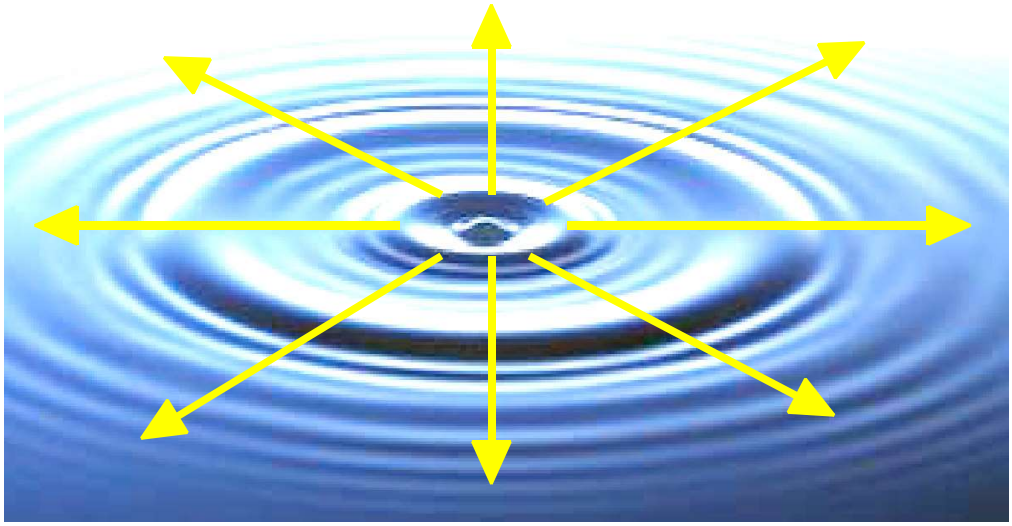
1) List at least 12 kinds of waves.

2) This photograph shows a water wave on the surface of a pond, created by throwing a stone into the pond.



(a) On the diagram, label the 'wave source'.

(b) What do the arrows represent?

3) (a) Complete the following:

All waves transfer (carry) _____ *from their* _____ *to their* _____.

(b) (i) What kind of 'sea wave' is represented by this diagram?

(ii) Write down evidence to show that this kind of wave can transfer (carry) a great deal of energy.

(c) Explain why the energy carried by 'sea waves' will be important to us in the future.

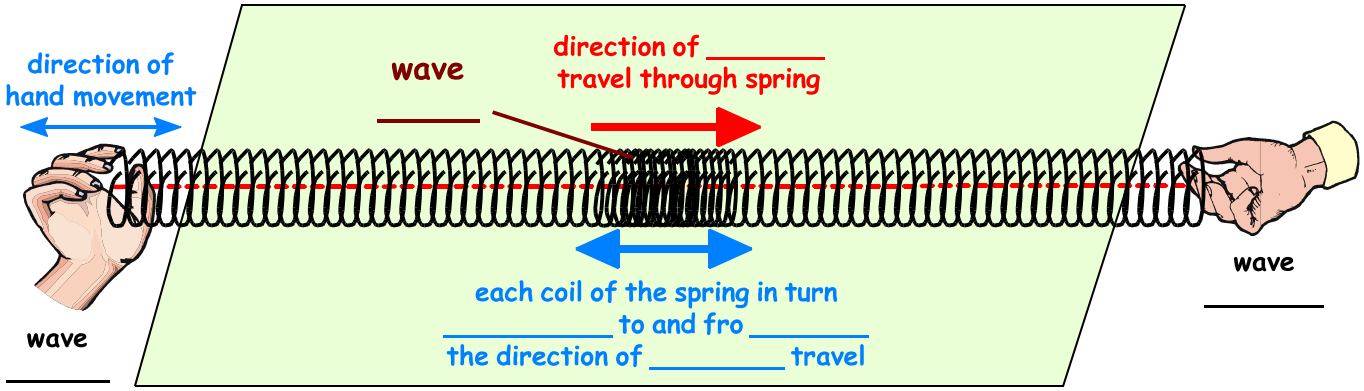
"N5 PHYSICS"

WAVES - Spread 2

1) There are two different types of wave motion.

Name each type.

2) This diagram shows a wave pulse travelling along a long stretched spring.

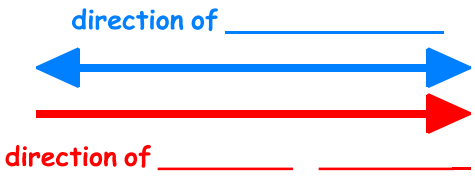


(a) What type of wave is travelling along the spring?

(b) Complete the labels on the diagram.

(c) Complete the following passage and the labels on the arrows:

As the _____ *wave pulse travels through the spring, each coil of the spring in turn* _____ *to and fro* _____ *the direction in which the* _____ *is travelling. Each coil passes on* _____ *to the next coil in line.*



(d) Complete the following:

In a _____ *wave, the* _____ *are* _____ *the direction in which* _____ *travels.*

(e) (i) What happens to every coil in the spring one the wave pulse has passed through the coil?

(ii) Do the coils in the spring travel along the spring with the energy travelling along the spring?

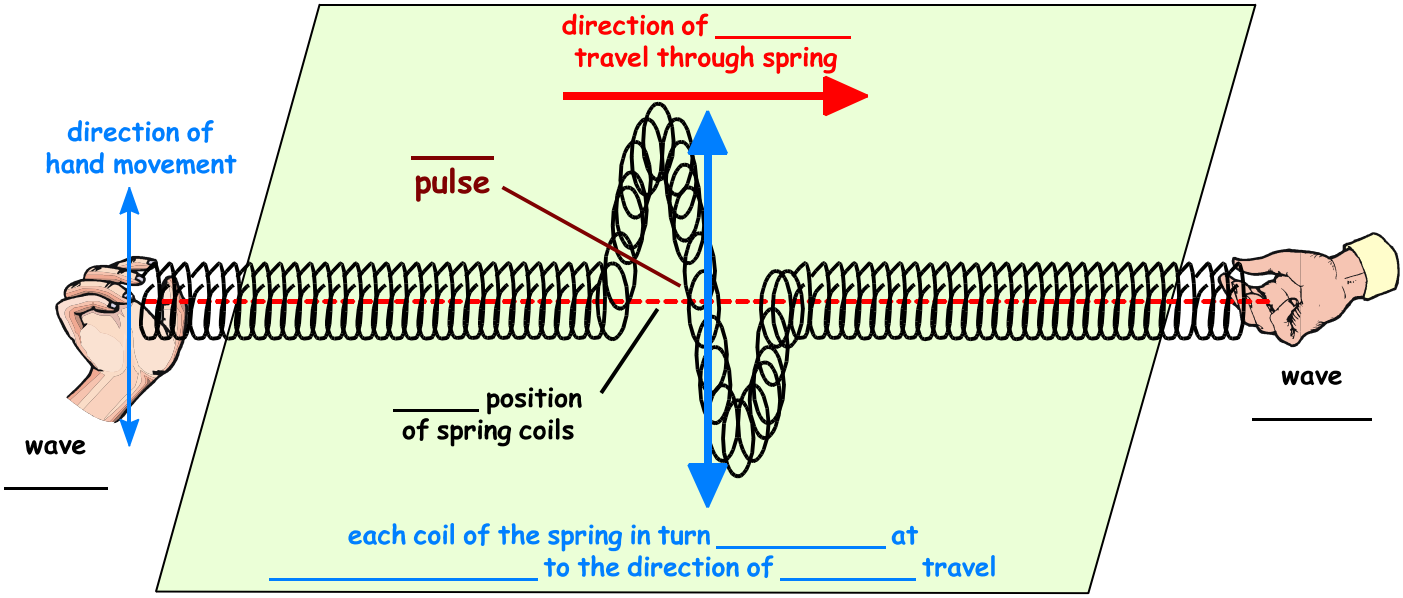
(iii) Complete the following:

During _____ *wave motion, only* _____ *is transferred. Any* _____ *(material) the* _____ *travels through* _____ _____ *travel along with the* _____ .

3) (a) Describe longitudinal wave motion.

(b) Give one example of a longitudinal wave.

4) This diagram shows a wave pulse travelling along a long stretched spring.

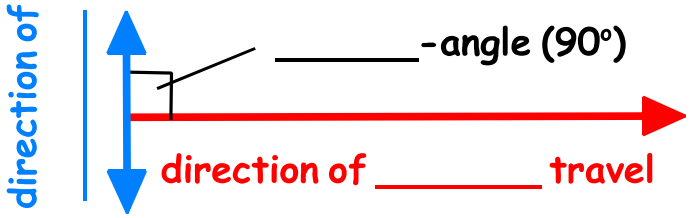


(a) What type of wave is travelling along the spring?

(b) Complete the labels on the diagram.

(c) Complete the following passage and the labels on the arrows:

As the _____ *wave pulse travels through the spring, each coil of the spring in turn* _____ _____ *, at* _____*to, the direction in which the* _____ *is travelling. Each coil passes on* _____ *to the next coil in line.*



(d) Complete the following:

In a _____ *wave, the* _____ *are at* _____ *to the direction in which* _____ *travels.*

(e) (i) What happens to every coil in the spring one the wave pulse has passed through the coil?

(ii) Do the coils in the spring travel along the spring with the energy travelling along the spring?

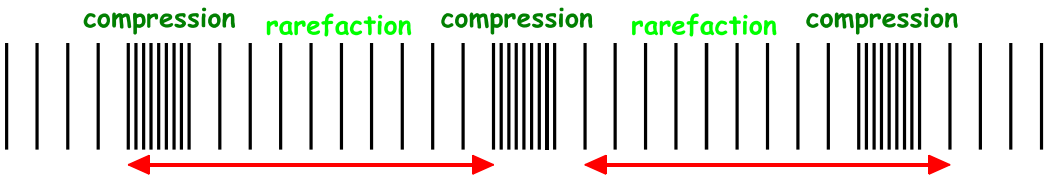
(iii) Complete the following:

During _____ *wave motion, only* _____ *is transferred. Any* _____ *(material) the* _____ *travels through* _____ _____ *travel along with the* _____ .

5) (a) Describe transverse wave motion.

(b) Give two examples of transverse waves.

1) This diagram represents a wave travelling through a material.

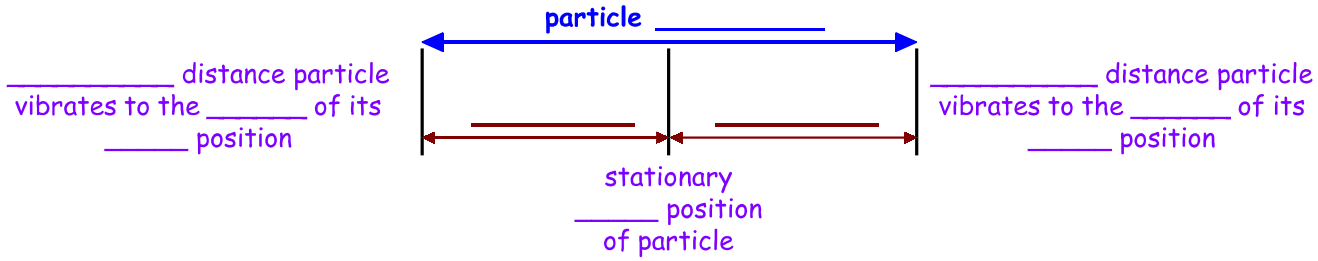


(a) What type of wave is travelling through the material?

(b) On the diagram, label a wavelength (x 2).

(c) Complete the following passage and the labels on the diagram below:

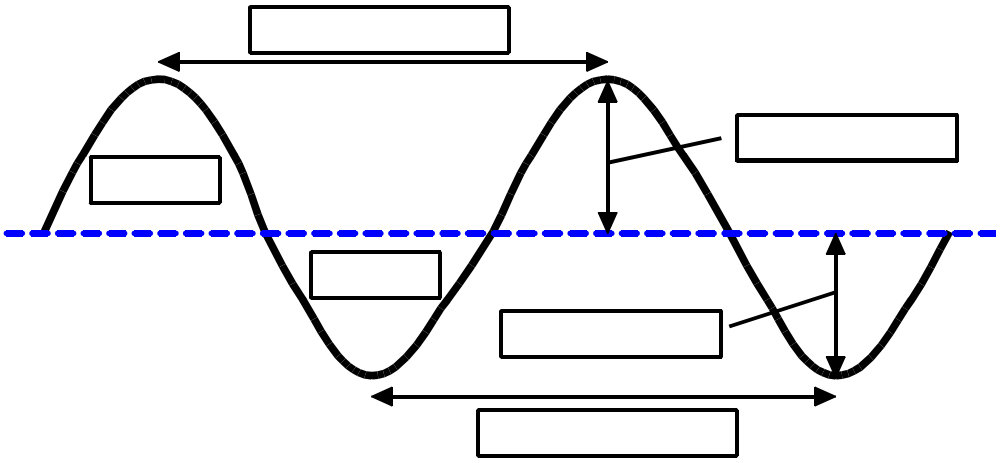
The amplitude of a _____ wave is the _____ _____ a _____ in the material the wave is travelling through _____ from its _____ _____ position. [Unit: _____ (__)].



2) (a) Explain what is meant by the 'amplitude' of a longitudinal wave.

(b) In what "unit" is 'amplitude' measured? - give the word and symbol.

3) This diagram represents a wave travelling through a material.



(a) What type of wave is travelling through the material?

(b) On the diagram, label: a wavelength (x 2), a crest, a trough and the amplitude (x 2).

(c) Complete the following passage:

The amplitude of a _____ wave is the full _____ of a wave _____ or _____ measured from the zero disturbance _____ _____ . Unit: _____ (__).

4) (a) Explain what is meant by the 'amplitude' of a transverse wave.

(b) In what "unit" is 'amplitude' measured? - give the word and symbol.

5) Complete the following:

The wavelength of a wave is the _____ *between two identical* _____ _____ *of the wave. [Unit:* _____ *(__)].*

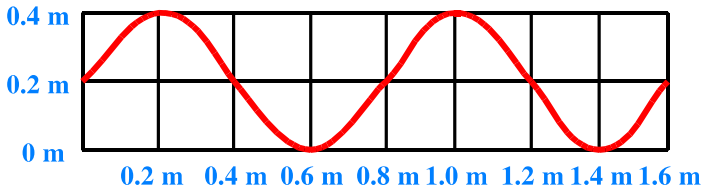
For a longitudinal wave, this is the distance between the start of two neighbouring _____.

For a transverse wave, this is the distance between two neighbouring _____ _____ *or the distance between two neighbouring* _____ _____ .

6) Explain what is meant by the 'wavelength' of any wave.

(b) In what "unit" is 'wavelength' measured? - give the word and symbol.

7) This diagram represents a wave.

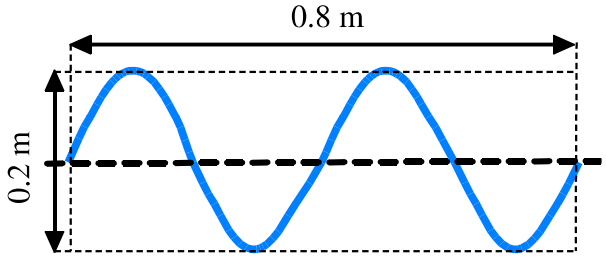


(a) Is the wave longitudinal or transverse?

(b) Determine the amplitude of the wave.

(c) Determine the wavelength of the wave.

8) A wave is shown in this diagram.



(a) What type of wave is shown?

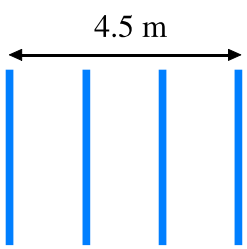
(b) What is the value for the amplitude of the wave?

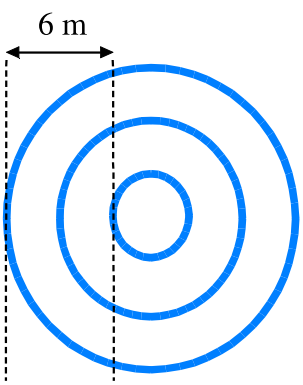
(c) What is the value for the wavelength of the wave?

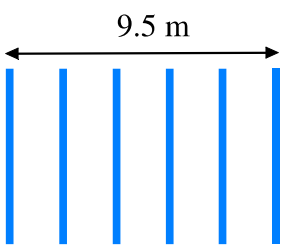
9) Each of these diagrams shows water waves viewed from above.
The lines represent wave crests.

(a) On each diagram, use a 'double-headed arrow' to show the wavelength.

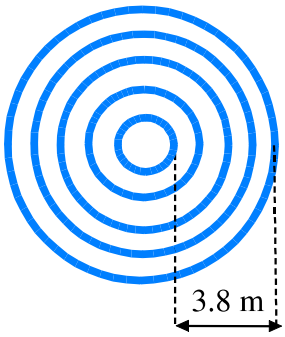
(b) For each diagram, determine the wavelength of the water waves.







10) Nicole dropped a stone from a bridge into a calm pond below.
Using a length marker on the pond bank, Nicole was able to determine that there was a distance of 3.8 m between the first and fifth of the circular water wave crests produced.



Calculate the wavelength of the circular water waves travelling across the pond.

11) Complete the following:

The frequency of a wave is the number of wave _____ (or _____ or _____ or _____) emitted by the _____ _____ in _____ _____ .
[Unit: _____ (__)].

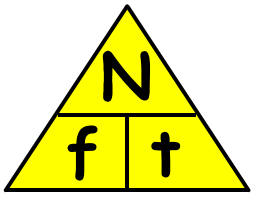
To determine the frequency of a wave, we can apply this equation:

$$\text{frequency} = \frac{\text{number of wave } \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_}{\_\_\_\_\_ \text{ (in } \_\_\_\_\_ \text{)}}$$

12) (a) Explain what is meant by the 'frequency' of any wave.

(b) In what "unit" is 'frequency' measured? - give the word and symbol.

(c) Label the equation triangle and complete the equations shown in the box:



f =

N =

t =

CARRY OUT THE FOLLOWING CALCULATIONS:

13) A wave source emits 250 wave pulses in a time of 40.0 s.

Calculate the frequency of the waves produced by the source.

14) A tuning fork emits sound waves by vibrating 640 times in a time of 1.25 s.

Calculate the frequency of the sound waves emitted.

15) While sending wave pulses along a stretched spring, a student moves their hand forwards then backwards, at constant speed, 15 times in 60 s.

Calculate the frequency of the wave pulses.

16) A wave source has a frequency of 12 Hz.

Calculate the number of wavelengths the source emits in a time of 4.5 s.

17) A siren has a frequency of 800 Hz.

Calculate the number of sound wave pulses the siren will emit in a time of 1.15 s.

18) A source of water waves has a frequency of 0.35 Hz.

Calculate the number of wave crests the source will produce in a time of 80 s.

19) A wave source has a frequency of 7.5 Hz.

Calculate the time it will take the wave source to emit 90 wave troughs.

20) A loudspeaker emits sound pulses of frequency 320 Hz.

Calculate the time required for the loudspeaker to emit 880 sound pulses.

21) By vibrating, a whistle produces sound of frequency 625 Hz.

Calculate the time the whistle will take to vibrate 925 times.

22) If 36 water wave ripples are emitted from a source in a time of 80 s, determine the frequency of the water waves.

23) If a sound generator emitted sound waves of frequency 80 Hz for a time of 1.2 s, determine the number of sound waves emitted from the sound generator in this time.

24) If sea waves have a frequency of 0.25 Hz, determine the time it will take for 10 wave troughs to pass a stationary boat that is floating on the sea.

25) If 54 transverse wave pulses are sent along a stretched spring in a time of 75 s, what is the frequency of the wave source?

26) If a vibrating piano string emits sound waves of constant frequency 256 Hz (middle C) over a time of 0.875 s, how many vibrations does the piano string make in this time?

27) If the wave pulses travelling along a brick wall have a frequency of 600 Hz, what time will it take for the wave source to generate 750 pulses?

1) Complete the following:

The period (T) of a wave is the _____ taken by the wave source to generate (produce) ____ _____ _____ . [Unit: _____ (__)].

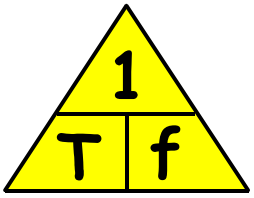
The period and frequency of a wave are related by this equation:

$$\text{period} = \frac{1}{\text{frequency}} \quad \text{or} \quad \text{frequency} = \frac{1}{\text{period}}$$

2) (a) Explain what is meant by the 'period' of any wave.

(b) In what "unit" is 'period' measured? - give the word and symbol.

(c) Label the equation triangle and complete the equations shown in the box:



T =

f =

CARRY OUT THE FOLLOWING CALCULATIONS:

3) For each stated frequency, calculate the period of the wave motion:

frequency = 0.80 Hz	frequency = 1.60 Hz	frequency = 4.0 Hz	frequency = 6.25 Hz	frequency = 12.5 Hz

---

4) For each stated period, calculate the frequency of the wave motion:

period = 0.2 s	period = 0.5 s	period = 2.5 s	period = 10 s	period = 80.0 s

5) Complete the following:

The speed of a wave is the distance one wave _____ (or _____ or _____ or _____) travels every _____ . [Unit: _____ (____)].

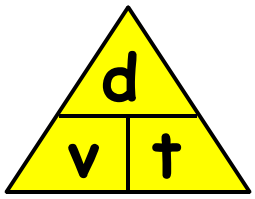
To determine the speed of a wave, we can apply this equation:

$$\text{wave speed} = \frac{\text{\_\_\_\_\_ travelled by wave \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_}}{\text{\_\_\_\_\_ (in \_\_\_\_\_)}}$$

6) (a) Explain what is meant by the 'speed' of any wave.

(b) In what "unit" is 'wave speed' measured? - give the word and symbol.

(c) Label the equation triangle and complete the equations shown in the box:



v =

d =

t =

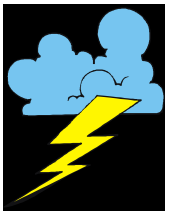
CARRY OUT THE FOLLOWING CALCULATIONS:

For questions 7-12, you should assume that light and sound are emitted by "an event" at the same time. Light travels through the air so quickly that we see an event happening at the instant it happens ..... nothing travels faster than light.

Sound travels through air almost one million times more slowly than light, so reaches us after the light does - there is a "time delay" between us seeing an event happening and hearing the sound emitted due to the event. For these six questions, you should substitute the speed of SOUND into the equation..... not the speed of LIGHT.

7) A girl sees a flare exploding in the distance. After 2.55 s, she hears the corresponding explosion.

How far away from the girl was the flare when it exploded?
(Speed of sound in air = 340 m s^{-1}).



8) One night, you see a flash of lightning. After 1.75 s, you hear the corresponding thunder.

How far away are you from the source of the thunder and lightning?
(Speed of sound in air = 340 m s^{-1}).

9) A lighthouse emits flashes of light and blasts of sound at the same time. A sailor on a ship hears a sound blast 2.90 s after seeing a light flash.

How far away is the ship from the lighthouse?
(Speed of sound in air = 340 m s^{-1}).

10) A boy sees a golfer hitting a golf ball. The boy is 42.5 m away from the golfer.

What time does it take for the sound of the golfer hitting the golf ball to reach the boy?
(Speed of sound in air = 340 m s^{-1}).

11) A soldier sees a shell exploding 833 m away from his bunker.

What time does it take for the sound of the explosion to reach the soldier?
(Speed of sound in air = 340 m s^{-1}).

12) You are standing 73.1 m away from a motorbike when you see the flash of a 'backfire' from its exhaust pipe.

What time does it take for the sound of the 'backfire' to reach you?
(Speed of sound in air = 340 m s^{-1}).

13) When Sajidha threw a stone into a pond, circular water waves travelled a distance of 7.0 m across the pond surface in a time of 2.5 s.

Calculate the speed of these water waves.

14) A drop of water from a leaking tap causes waves on the surface of Brenda's bath water.

If these waves travel a distance of 0.4 m in a time of 1.6 s, at what speed are they travelling?

15) Musical notes travel a distance of 62.9 m through the air in a time of 185 ms (185×10^{-3} s) [0.185 s].

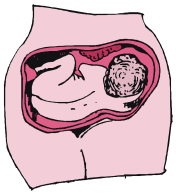
Use this information to calculate the speed of sound in air.

16) A tsunami sea wave travelled up a beach at a speed of 15 m s^{-1}. This took a time of 4.6 s.

Calculate the distance the tsunami sea wave travelled up the beach.

17) Sid the surfer rides the crest of a sea wave travelling at a speed of 3.5 m s^{-1} for a time of 8.0 s.

What distance does the sea wave carry Sid in this time?



18) During a scan of a baby in its mother's womb, an ultrasound pulse travels through the mother's body tissue at a speed of 1 500 m s^{-1} for a time of 125 µs (125×10^{-6} s) [0.000125 s].

Use this information to calculate the distance the ultrasound pulse travels through the mother in this time.

19) Sea waves travel a distance of 80 m towards a cliff at a speed of 2.5 m s^{-1}.

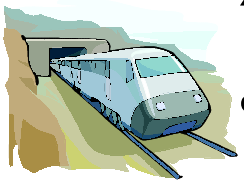
Calculate the time this will take the sea waves.

20) As the tide goes out, sea waves travel a distance of 50 m at a speed of 2.5 m s^{-1}.

What time do the sea waves take to do so?

21) During a medical procedure, ultrasound travels a distance of 0.4715 m through human bone at a speed of 4 100 m s^{-1}.

Use this information to calculate the time taken for ultrasound to travel this distance through human bone.



22) A moving train causes sound to travel a distance of 6 370 m along a steel rail track in a time of 1.225 s.

Calculate the speed of sound in steel.

23) A nut is dropped onto an aluminium spanner, causing a sound pulse to travel through the aluminium at a speed of 5 200 m s^{-1} for a time of 91.25 µs (91.25×10^{-6} s) [0.00009125 s].

What distance does the sound pulse travel through the aluminium in this time?

24) During medical treatment, a longitudinal wave vibration travels a distance of 0.1800 m through human muscle tissue at a speed of 1 600 m s^{-1}.

What time does this take?

Questions 25-30 involve the reflection of waves from an object.

Be careful to use the correct time in your calculations.

25) Susan shouts at a brick wall.
After a time of 350 ms (350×10^{-3} s) [0.350 s], she hears her echo - the sound of her shout reflected off the wall.
(Speed of sound in air = 340 m s^{-1}).

Susan

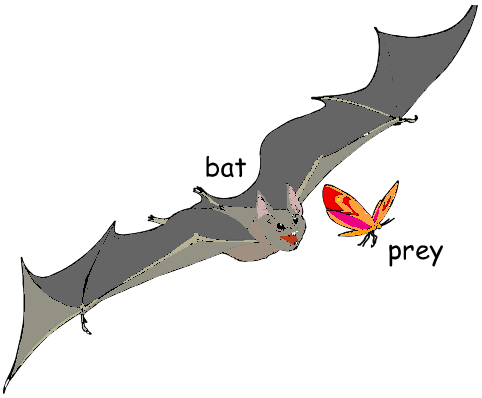
brick wall

(a) Calculate the time taken for the sound of Susan's shout to reach the brick wall.

(b) Calculate the distance between Susan and the brick wall.

---

26) A bat emits pulses of ultrasound to determine how far ahead its prey is.
After a time of 4.40 ms (4.40×10^{-3} s) [0.00440 s], an ultrasound pulse reflected off the prey is detected by the bat. (Speed of ultrasound in air = 340 m s^{-1}).



(a) Calculate the time taken for the pulse of ultrasound to reach the bat's prey.

(b) Calculate the distance between the bat and its prey.

---

27) A survey boat sends a pulse of ultrasound from its hull directly down to the bed of a loch.
After a time of 170.4 ms (170.4×10^{-3} s) [0.1704 s], an ultrasound pulse reflected off the loch bed is detected by the boat. (Speed of ultrasound in water = 1 500 m s^{-1}).

(a) Calculate the time taken for the pulse of ultrasound to reach the loch bed.

(b) Calculate the distance between the survey boat's hull and the loch bed, i.e., the depth of the loch.

loch bed

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28) On one mission to the moon, astronauts left a large mirror on the moon surface, directly facing the earth.
A pulse of laser light is sent from earth's surface to the mirror on the moon's surface.
After a time of 2.52 s, the pulse of laser light reflected off the mirror on the moon is received back on earth.
(Speed of laser light in outer space = 300 000 000 m s^{-1}, i.e., 3.00×10^{8} m s^{-1}).

moon

(a) Calculate the time taken for the pulse of laser light to reach the moon's surface.

(b) Calculate the distance between the earth's surface and the moon's surface.

earth

29) A radar wave pulse is sent from a radar dish on the earth's surface towards a low-flying aircraft. After a time of 2.80 μs (2.80×10^{-6} s) [0.00000280 s], the radar dish detects the reflected radar pulse from the aircraft. (Speed of radar waves in air = 300 000 000 m s^{-1}, i.e., 3.00×10^{8} m s^{-1}).

low-flying aircraft

(a) Calculate the time taken for the radar wave pulse to reach the low-flying aircraft.

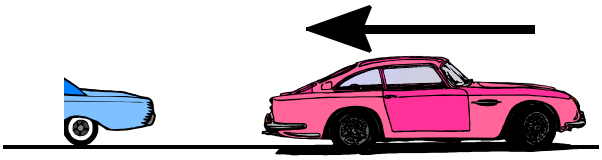
(b) Calculate the distance between the radar dish and the low-flying aircraft.

radar dish

---

30) A vehicle reversing system uses radio wave pulses to detect when a reversing car is the optimum safe parking distance away from the stationary car behind.

A radio wave pulse is sent from the bumper of the reversing car towards the stationary car behind. After a time of 13.2 ns (13.2×10^{-9} s) [0.0000000132 s], a sensor on the reversing car's bumper detects the reflected radio wave pulse from the stationary car behind, indicating that the optimum safe parking distance has been reached. (Speed of radio waves in air = 300 000 000 m s^{-1}, i.e., 3.00×10^{8} m s^{-1}).



stationary car reversing car

(a) Calculate the time taken for the radio wave pulse to reach the stationary car behind the reversing car.

(b) Calculate the optimum safe parking distance between the two cars.

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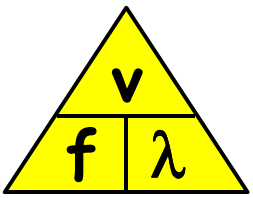
31) Complete the following:

The speed, frequency and wavelength of a wave are related by this equation:

wave speed = _____ x _____

32) Label the equation triangle and complete the equations shown in the box:



v =

f =

λ =

CARRY OUT THE FOLLOWING CALCULATIONS:

33) Calculate the speed of water waves on a pond that have a frequency of 0.15 Hz and a wavelength of 5.0 m.

34) Calculate the speed of sound waves in air if they have a frequency of 500 Hz and a wavelength of 0.68 m.

35) Calculate the speed of waves spreading outwards from their source that have a frequency of 0.25 Hz and a wavelength of 0.68 m.

36) Calculate the frequency of water waves in a harbour if they travel with a speed of 3.0 m s^{-1} and have a wavelength of 4.0 m.

37) Calculate the frequency of sound waves in air if they travel with a speed of 340 m s^{-1} and have a wavelength of 1.7 m.

38) Calculate the frequency of waves travelling away from their source at a speed of 12.5 m s^{-1} if the waves have a wavelength of 2.5 m.

---

39) Calculate the wavelength of water waves on a pond that travel with a speed of 0.75 m s^{-1} and have a frequency of 1.5 Hz.

40) A Calculate the wavelength of sound waves in air that travel with a speed of 340 m s^{-1} and have a frequency of 6 800 Hz.

41) Calculate the wavelength of waves travelling at a speed of 2.4 m s^{-1} if they have a frequency of 0.30 Hz.

---

42) Every second, 2 waves are produced on Alan's bath water by water drops dripping from a bath tap. If these waves have a wavelength of 0.05 m, calculate their speed.

43) The wind causes waves to travel across a puddle with a speed of 2.4 m s^{-1}. If the waves have a wavelength of 0.60 m, calculate their frequency.

44) A wave generator in a swimming pool produces 2.5 waves every second. The waves travel across the swimming pool with a speed of 1.2 m s^{-1}. Calculate their wavelength.

---

45) A submarine sends a pulse of sound through sea water. Determine the speed of the sound pulse if the submarine is emitting sound of frequency 7 500 Hz and wavelength 0.20 m.

46) Sound waves travel through steel at a speed of of 5 200 m s^{-1}. In the steel, the sound waves have a wavelength of 2.0 m. Determine their frequency.

47) Ultrasound of frequency 21 000 Hz travels through human muscle at a speed of 1 600 m s^{-1}. Determine the wavelength of ultrasound in human muscle.

1) Complete the following:

When waves pass through a _____ in an object or around the _____ of an object, the _____ of the wavefronts changes - part or all of each wavefront becomes _____ as the waves _____.

This effect is known as _____.

2) (a) Explain the meaning of the term "diffraction".

(b) Which waves diffract most ..... those with a shorter wavelength or those with a longer wavelength?

(a) Diffraction Through a Gap in an Object

3) (a) On the wave diagrams below, what do we call the arrows on the diagrams, drawn at 90° to the wavefronts?

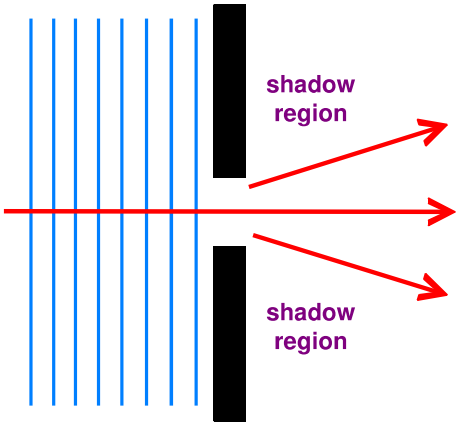
(b) What do these arrows show?

(c) Fill in the missing words and complete each diagram. (Take your time. Use a sharp pencil):

WAVES WITH A SHORTER WAVELENGTH - LESS THAN WIDTH OF GAP IN OBJECT

There is very little _____ - only at the _____ of each wavefront that has passed through the gap.

There are two large _____ _____, where no diffracted waves reach.



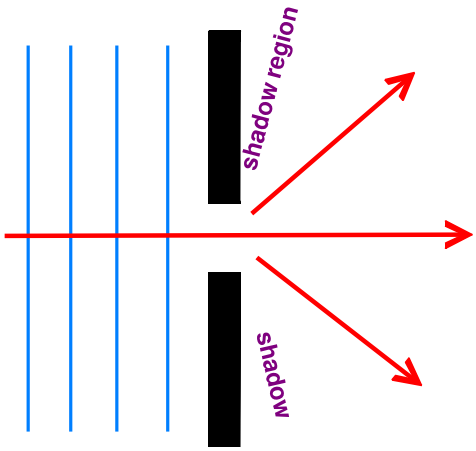
DURING DIFFRACTION, THE WAVELENGTH OF THE WAVES DOES NOT CHANGE.

THIS IS VERY IMPORTANT TO REMEMBER WHEN YOU ARE DRAWING DIAGRAMS SHOWING THE DIFFRACTION OF WAVEFRONTS.

WAVES WITH A LONGER WAVELENGTH - EQUAL TO OR GREATER THAN WIDTH OF GAP IN OBJECT

There is a great deal of _____ - the _____ in the object acts as a source of _____ waves.

There are two small _____ _____, where no diffracted waves reach.



The greatest amount of _____ takes place when the _____ of the waves is _____ to or _____ _____ the width of the gap they are passing through.

The _____ the wavelength, the _____ the diffraction.

(b) Diffraction Around the Edge of an Object

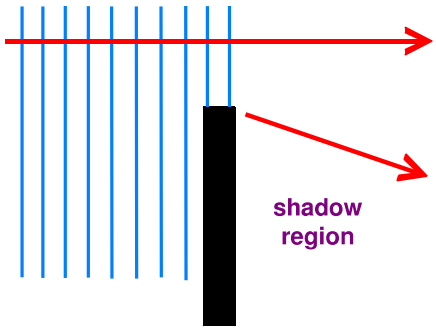
Fill in the missing words and complete each diagram. (Take your time. Use a sharp pencil):

(i) Around One Edge

<u>WAVES WITH A SHORTER WAVELENGTH</u>

There is very little _____ at the edge of each wavefront that has passed and touched the object.

There is a large _____ _____, where no diffracted waves reach.



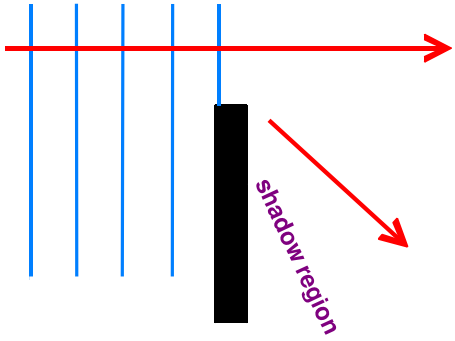
DURING DIFFRACTION, THE WAVELENGTH OF THE WAVES DOES NOT CHANGE.

THIS IS VERY IMPORTANT TO REMEMBER WHEN YOU ARE DRAWING DIAGRAMS SHOWING THE DIFFRACTION OF WAVEFRONTS

<u>WAVES WITH A LONGER WAVELENGTH</u>

There is a great deal of _____ at the edge of each wavefront that has passed and touched the object.

There is a small _____ _____, where no diffracted waves reach.

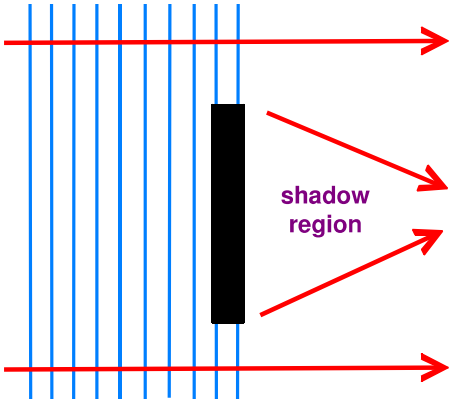


(ii) Around Both Edges

<u>WAVES WITH A SHORTER WAVELENGTH</u>

There is very little _____ at the edge of each wavefront that has passed and touched the object.

There is a large _____ _____, where no diffracted waves reach.



DURING DIFFRACTION, THE WAVELENGTH OF THE WAVES DOES NOT CHANGE.

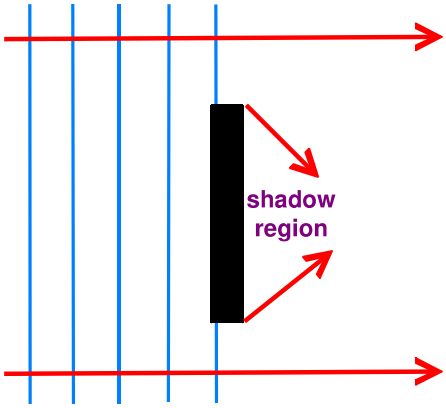
THIS IS VERY IMPORTANT TO REMEMBER WHEN YOU ARE DRAWING DIAGRAMS SHOWING THE DIFFRACTION OF WAVEFRONTS

<u>WAVES WITH A LONGER WAVELENGTH</u>

There is a great deal of _____ at the edge of each wavefront that has passed and touched the object

- the wavefronts _____ ____ again after travelling a short distance past the object.

There is a small _____ _____, where no diffracted waves reach.



A greater amount of _____ takes place for waves of _____ wavelength - the _____ the wavelength, the _____ the diffraction.

1) Complete the following:

When waves pass from one medium (material) into another medium (material) of different _____, their _____ changes.

This change in _____ is known as _____.

2) Explain the meaning of the term "refraction".

3) Complete the following:

When the _____ of a wave changes due to _____, the _____ of the wave also changes. Its _____ may also change.

A _____ is a line drawn to represent a wave _____, _____ or _____.

A _____ is a line drawn at ____ to a wavefront. _____ show the direction of _____ transfer.

A _____ is a line drawn at ____ to the _____ between two media (materials), at the point where a ray _____ the _____.

An angle of _____ is the angle between the _____ line and the _____ before the _____ passes into the different medium (material).

An angle of _____ is the angle between the _____ line and the _____ after the _____ passes into the different medium (material).

4) Complete the table to show what happens to the wave speed, wavelength and direction of a wave for each situation:

Situation	Wave Speed	Wavelength	Wave Direction
Wave passes into medium (material) of different density at 90° to the surface boundary. (Angle of incidence = 0°).	_____ Less dense to more dense medium: speed _____. More dense to less dense medium: speed _____.	_____ Less dense to more dense medium: wavelength _____. More dense to less dense medium: wavelength _____.	_____ ____ _____
Wave passes into medium (material) of different density at angle of incidence other than 90° to the surface boundary. (Angle of incidence is greater than 0°).	_____ Less dense to more dense medium: speed _____. More dense to less dense medium: speed _____.	_____ Less dense to more dense medium: wavelength _____. More dense to less dense medium: wavelength _____.	_____ Less dense to more dense medium: angle between ray and normal line _____. More dense to less dense medium: angle between ray and normal line _____.

5) Complete the following examples of refraction for a parallel-sided block.

Parallel-Sided Block

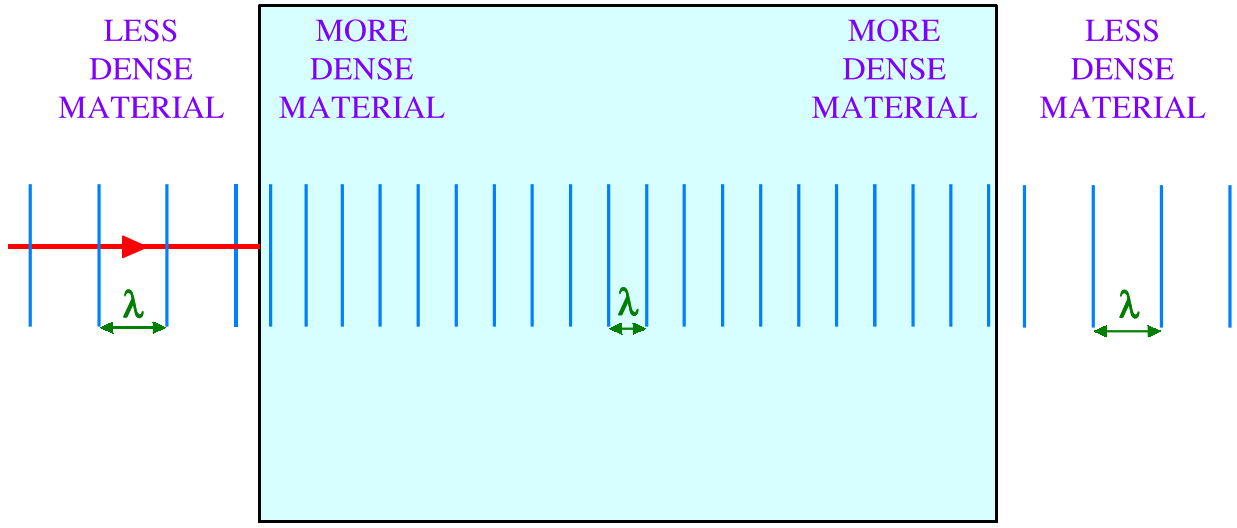
Use a ruler to draw the light rays.

(i) Angle of Incidence = 90° to Surface Boundary

At a boundary: WAVE SPEED _____

WAVELENGTH (λ) _____

WAVE DIRECTION _____ ___ _____



(ii) Angle of Incidence Other Than 90° to Surface Boundary

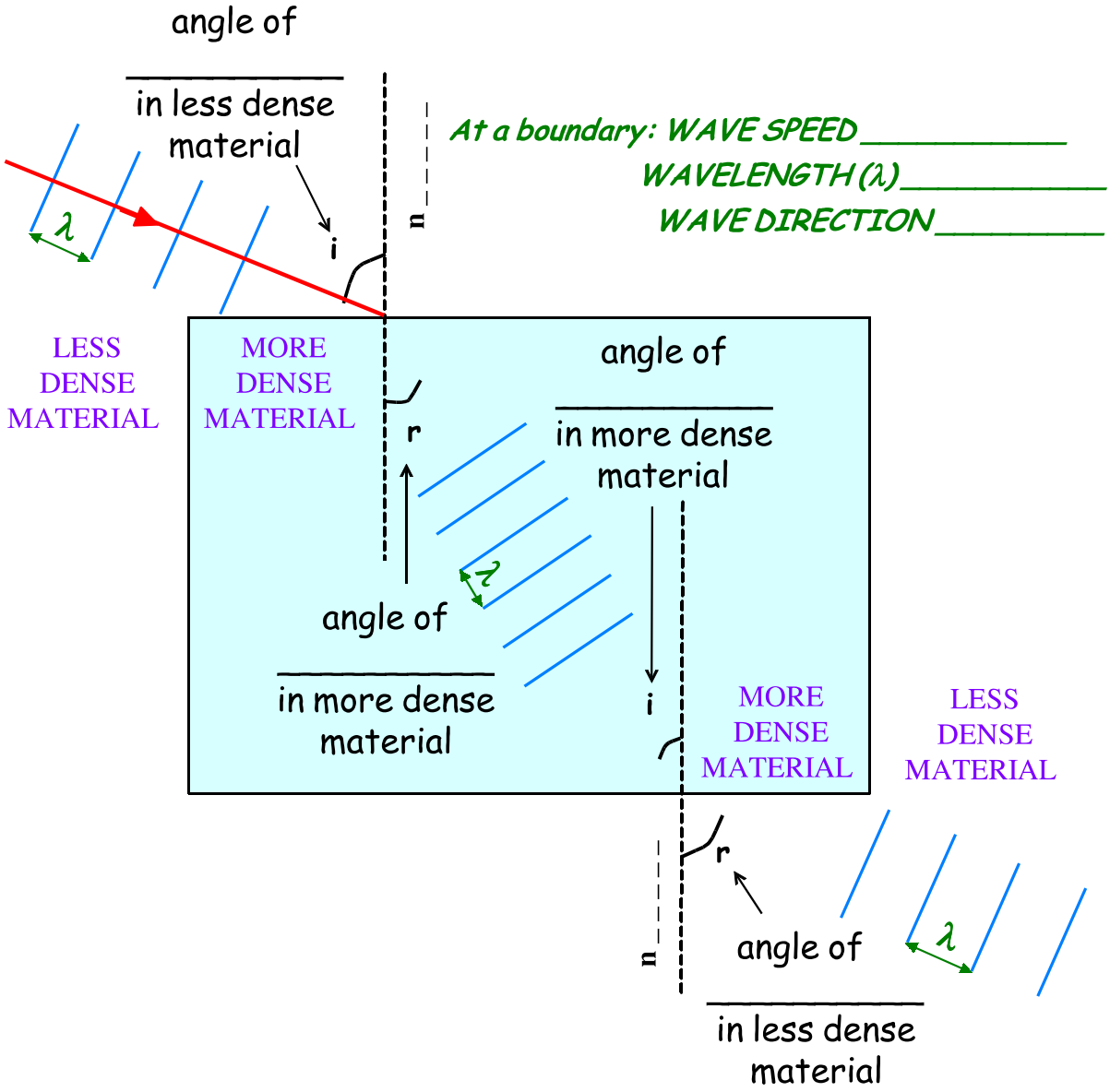
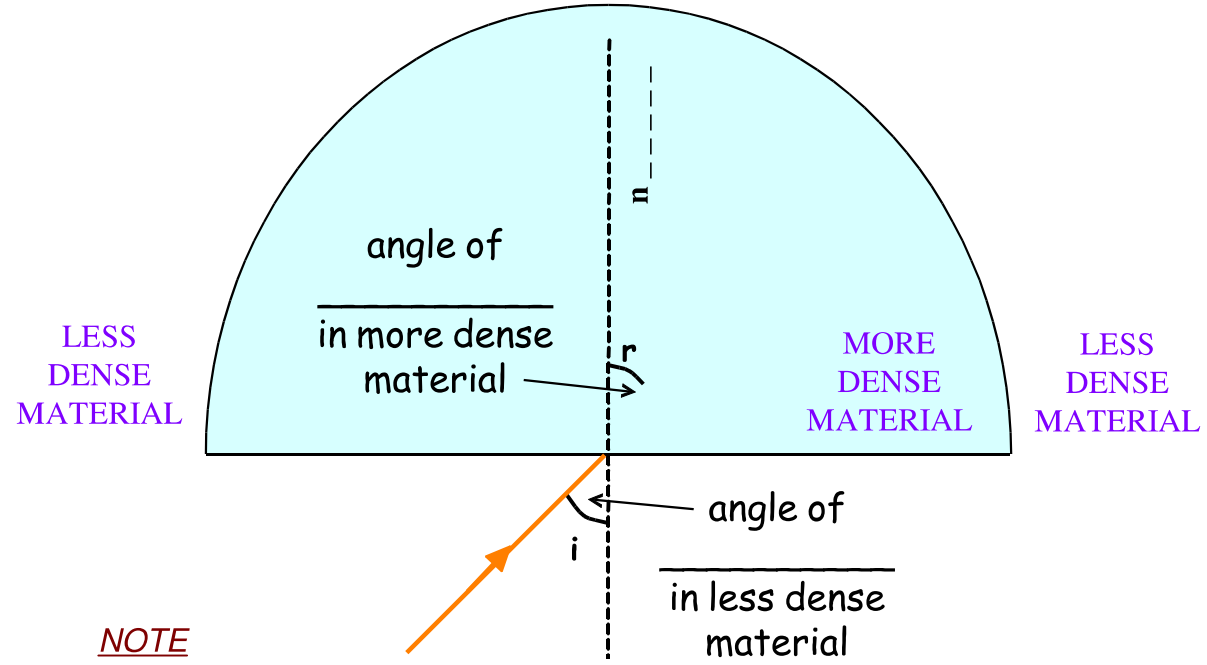


diagram copyright M. Cunningham

1) Complete the following examples of refraction for a semi-circular block.
Use a ruler to draw the light rays.

Semi-Circular Block



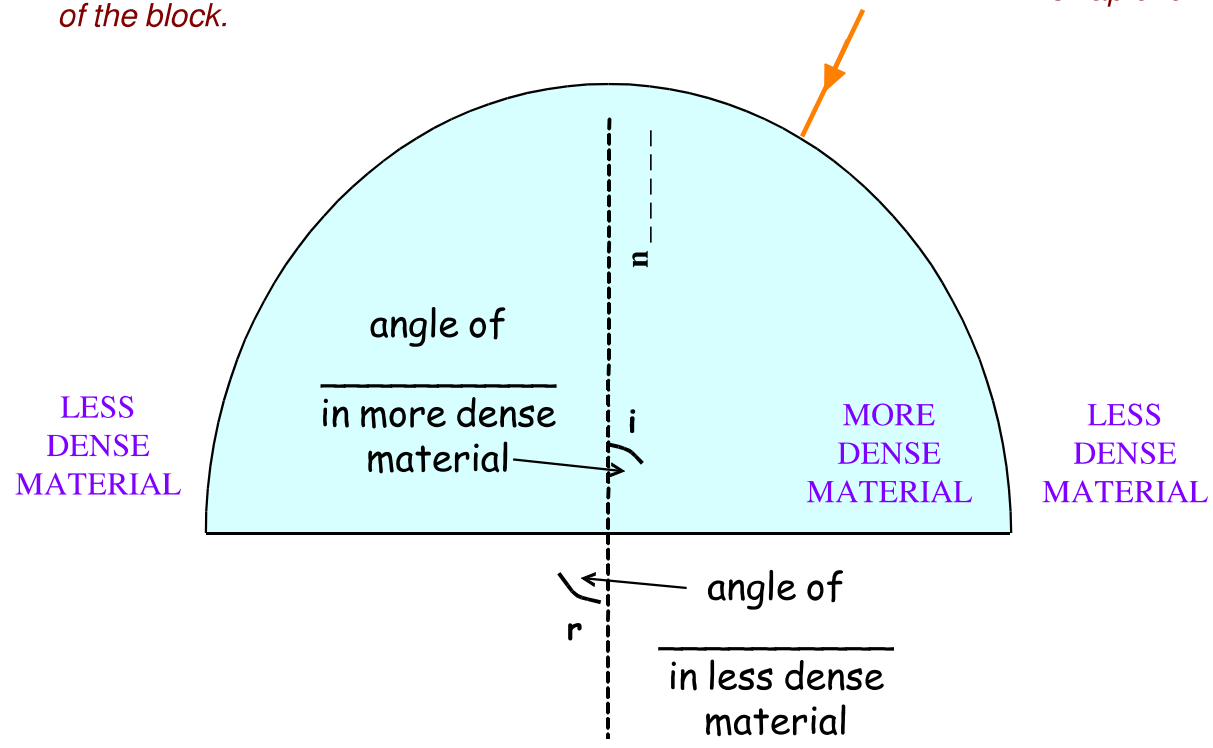
NOTE

Notice that when a light ray passes out of or in to the curved face of a semi-circular block, the light ray does not change direction.

This is because the light ray is perpendicular (at 90°) to the curved face of the block.

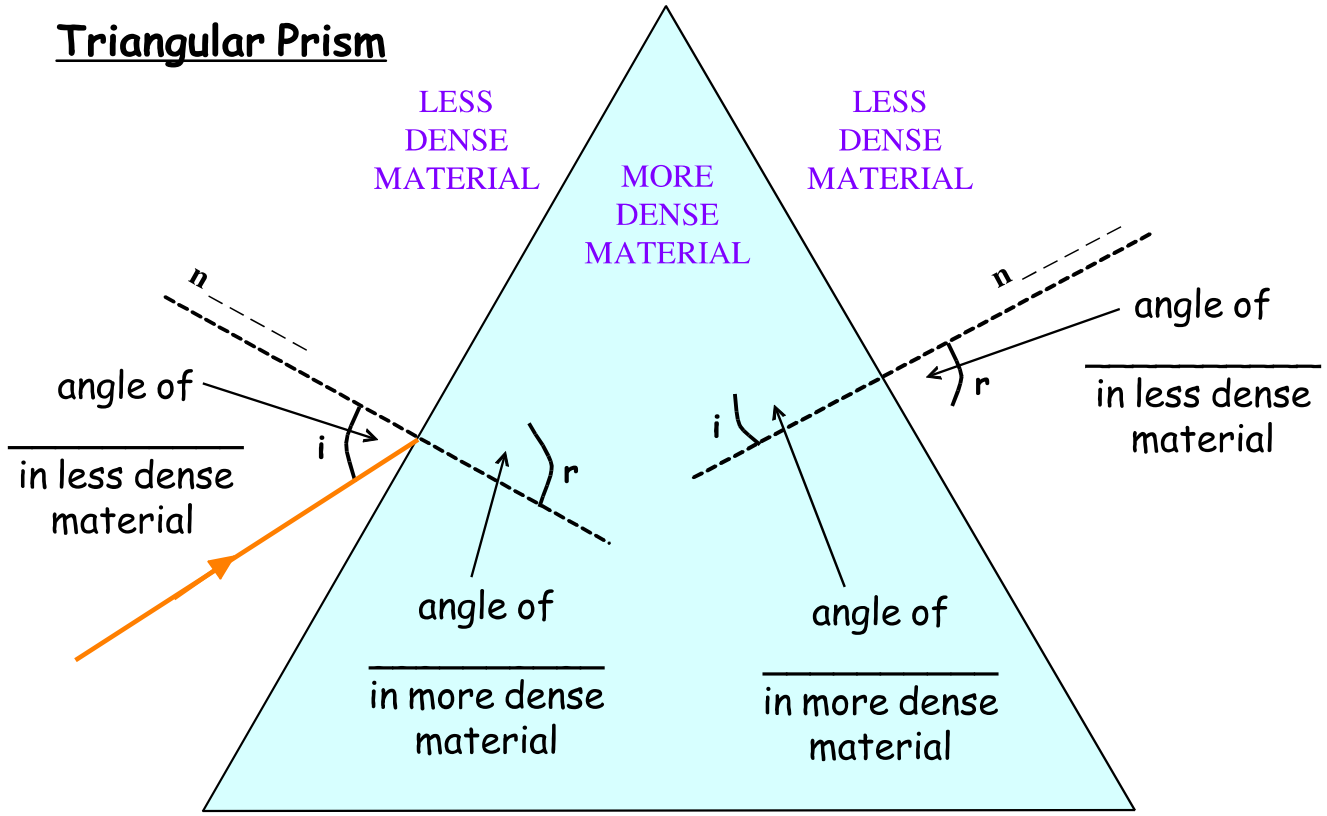
NOTE

When a light ray reverses direction, the angles of 'incidence' and 'refraction' swap over.



2) Complete the following example of refraction for a triangular prism.
Use a ruler to draw the light rays.

Triangular Prism



Important Uses for Refraction

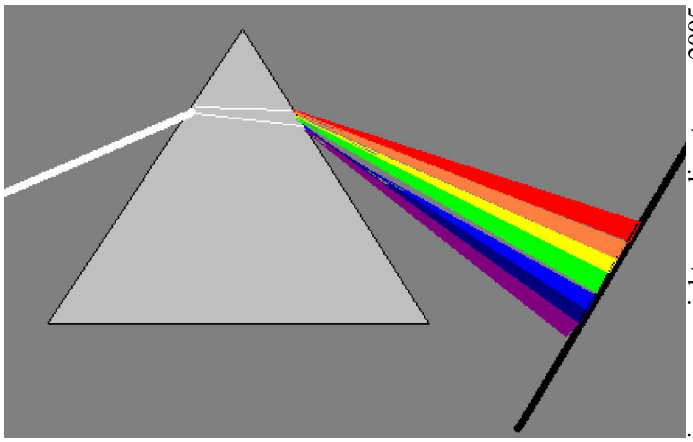
3) Complete the following:

Triangular Prism

A ray of _____ _____ can be _____ ___ up into its _____ constituent _____ by passing the _____ _____ ray through a _____ glass _____.

This is due to _____.

As it passes through the _____, each colour present in _____ _____ is _____ by a _____ _____ _____. Therefore, the white light is _____ into its _____ _____.



Lenses

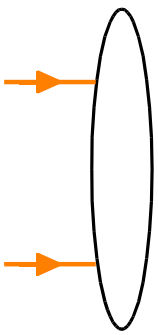
_____ are designed to change the _____ of the _____ _____ that enter them.

This happens due to _____.

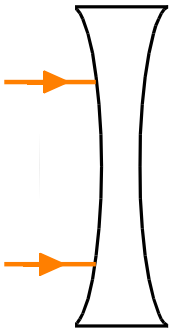
A _____ (_____) lens can make the _____ ____ that enter it _____ on one point - the _____ point.

A _____ (_____) lens can make the _____ ____ that enter it _____ (_____ _____).

There are many important uses for lenses.



convex (converging) lens



concave (diverging) lens

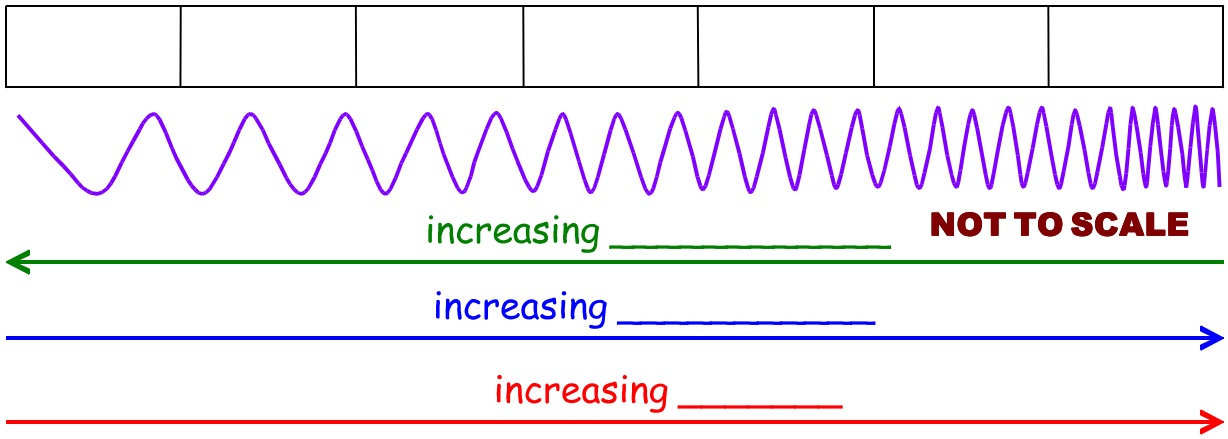
1) Complete the following:

There is a very important group (family) of _____ waves - the '_____ _____'. These waves provide us with valuable information about the objects in the _____. A large number of 'modern day' applications and devices depend on these waves.

The '_____ _____' is a family of _____ waves that can travel through _____ _____/a _____ (where there are no _____), carrying _____ at _____ m s^{-1} (__ x 10— m s^{-1}), the speed of _____.

2) Complete the following:

The '_____ _____' is represented by the diagram below:



This table summarises the approximate frequency and wavelength range of the members (bands) of the 'electromagnetic spectrum'. There is overlap between the range values.

Member (band) of electromagnetic spectrum							
Approximate frequency range	3 x 10^3 Hz to 3 x 10^9 Hz	3 x 10^9 Hz to 3 x 10^{11} Hz	3 x 10^{11} Hz to 4.3 x 10^9 Hz	4.3 x 10^{14} Hz to 7.5 x 10^{14} Hz	7.5 x 10^{14} Hz to 3 x 10^{17} Hz	3 x 10^{17} Hz to 3 x 10^{19} Hz	3 x 10^{19} Hz and greater
Approximate wavelength range							

3) Which member of the electromagnetic spectrum has the:

(a) shortest wavelength: _____ (b) longest wavelength? _____

4) Which member of the electromagnetic spectrum has the:

(a) lowest frequency: _____ (b) highest frequency? _____

5) Which member of the electromagnetic spectrum has the:

(a) lowest energy: _____ (b) highest energy? _____

6) There is a connection between the frequency and energy of the members of the electromagnetic spectrum ..... What is the connection?

7) Complete the following:

Visible Light Waves - the 'Visible Spectrum'

The _____ _____ _____ of the electromagnetic spectrum comprises _____ different colours, each with its own _____ and _____ range - _____, _____, _____, _____, _____, _____ and _____.

7.5×10^{14} Hz
700 nm
(approx)

visible light waves band
(also known as the 'visible spectrum')

4.3×10^{14} Hz
400 nm
(approx)

8) Complete the following table to show ***at least one*** typical source, typical detector and typical application for each member(band) of the electromagnetic spectrum:

Typical Sources, Detectors and Applications for Each Member of the Electromagnetic Spectrum

Member (Band) of Electromagnetic Spectrum	Typical Sources	Typical Detectors	Typical Applications
radio waves			
microwaves			
infra-red waves			
visible light waves			
ultra-violet waves			
X-rays			
gamma rays			

Answers to Questions Involving Calculations

Spread 3

7) (b) 0.2 m (c) 0.8 m
8) (b) 0.1 m (c) 0.4 m
9) 1.5 m
3 m
1.9 m
10) 0.95 m
13) 6.25 Hz
14) 512 Hz
15) 0.25 Hz
16) 54 wavelengths
17) 920 sound wave pulses
18) 28 wave crests
19) 12 s
20) 2.75 s
21) 1.48 s
22) 0.45 Hz
23) 96 sound waves
24) 40 s
25) 0.72 Hz
26) 224 vibrations
27) 1.25 s

Spread 4

3) 1.25 s
0.625 s
0.25 s
0.16 s
0.08 s
4) 5 Hz
2 Hz
0.4 Hz
0.1 Hz
0.0125 Hz
7) 867 m
8) 595 m
9) 986 m
10) 0.125 s
11) 2.45 s
12) 0.215 s
13) 2.8 m s^{-1}
14) 0.25 m s^{-1}
15) 340 m s^{-1}
16) 69 m
17) 28 m
18) 0.19 m
19) 32 s
20) 20 s
21) 0.000115 s
22) 5 200 m s^{-1}
23) 0.47 m
24) 0.0001125 s
25) (a) 175 ms (0.175 s)
(b) 59.5 m
26) (a) 2.20 ms (0.00220 s)
(b) 0.748 m
27) (a) 85.2 ms (0.0852 s)
(b) 127.8 m
28) (a) 1.26 s
(b) 37 800 000 m
29) (a) 1.4 µs (0.00000140 s)
(b) 42 m
30) (a) 6.6 ns
(0.0000000066 s)
(b) 1.98 m
33) 0.75 m s^{-1}
34) 340 m s^{-1}
35) 0.17 m s^{-1}
36) 0.75 Hz
37) 200 Hz
38) 0.2 Hz
39) 0.5 m
40) 0.05 m
41) 8 m
42) 0.1 m s^{-1}
43) 4 Hz
44) 0.48 m
45) 1 500 m s^{-1}
46) 2 600 Hz
47) 0.076 m