2. Tie a string as a marker in the middle of the spring at A.

3. Push the spring quickly forward and then back.




**Observation:**

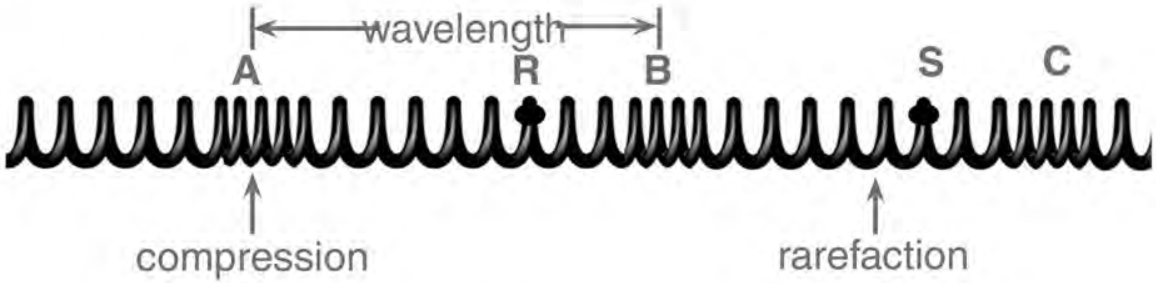
1. In which direction does the piece of string move?

**Forwards and then backwards**

2. What can you conclude about the displacement of the particles and the direction of movement of the wave?

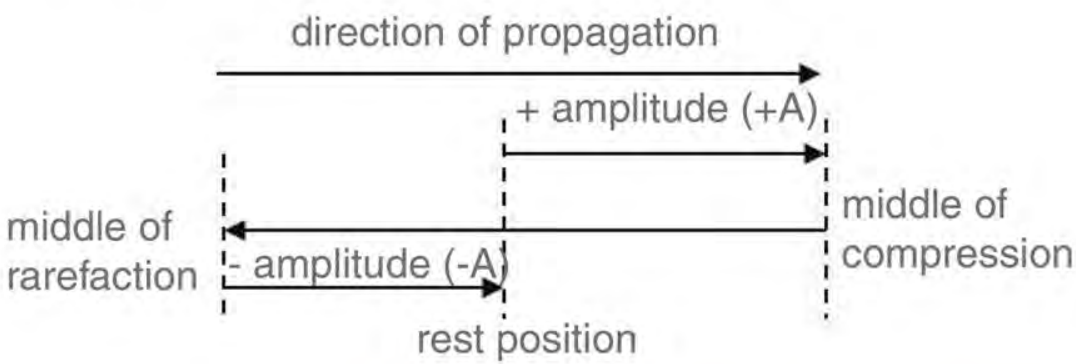
**The displacement is parallel to the direction of movement or the wave.**

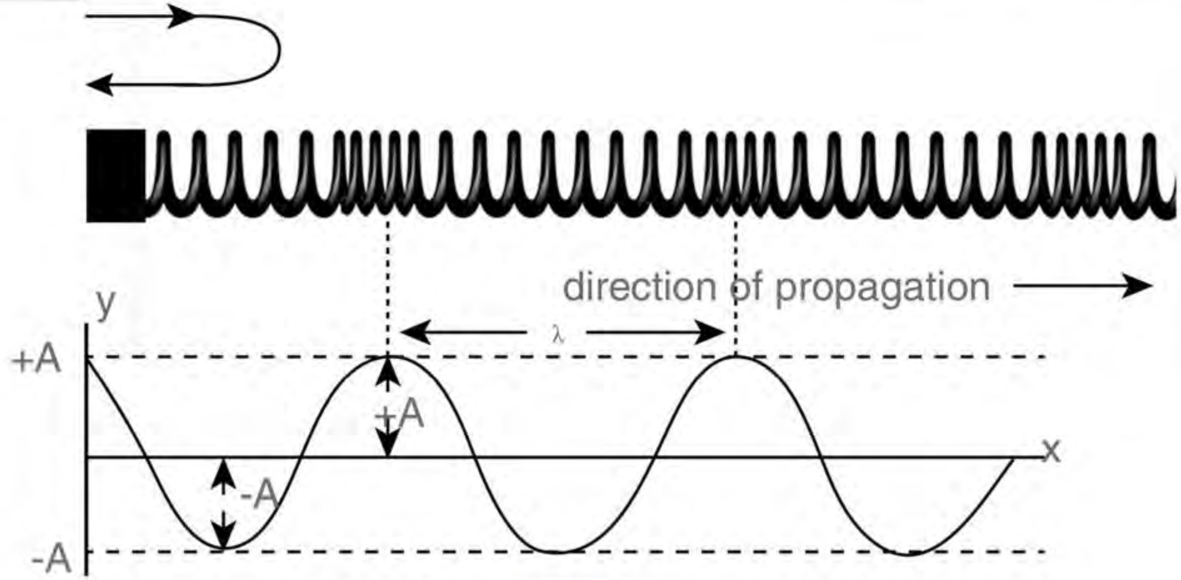
Longitudinal wave




## 3.2 Representation of longitudinal waves

**Graphical representation**






$$T = \frac{1}{f}$$

period (s) ← T; f → frequency (Hz)

$$v = \frac{D}{\Delta t}$$

speed ($m \cdot s^{-1}$) ← v; D → distance (m); Δt → time (s)

$$v = f\lambda$$

speed ($m \cdot s^{-1}$) ← v; λ → wavelength (m); f → frequency (Hz)

A longitudinal wave is a wave in which the particles of the medium move parallel to the direction of movement of the wave.

## Examples

The distance between five consecutive compressions of a longitudinal wave is 200 mm. One compression covers a distance of 350 mm in 2 s.

Calculate:

1. the speed of the wave.
2. the wavelength.
3. the frequency of the waves.

**Solutions:**

1.

$v = ?$

$D = 350 \text{ mm}$

$\phantom{D} = 0{,}35 \text{ m}$

$t = 2 \text{ s}$

$$v = \frac{D}{\Delta t} = \frac{0{,}35}{2} = 0{,}175 \text{ m·s}^{-1}$$

2. The distance between five consecutive compressions represents four wavelengths.

$\therefore$ length of 4 waves = 200 mm = 0,2 m

$$\lambda = \frac{0{,}2}{4} = 0{,}05 \text{ m}$$

3.

$$v = f\lambda$$

$$0{,}175 = f(0{,}05)$$

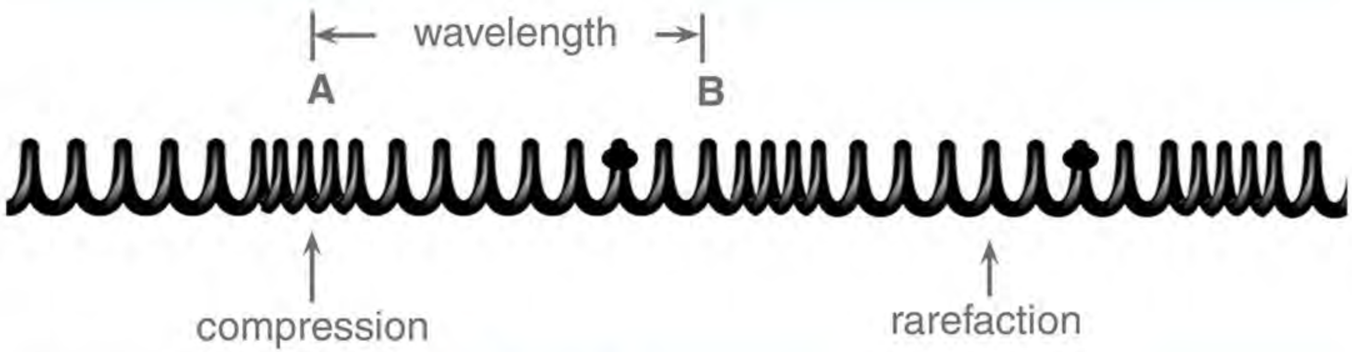
$$f = 3{,}5 \text{ Hz}$$

## Exercise 4: Page 42

1. What is a longitudinal wave?

**A longitudinal wave is a wave in which the particles of the medium move parallel to the direction of movement of the wave.**

2. Draw a sketch of a longitudinal wave. Indicate the following on your sketch: compressions, rarefactions, wavelength.




3. Give an example of a longitudinal wave.

**Sound waves**

4 The distance between two consecutive compressions in a longitudinal wave is 0,25 m and the frequency of the source is 50 Hz. Calculate:

4.1 the speed of the wave.

**$v = f\lambda$**
**$= 50 \times 0,25$**
**$= 12,5\ m\cdot s^{-1}$**

4.2 the period of the wave.

**$T = \frac{1}{f}$**
**$= \frac{1}{50}$**
**$= 0,02\ s$**

5 The distance between a compression and the following rarefaction is 10 cm. It takes 0,5 s for three consecutive compressions and two consecutive rarefactions of a longitudinal wave to move past a certain point.
Calculate:

5.1 the wavelength of the wave.

**compression → rarefaction = ½ wavelength**
**$\lambda = 2 \times 10$ cm**
**$= 20$ cm $= 0,2$ m**

5.2 the period of the wave.

**2 waves take 0,5 s.**
**1 wave takes 0,25 s.**
**$T = 0,25$ s**

5.3 the frequency of the wave.

$f = {}^{1}/_{T}$
$= {}^{1}/_{0,25}$
$= 4\ Hz$

5.4 the speed of the wave.

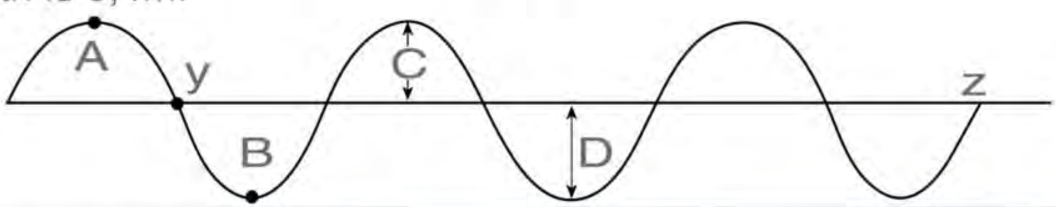
$v = f\lambda$
$= 4 \times 0,2$
$= 0,8\ m{\cdot}s^{-1}$

5.5 the distance covered by the wave in 0,5 s.

$$v = \frac{D}{\Delta t}$$
$$0,8 = \frac{D}{0,5}$$
$$\Delta D = 0,8 \times 0,5$$
$$\Delta D = 0,4\ m$$

A longitudinal wave can be represented on a graph.

6 The wavelength is 0,4m.



6.1 Name:

**A: crest/compression**

**B: trough/rarefaction**

**C: amplitude**

**D: amplitude**

6.2 How many wavelenghts are there from y to z?

**2,5 wavelengths**

6.3 What is the distance between points y to z?

**2,5 × 0,4 = 1 m**