Farr High School

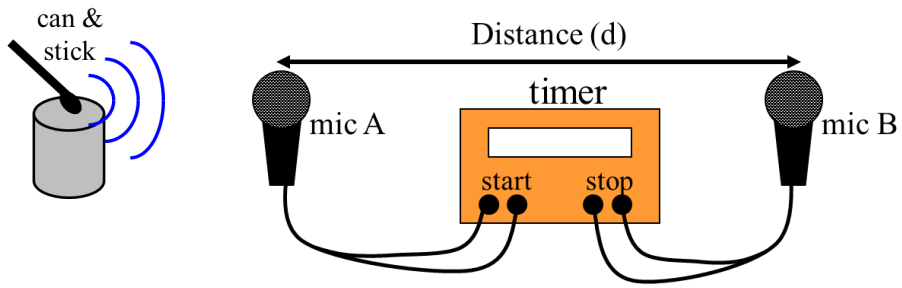
NATIONAL 4 PHYSICS

Unit 2
Waves and Radiation

Question Booklet

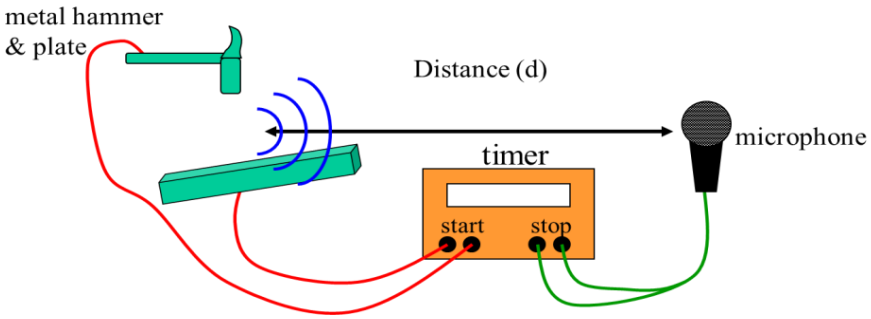
1. Speed of Sound

1. A pupil sets up the following equipment to measure the speed of sound in air. She hits the can with the stick and produces a sound wave as shown.



(a) What should she use to measure the distance between the microphones?
(b) Which microphone starts the timer?
(c) Which microphone stops the timer?

2. The following apparatus was set up to measure the speed of sound:

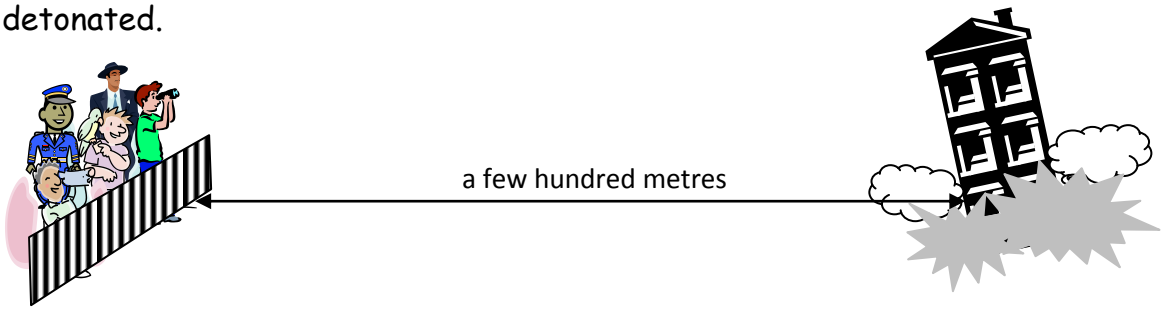


(a) Describe how you would use this equipment to measure the speed of sound.
(b) If the distance between the hammer and microphone was increased, would this give you a more accurate or less accurate result? Explain your answer.

3. (a) During a thunder storm, what signal is made first – the sound, the light or are they both made at the same time?
(b) So why do we <u>see</u> the light before we <u>hear</u> the thunder?

4. (a) State an approximate value for the speed of sound in air.
(b) What is the speed of light in air?

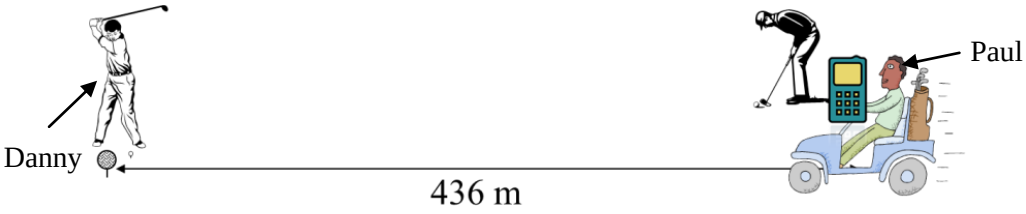
5. A block of flats is to be demolished. The crowd stands at a safe distance away from the building as shown in the diagram. The explosives are then detonated.



The people see the flash from the explosion then, a few moments later, they hear the bang.

(a) Explain why the people in the crowd see the flash before they hear the bang.
(b) Give another example of this effect.

6. Physics teacher, Paul, is waiting at the green of the 18th hole at Palacerigg golf course. He sees his friend, Danny, about to tee off. The tee is 436 metres away from Paul, who quickly decides that this would be a perfect opportunity to measure the speed of sound. Luckily his mobile phone is equipped with a stopwatch.

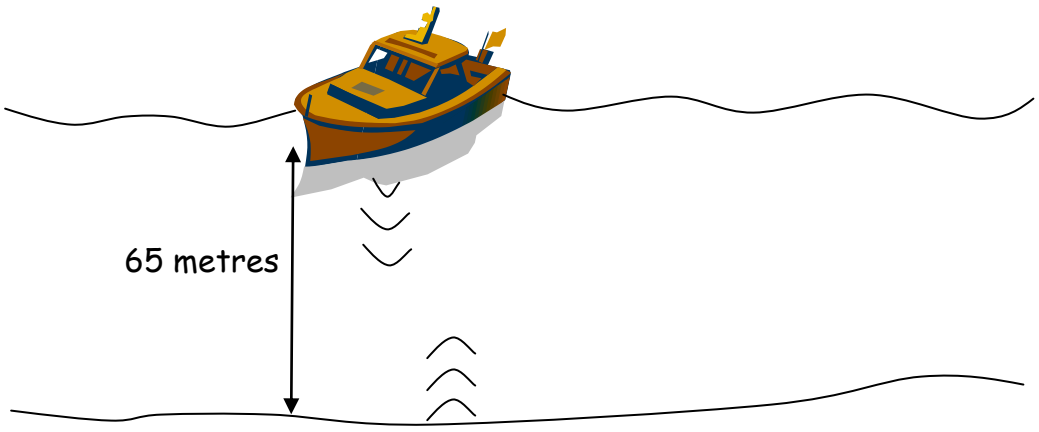


(a) Describe how Paul measures the speed of sound on the golf course.
(b) Explain whether or not you think he will get an accurate result.

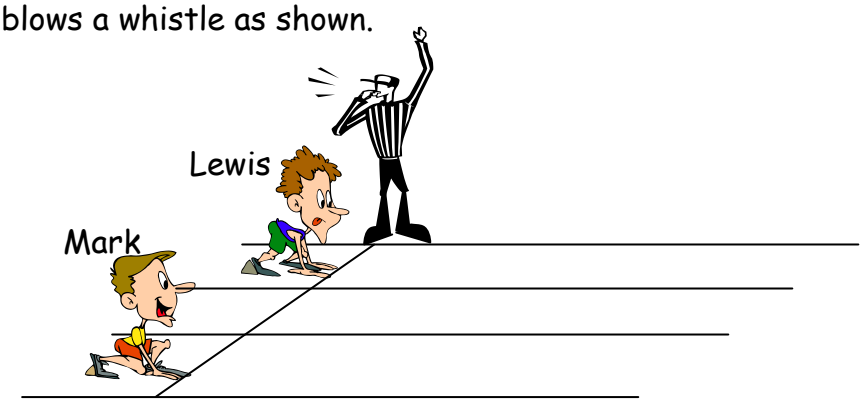
7. Rachel is investigating sound echoes from a cliff face. She bangs a drum and, at the same time, starts her stopwatch. She stops timing when she hears the echo.

If Rachel records a time of 1 second, how long did it take the sound to reach the cliff face?

8. Some scientists are using sound waves to investigate the depth of water in a loch. They transmit a pulse of sound down through the water and time how long it takes for the echo to return to the boat. If the water is 65 metres deep at this point, what distance does the sound pulse travel?



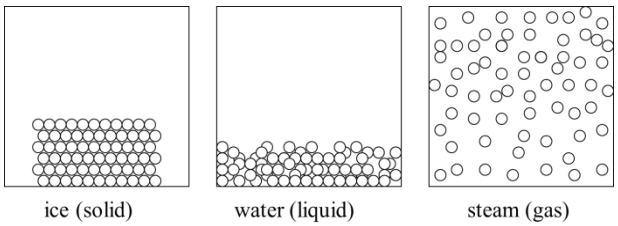
9. In a 100 metre race, 2 runners are crouched on the starting line and the starter blows a whistle as shown.



(a) Why will Lewis be able to start the race before Mark?
(b) For important events, can you think of a fairer way to start the race?

10. The diagram below represents the particle arrangement for an ice cube (solid) changing to water (liquid) then steam (gas).

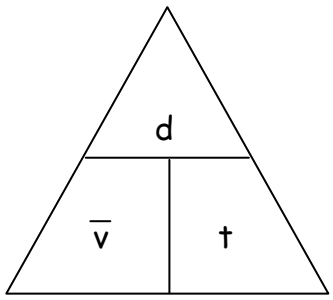
By thinking about the arrangement of the particles, do you think sound will travel fastest in a solid, or liquid or gas?
Explain your answer.



2. Speed, Distance and Time Calculations

In this section you can use the equation:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$



also written as

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

where **d** = distance in metres (m)
$\bar{v}$ = average speed in metres per second (m/s)
t = time in seconds (s).

Helpful Hint
The speed of light is much faster than the speed of sound.
The speed of light in air is 300 000 000 metres per second.
The speed of sound in air is approximately 340 metres per second.

1. Copy and complete: speed = $\frac{d\text{ - - - - - - -}}{t\text{ - - -}}$

2. Calculate the speed of each of the following wave signals, in air, and state whether the signal is sound or light.
   (a) 600 000 000 metres covered in 2 seconds.
   (b) 1700 metres covered in 5 seconds.
   (c) 500 metres covered in 1.47 seconds.

3. Using "distance = speed x time", calculate how far **light** travels in:
   (a) 1 second (b) 3 seconds (c) 10 seconds.

4. Assuming that the speed of sound is 340 metres per second, use "distance = speed x time" to calculate how far **sound** travels in:
   (a) 1 second (b) 3 seconds (c) 10 seconds.

5. Colin sees a flash of lightning and then counts 4 seconds before he hears the clap of thunder. Work out how far away he is from the storm by using "time = distance / speed", if the speed of sound is 340 metres per second.

6. A group of Physics pupils sets out to measure the speed of sound. The pupils stand a distance of 200 metres from the teacher who has a flash gun and starter pistol. The pupils have to start a stopwatch when they **see** the flash and stop it when they **hear** the bang. The experiment is carried out three times and the results are shown in the table below.

Distance from gun to pupils (metres)	*Time recorded* (seconds)	*Speed of Sound* (metres per second)
200 m	0·63	
200 m	0·62	
200 m	0·65	

(a) Write down the equation for speed, using distance and time.
(b) Calculate the speed of sound from each pupil's set of measurements.
(b) From the 3 results, work out the average value for the speed of sound.

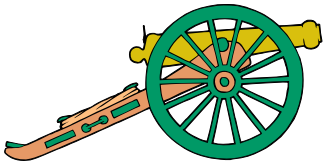
7. Spectators are told to stay behind a barrier which is 100 metres away from where fireworks are being set off at a display.

The following equation can be used to find the time taken for the sound to travel to the spectators.

$$\text{time} = \frac{\text{d}\text{-}\text{-}\text{-}\text{-}\text{-}\text{-}\text{-}}{\text{s}\text{-}\text{-}\text{-}\text{-}} \qquad \text{so} \qquad \text{t} = \frac{?}{?}$$

(a) Copy and complete the equations.
(b) Work out how long it will take spectators to hear a 'banger' after they see it explode if the speed of sound is 340 metres per second.

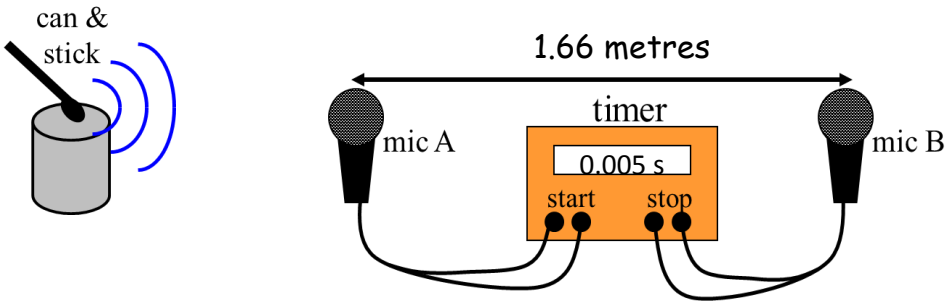
8. During the Edinburgh Tattoo, tourists on Princes Street see the canon smoke from the castle 3 seconds before they hear the bang.



(a) Write down the equation you can use to work out the distance between the castle and the tourists.
(b) How far are the tourists from the castle if the speed of sound is 340 metres per second?

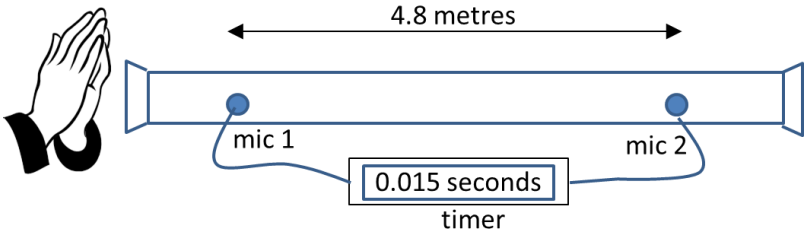
9. Michael sees a military jet and then 4·5 seconds later hears the roar from its engine. How far away is the jet assuming the speed of sound is 340 metres per second? Remember to write down your equation first!

10. A pupil sets up the following experiment to measure the speed of sound in air. She hits the can with the stick to make the sound.



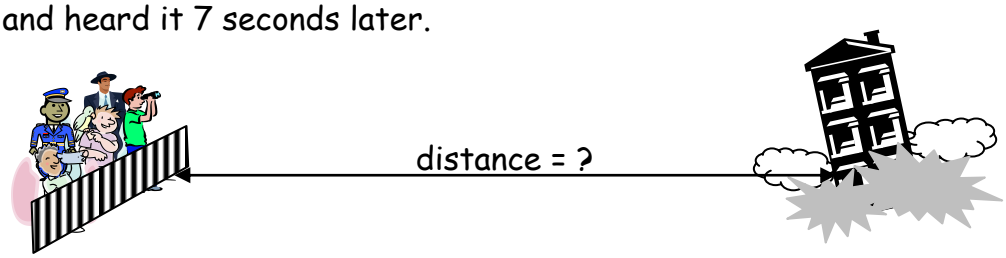
Use the measurements shown in the diagram to calculate the speed of sound in air.

11. In another experiment, a pupil puts 2 microphones in a long pipe as shown. This pupil claps his hands to create the sound waves.



Use the measurements shown in the diagram to calculate the speed of sound in air.

12. During the demolition of a building in Glasgow, spectators saw the explosion first and heard it 7 seconds later.



If the sound from the explosion travelled at 340 metres per second through the air, how far from the explosion were the spectators standing?

3. Transverse & Longitudinal Waves

1. What do waves carry?

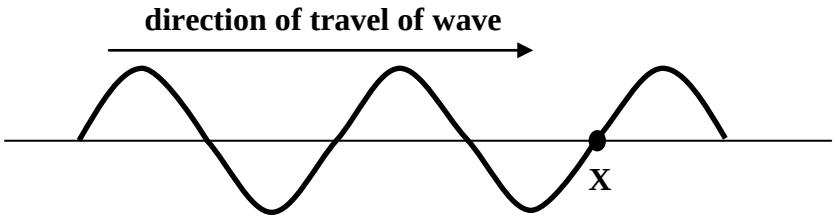
2. What are the names of the 2 types of waves that you have studied.

3. Copy and complete the table below to show the wave type of each of the following waves:

water waves; sound waves; light waves;
radio waves; microwaves; ultrasound.

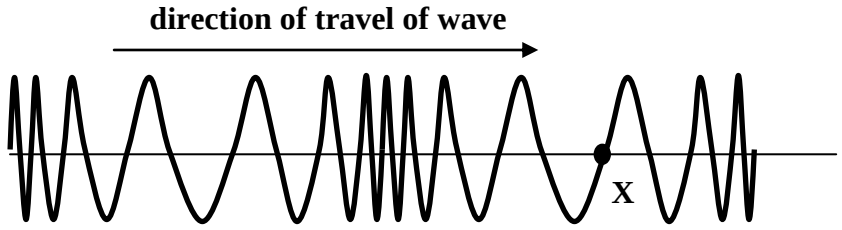
L - - - - - - - - - - -	T - - - - - - - - -

4. Look at the diagram below and answer the following questions.



(a) What type of wave is this?
(b) The wave is moving from left to right. Describe how point X on the wave is moving.
(c) A pupil uses this diagram to describe how sound waves pass through the air. Explain why the pupil is wrong.

5. A "slinky" can be used to show different types of wave.



(a) What type of wave is the "slinky" showing here?

(b) The wave is moving from left to right. Describe how point X on the wave is moving.

6. Copy and complete the following sentences using the words from the word bank below:

_____ waves, for example water waves, carry _____ by vibrating at right angles to the direction of the wave's motion.

_____ waves, for example sound waves, carry _____ through a _____ where the particles vibrate in the _____ direction as the wave's motion.

Word bank		
energy	**longitudinal**	**transverse**
same	**energy**	**medium**

4. Waves Words – Wavelength & Amplitude

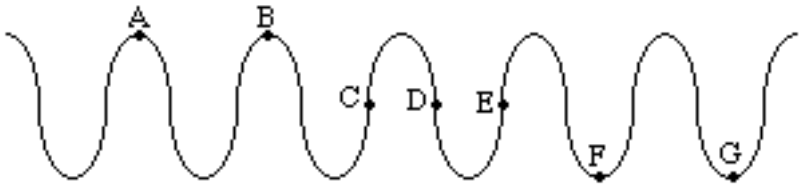
Helpful Hint

Wavelength (symbol λ) means the length of a wave. It is measured as the distance from one point on a wave to an identical point on the next wave.

e.g.

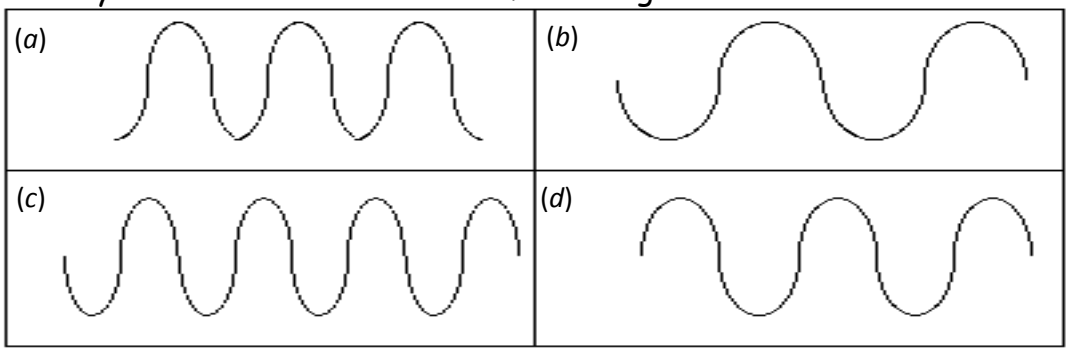
The amplitude of a wave is the height from the centre line.

1. 'A-B' represents one wavelength in the diagram below.



State two other pairs of letters which represent one wavelength.

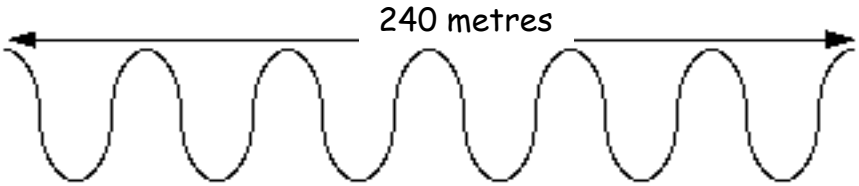
2. How many waves are shown in each of the diagrams below?



3. The wave train shown below is 20 metres long. How long is each wave?

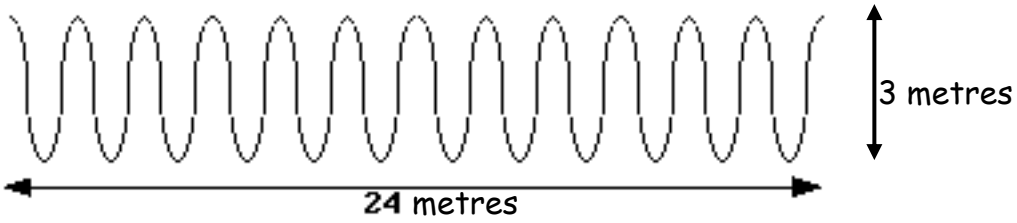
4. The wavelength of the waves in the diagram below is 3 centimetres. What is the distance between X and Y?

5. What is the wavelength of the waves in the diagram below?



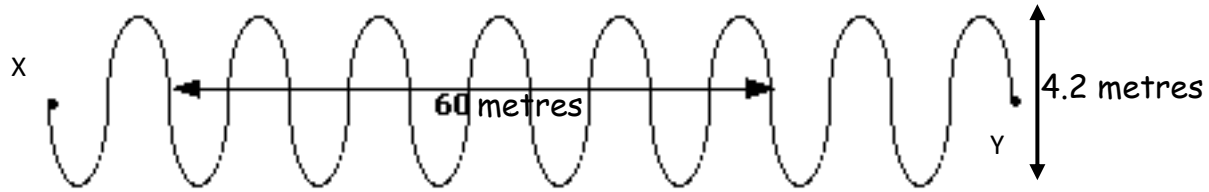
6. Draw a wave train consisting of 2 waves. Put the labels **wavelength** and **amplitude** on your diagram in appropriate places.

7.



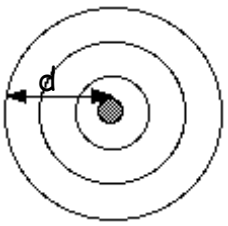
(a) How many waves are shown in the diagram above?
(b) What is the wavelength of each of these waves?
(c) What is the amplitude of these waves?

8. (a) Calculate the wavelength of the waves shown below.



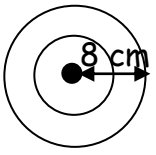
(b) What is the distance from X to Y in this wave train?
(c) What is the amplitude of these waves?

9. A stone is thrown into a pond, and a wave pattern is produced as shown below. The wavelength of the waves is 6 centimetres.



Calculate the distance, d, travelled by the outside wave.

10. A stone is thrown into another pond creating waves as shown below.



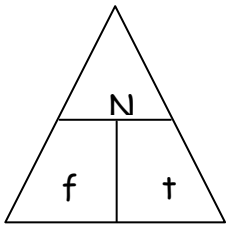
Use the information in the diagram to calculate wavelength of these waves.

5. Frequency of a Wave

In this section you can use the equation:

$$\text{frequency} = \frac{\text{number of waves}}{\text{time}}$$

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



where f = **frequency** is measured in Hertz (Hz)
N = **number of waves**
t = **time** is measured in seconds (s).

1. Calculate the frequency of each of the following waves:

   (a) 10 waves passing a point in 5 seconds.
   (b) 240 waves produced in a time of 60 seconds.
   (c) 30 waves produced in a time of 60 seconds.
   (d) 9 600 waves passing a point in 800 seconds.
   (e) In a 90 second period of time, 4 500 waves are produced.
   (f) Every 15 seconds, 300 000 waves are generated.

2. If a wave machine produces 5 waves each second what is the frequency of the machine?

3. A man stands on a beach and counts 40 waves hitting the shore in 10 seconds. What is the frequency of these waves?

4. Some sound waves have a frequency of 10 000 Hertz.
   (a) How many of these waves will be produced in 1 second?
   (b) How many of these waves will be produced in 100 seconds?

5. Water waves with a frequency of 1.6 Hertz pass beneath a pier.
   (a) How many of these water waves will pass in 1 second?
   (b) How many water waves pass the pier in 60 seconds?

6. Waves crash onto a beach at a frequency of 0.25 Hertz.
   (a) How many waves hit the beach per second?
   (b) How many waves hit the beach in 1 minute?

7. In a swimming pool a wave machine creates waves with a frequency of 2 Hertz for a time of 5 minutes.
   (a) How many seconds are in 5 minutes?
   (b) So how many waves are produced in 5 minutes?

8. (a) Copy and complete the equation for "time" if you know the "frequency" of the waves and the "number of waves":

$$\text{time} = \frac{\text{n - - - - - -- - - - - -}}{\text{f - - - - - - - -}} \qquad \text{so} \qquad t = \frac{?}{?}$$

   (b) A smoke alarm sends out high-pitched sound waves with a frequency of 12 000 Hertz. How long will it take this alarm to emit 240 000 waves?

9. A tuning fork makes a sound with a frequency of 440 Hertz. How long does it take to produce 2 200 waves at this frequency?

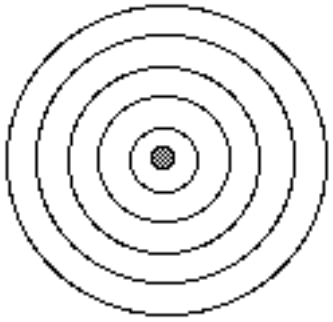
10. A clarinet player plays a long note emitting 9 000 waves with a frequency of 1 500 Hertz. For how long does she play this note?

11. A woman's ear detects 4 000 sound waves from an alert on her mobile phone. If the frequency of the sound is 8000 Hertz, how long does the alert last?

12. How many 12 000 Hertz sound waves will a keyboard produce if it holds this note for 5 seconds?

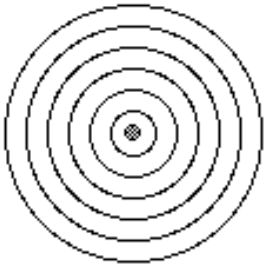
13. How long will it take a boy to send out 1 800 sound waves if he whistles a note with a frequency of 600 Hz?

14. A rock is thrown into a pond and an overhead photograph is taken 2 seconds later. The photograph, as shown in the diagram below, reveals that 5 waves were produced in the 2 second period.



What is the frequency of these water waves?

15. A pebble was thrown into a still pond and wave ripples were produced at a rate of 3 waves per second.
The diagram below represents the wave pattern in the pond a short time after the pebble was dropped.

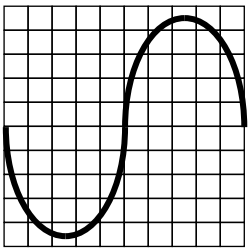


(a) What was the frequency of the waves, in Hertz?
(b) How many waves are represented in the diagram above?
(c) How long did it take for this wave pattern to form?

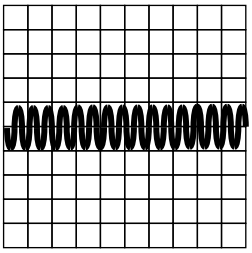
6. Wave Traces

1. Although sound waves are longitudinal, they can be converted to electrical signals and represented on an oscilloscope as transverse waves.
   Use the words "high frequency" or "low frequency" **and** "loud" or "quiet" to describe the sound represented by each of the following oscilloscope traces:

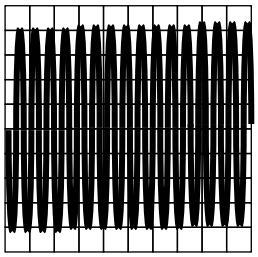
(a)



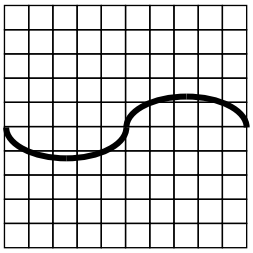
(b)



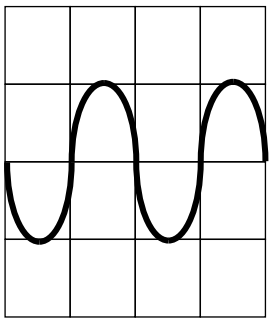
(c)



(d)



2. Look at the oscilloscope trace below, which represents a sound from a keyboard.



(a) Draw the trace that would be obtained if a note of higher pitch but same volume was played.

(b) Draw the trace that would be obtained if the same note was played at a louder volume.

7. Sound Level

1. Use the following table of information to answer the questions below.

Sound Levels for Various Environmental Sounds	
Weakest sound heard	0dB
Whisper Quiet Library at 2 m	30dB
Normal conversation at 1 m	60-65dB
Telephone dial tone	80dB
Train whistle at 500', Truck Traffic	90dB
Level at which sustained exposure may result in hearing loss	***90 - 95dB***
Hand Drill	98dB
Snowmobile, Motorcycle	100dB
Sandblasting, Loud Rock Concert	115dB
Pain begins	***125dB***
Pneumatic riveter at 1 m	125dB
Even short term exposure can cause permanent damage - Loudest recommended exposure <u>WITH</u> hearing protection	***140dB***
Jet engine at 30 m	140dB
Death of hearing tissue	180dB
Loudest sound possible	194dB

(a) What is the approximate sound level of a whisper at a 2 m distance?
(b) What produces a sound level of 100 dB?
(c) Why is the sound level of 90 – 95 decibels so important?
(d) Explain why ear protection should be worn if operating a hand drill for a prolonged period of time.
(e) Draw a bar graph to show the sound levels of a whisper, normal conversation, truck traffic, a motorcycle and a jet engine.

2. What do we call loud sounds that are harmful to our environment?

3. Noise cancellation technology is used in headphones worn by helicopter pilots. Why is this useful?

4. Sounds can be reflected and absorbed. In a sound proofed recording studio, the walls are covered in material to prevent sound escaping from the studio. Should this material be a good absorber or a good reflector of sound? Explain your answer.

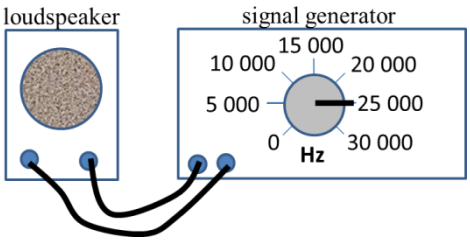
5. Give 2 examples of noise pollution.

8. Sonar and Ultrasound

1. State the frequency range of human hearing.

2. Explain what is meant by the word "ultrasound".

3. A pupil connects a loudspeaker to a signal generator and increases the frequency up to 25 000 Hz, as shown.



(a) Will the pupil be able to hear the sound produced?
(b) What is the maximum frequency of sound wave the pupil will be able to hear?
(c) What is the minimum frequency of sound the pupil will be able to hear?
(d) With the signal generator set at a very high frequency, pupils in the class can hear it but the teacher cannot.
Why do you the teacher can't hear the sound?

4. Some shops have a sound device that makes a continuous, very high pitched sound. Why do you think a shop keeper might install this kind of device?

5. State 3 applications of ultrasound.

6. Explain how ultrasound can be used to examine a baby in the womb. Draw a diagram to support your answer and label it with the words, **transmitter** and **receiver**.

7. Which of the following wave properties is important when ultrasound is used to examine the inside of a body: **refraction**, **diffraction** or **reflection**?

8. Why is jelly used on a patient during an ultrasound scan?

9. For what does the acronym, SONAR, stand?

10. Read the news article below then answer the questions that follow.

WED, 04 APR 2012 3:22P.M.

Environmentalists in Peru are warning that an unprecedented number of dead dolphins are washing up on the country's shores because of the use of deep water sonar systems by the shipping industry.
It follows the discovery of 615 of the mammals in the last few weeks along a 135 kilometre stretch of coastline. As many as 3,000 dead dolphins have been found since the beginning of Peru's summer.

Researchers at the Organisation for the Conservation of Aquatic Animals (ORCA), a Peruvian marine animal conservation organisation, said that ships using deep water sonar are to blame for the mass deaths.

After studying the corpses of many of the dolphins, it was noticed that they did not bear marks of external damage caused by fishing practices or signs of poisoning. Instead, researchers found damage in the dolphins' middle ear bones, which is said to be a sign of decompression syndrome. "We have been noting that the animals were suffering from acute decompression syndrome - that is to say, a violent death produced by an acoustic boom that disorients the animal and produces haemorrhages which cause the animal to end up dying on the beach," said ORCA director Dr Carlos Yaipen.

The damage is said to come from sonic bursts that are produced by deep water sonar signals sometimes used in the search for petroleum. US federal regulators are curbing an oil and natural gas exploration company from using seismic equipment that sends out underwater pulses along Louisiana's coast until the bottlenose dolphin calving season ends.

ORCA calculates that the phenomenon represents the highest number of beached dolphins recorded anywhere in the world in the last decade.

(a) For what does "ORCA" stand?

(b) How many dead dolphins have been found since the beginning of Peru's summer?

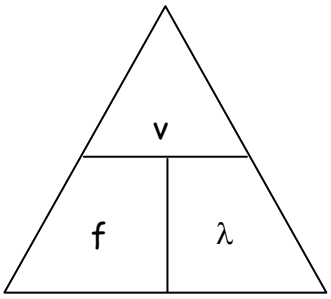
(c) What evidence did the researchers at ORCA have to suggest that deep water sonar was to blame for the death of the dolphins?

(d) What action has been taken elsewhere in order to protect dolphins from the impact of sonar?

9. The Wave Equation

In this section you can use the equation:

speed = frequency x wavelength



also written as

$$v = f\lambda$$

where **v** = speed of the wave in metres per second (m/s)
f = frequency in Hertz (Hz)
λ= wavelength in metres (m).

1. Calculate the speed of the each of the following waves, given the frequency, in Hertz, and the wavelength in metres:

	Frequency (Hz)	*Wavelength* (m)
(*a*)	5	3
(*b*)	30	20
(*c*)	10	2
(*d*)	0.5	50
(*e*)	2	0.25
(*f*)	50	0·02

2. Sound of frequency 440 Hz has a wavelength of 3·41 m in water. Calculate the speed of this sound in water.

3. What is the speed of waves which have a frequency of 50 Hz and a wavelength of 3 m?

4. Water waves in a swimming pool are travelling with a speed of 2 m/s and have a wavelength of 0·8 m.

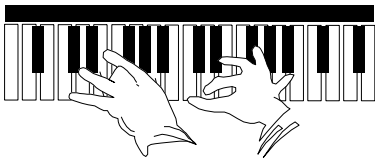
   (a) Copy and complete the equation for frequency … $\mathbf{f} = \frac{?}{?}$

   (b) Calculate the frequency of these water waves.

5. A wave generator in a ripple tank creates waves which have a wavelength of 0·02 m. If the speed of these waves is 1·2 m/s what is their frequency?

6. Waves produced by a wave generator in a ripple tank have a wavelength of 0.016 m. At what frequency is the wave generator operating, if the wave speed is 0·64 m/s?

7. The musical note 'E' has a frequency of 320 Hz. The sound it makes travels with a speed of 340 m/s in air.



(a) Copy and complete the equation for wavelength … $\lambda = \frac{?}{?}$

(b) Calculate the wavelength of this sound.

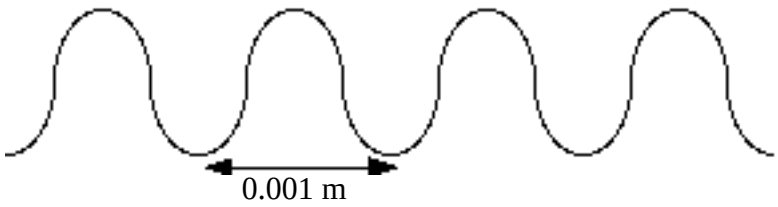
8. A wave machine in a swimming pool produces waves with a frequency of 1 Hz. If they travel across the pool at 1·5 m/s, what is their wavelength?

9. The speed of sound in steel is 5 200 m/s. What is the wavelength of a sound wave which has a frequency of 6 500 Hz in steel?

10. How fast will waves with a frequency of 15 000 Hz and a wavelength of 0.022 m travel?
(You will need to write down your equation for "v" first!)

11. What is the wavelength of waves which have a frequency of 6 000 000 Hz and a speed of 1 800 m/s?

12. Calculate the frequency of the waves shown in the diagram below given that they have a speed of 0·05 m/s.

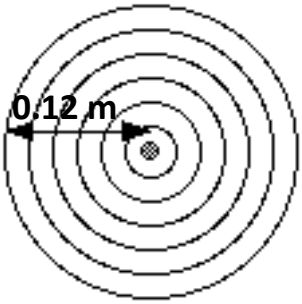


13. John counts 40 complete waves along the length of a swimming pool. The pool is 80 m long and the waves are travelling with a speed of 2 m/s.

    Calculate:
    (a) the wavelength of the waves given that 40 waves cover 80 m
    (b) the frequency of the waves (by using the wave equation, $f = v / \lambda$)
    (c) the number of waves produced in 1 second
    (d) the number of waves produced in 1 minute.

14. Waves, like the ones shown in the diagram below, are produced at a rate of 8 000 Hz. Calculate the speed of these waves.

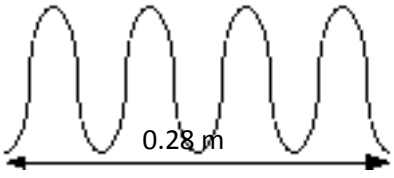
15. A wave pattern formed 3 seconds after a pebble is dropped into a pond is shown below.



    (a) How many waves were formed in 3 seconds?
    (b) Use f = N / t to find the frequency of the waves.
    (c) Use the diagram to find the wavelength of the waves.
    (d) Use the wave equation to calculate the speed of the waves.

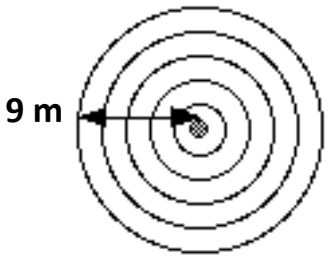
16. 30 water waves per second are created in a pool. Some of these are represented in the diagram.

    (a) State the wavelength of the waves.
    (b) State the frequency if the waves, in Hz.
    (c) Calculate the wave speed.



17. The waves shown in the diagram below were produced at a rate of 30 waves per minute.

(a) What is their frequency? (f = N / t)
(b) What is their wavelength?
(c) Calculate the speed of these waves using v = f λ.



18. The diagram below represents some water waves coming onto shore.

Jackie stands on the shore and counts 36 wave crests crashing onto it in 1 minute.

(a) Calculate the frequency of these waves, using f = N / t.
(b) Calculate the wavelength of the waves from the diagram.
(c) Use the wave equation to calculate the speed of the waves.

10. The Electromagnetic Spectrum

Radio & TV

1. Copy and complete this sentence:
"Radio and TV waves are sent out from a t_____ and picked up by a r_____ . These waves are good at _____ around obstacles like buildings and hills."

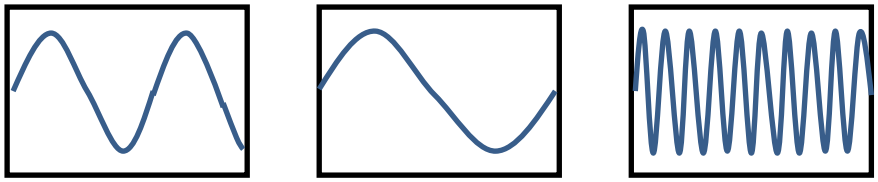
2. Can radio and TV waves pass through walls and windows? Give a reason why you think they can or can't.

3. The table below shows some radio frequencies of well known radio stations.

Station	Frequency
Clyde 2	115 kHz
Radio 5 Live	909 kHz
Radio 2	89.9 MHz
Radio Scotland	94.3 MHz
Clyde 1	103.3 MHz

(a) Some frequencies are in "**k**Hz" and some are in "**M**Hz".
What do the letters "k" and "M" stand for?
(b) How many waves does Clyde 2 transmit each second?
(c) Which of these stations transmits at the highest frequency?
(d) Which station transmits at the lowest frequency?

4. TV waves usually have higher frequencies than radio waves.
(a) Which of the following signals is likely to be the TV signal:



A B C

(b) Match these three frequencies to the traces shown in part (a):

909 kHz	700 MHz	94.3 MHz

5. Read the following information about radio waves then answer the questions that follow.

Radio waves can produced by various types of transmitter but they are also given off by stars, electrical sparks and lightning. These waves have the lowest frequencies in the electromagnetic spectrum, and are used mainly for communications.

Radio waves are divided into:-

Long Wave - around 1~2 km in wavelength. The radio station "Atlantic 252" broadcasts here.

Medium Wave - around 100m in wavelength, used by BBC Radio 5 and other "AM" stations.

VHF - stands for "Very High Frequency" and has wavelengths of around 2m. This is where you find stereo "FM" radio stations, such as BBC Radio 1 and, further up the VHF band, are civilian aircraft and taxis.

UHF - stands for "Ultra High Frequency", and has wavelengths of less than a metre. It is used for Police radio communications, television transmissions and military aircraft radios - although military communications are now mostly digital and encrypted.

(a) Why do you sometimes hear interference on your radio during a thunderstorm?
(b) What is the main use of radio waves?
(c) What is an approximate wavelength for Medium Wave radio signals?
(d) In which radio band would you find waves of less than a metre long?
(e) What does VHF stand for?
(f) Name a radio station that broadcasts on Long Wave?

6. (a) Do radio waves travel at the speed of light or the speed of sound?
(b) During a match, an Airdrie fan is listening to the commentator on his radio. The commentator's voice is also coming through a speaker in the stadium, 200m away.
Does the fan hear the commentator from his radio and the speaker at the same time? Explain your answer.

Microwaves

7. State 3 uses of microwaves.

8. Why is it dangerous for pregnant women to be exposed to microwaves used in microwave ovens?

9. (a) Do microwaves have higher or lower frequencies than TV waves?
   (b) Do microwaves have longer or shorter wavelengths than TV waves?

10. (a) At what speed do microwaves travel through air?
    (b) Use the wave equation to calculate the frequency of microwaves that have a wavelength of 0.1 m.

11. Dish aerials are used to pick up microwaves for some TV channels.
    (a) How do these microwaves get to the dish aerial from the TV station?
    (b) The signal is quite weak, by the time it reaches a dish aerial on a house. What size of dish is best at picking up a clear signal; big or small?

12. Sketch a picture to describe how a satellite can be used to send a microwave signal from Glasgow to New York.

Infra Red

13. State 3 uses of infra red radiation.

14. What is a "thermogram"?

15. Explain how cancerous tumours can be detected with a thermogram?

16. Some surfaces are better than others at absorbing infra red radiation. The table below shows the percentage of infra red radiation absorbed by different surfaces.

Surface	Percentage of infra red radiation absorbed (%)
whitewashed wall	40
red brick wall	70
polished aluminium	25
black tar	90

    (a) Draw a bar graph to display this information.
    (b) Which surface is the best absorber of infra red radiation?

(c) Why might this be a problem for engineers building roads in hot countries.

(d) Why do you think most houses in hot countries are whitewashed rather than covered in polished aluminium?

17. Infra red detectors can be used in burglar alarms. Explain how these alarms would work.

18. (a) At what speed do infra red waves travel through air?

(b) Use the wave equation to calculate the wavelength of infra red waves that have a frequency of 3 000 000 000 000 Hz.

Visible Light

19. White light is made up of many colours. What are the seven colours we can identify in white light?

20. What name is given to a concentrated beam of light, of one colour, that travels in one direction.

21. Lasers are used in many places. Copy and complete the table below to show examples of how lasers can be used. You can use the following list of examples (or add in others):

reading bar codes	signals in optical fibres	welding metal
CD players	killing cancer cells	cutting metal
drying paint	eye surgery	levelling tools

Place	Examples of Laser Use
Shops	
Home	
Communications	
Medicine	
Industry	

22. Laser pointers use low power laser beams however these can still be dangerous.
What part of the body would be most easily damaged by this laser light?

23. Are laser beams always visible?

24. Name 2 marks on the skin that can be removed with lasers.

Ultraviolet

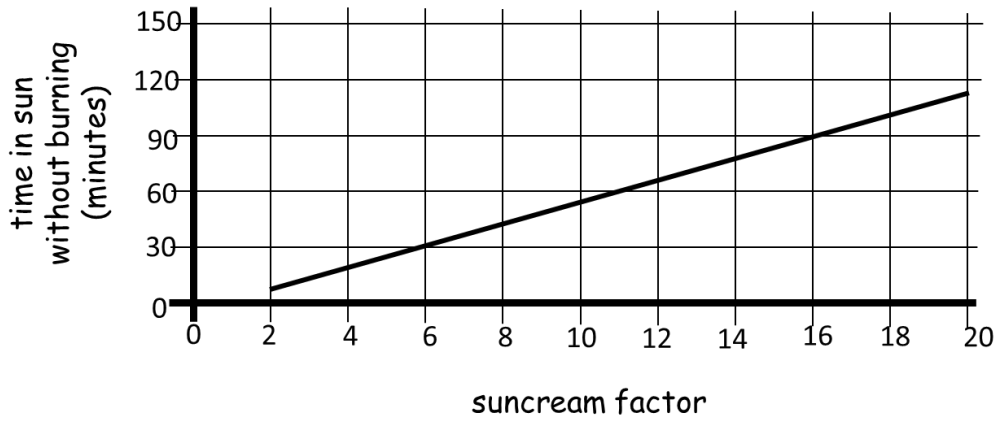
25. Is ultraviolet radiation visible or invisible?

26. State 3 uses of ultraviolet radiation.

27. (a) What is the danger of over exposure to ultra violet radiation?
(b) Suggest ways in which this risk can be reduced.

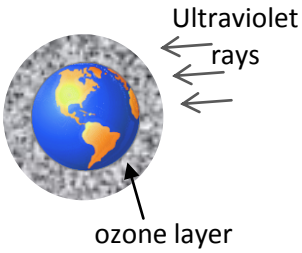
28. What happens to "fluorescent" chemicals when we shine ultraviolet radiation on them?

29. A hotel manager in a Spanish hotel is very concerned about the health of his visitors' skin. He puts up a graph showing how long you can stay in the sun without burning, for different suncream factors, on a hot, sunny day.



(a) How long can you safely stay in the sun with factor 6 cream?
(b) How long can you safely stay in the sun with factor 14 cream?
(c) What is the connection between the suncream factor and the time you can stay in the sun without burning.

30. A layer of gas called "the ozone" surrounds Earth. It is very important because it keeps out most of the ultraviolet radiation from the Sun. Pollution by humans, however, is eating away at the ozone layer and making it thinner. In some places it has even caused holes to form in the ozone layer.



(a) What is the name of the layer of gas that protects us from the huge amounts of ultraviolet radiation that the Sun gives off?

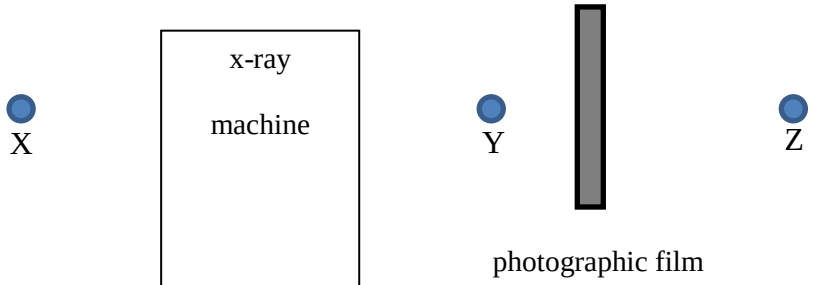
(b) Why do doctors fear that there will be more cases of skin cancer in the future?

X-Rays

31. Are X-Rays visible or invisible?

32. Photographic film is clear. What happens to the film when X-Rays hit the film?

33. An x-ray photograph is taken of a patient's knee.

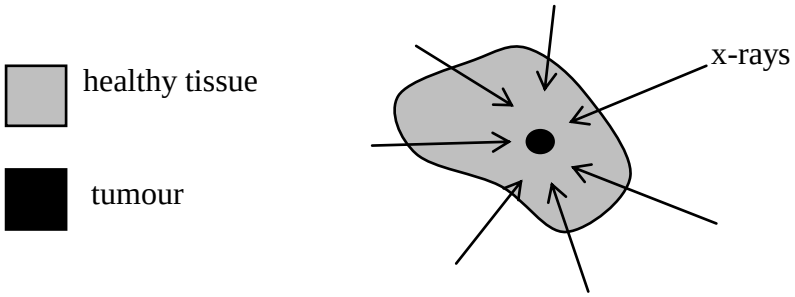


(a) At which p d the patient's knee be placed; X, Y or Z ?

(b) Why does nd behind a lead screen while the x-ray machine is operating?

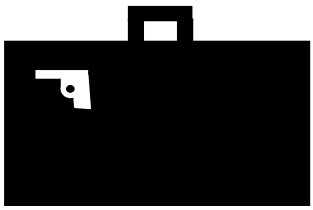
(c) Explain how the photographic film shows up the bones in the patient's knee.

34. High energy x-rays can be used to reduce cancerous tumours. The x-rays are passed through the body at various angles to reach the tumour.



Why are the x-rays passed through the body at different angles?

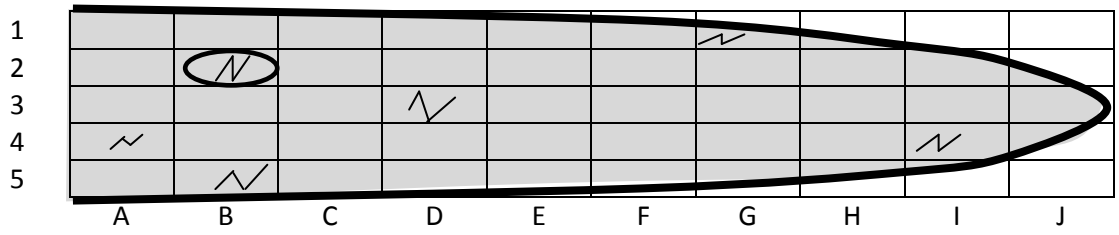
35. Here is an X-Ray photograph of a suitcase taken at an airport.



(a) Why don't the socks show up on the picture?

(b) Why does the gun show up on the picture?

36. Here is the X-Ray picture of an aeroplane wing. A grid is put over the top so that the engineers can pinpoint the location of six cracks.



One crack appears at B2.

(a) Use the grid references to write down the positions of the other 5 cracks.
(b) What colour will the wing show up as on the X-Ray film?
(c) What colour will the cracks show up as on the X-Ray film?

Gamma Rays

37. Are gamma rays visible to the human eye?

38. Over exposure to gamma radiation is dangerous. Explain why.

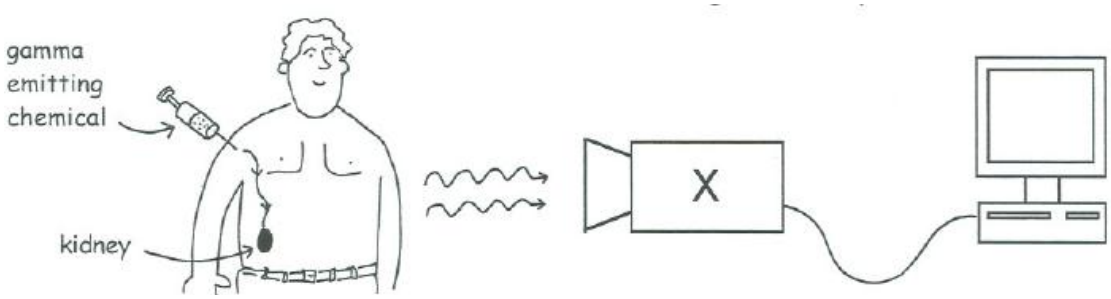
39. State 2 medical uses of gamma rays.

40. Gamma rays can be used to detect cracks in water pipes. Explain how this could be done.

41. Gamma rays can kill healthy living cells like brain and blood cells.

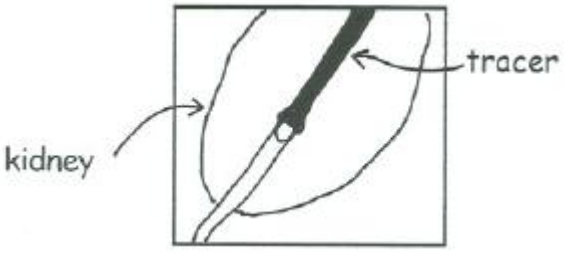
    (a) What do we call unhealthy cells in the body which have gone bad?
    (b) Are these cells living cells?
    (c) So what can we use to kill them?

42. Mr Baker has a pain in his kidneys. A liquid containing a gamma source is injected into his bloodstream. The blood will carry the liquid to the kidneys.



    (a) What do we call this type of liquid?
    (b) As it flows through his kidneys, what radiation does the liquid give off?
    (c) What do we call the device marked X that can detect this radiation?

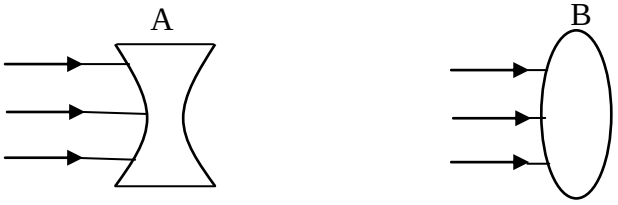
    Here is a computer image of one of his kidneys. The dark colour shows his blood.



    (d) What is wrong with his kidney?

11. Refraction and the Eye

1. Look at the 2 lenses drawn below:



(a) Identify the type of each lens, A and B.

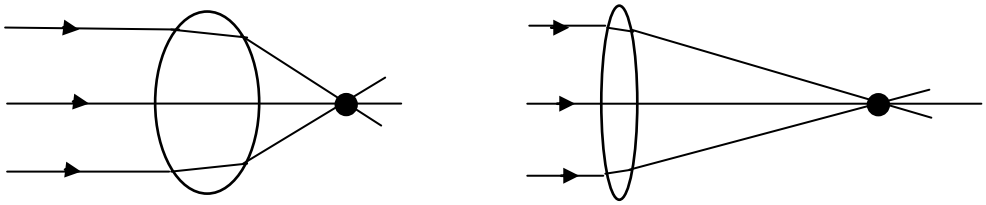
(b) Copy and complete the diagrams to show how each lens affects the rays of light.

2. The following apparatus is set up to measure the focal length of a convex lens.

(a) Describe how the apparatus is used to measure the focal length of the lens.

(b) Should the window be near or far away from the lens, for the most accurate answer?

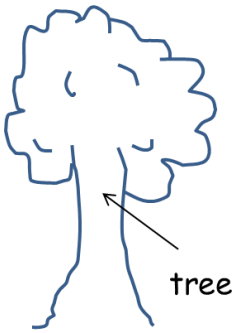
3. In an experiment, 2 lenses bring light to a point, as shown below.

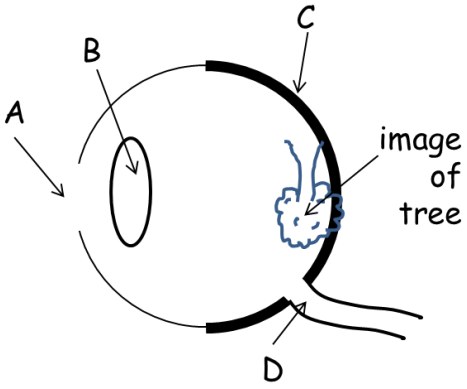


(a) What word is used to identify the point where the rays of light meet?

(b) What conclusion can you make about the thickness of a convex lens?

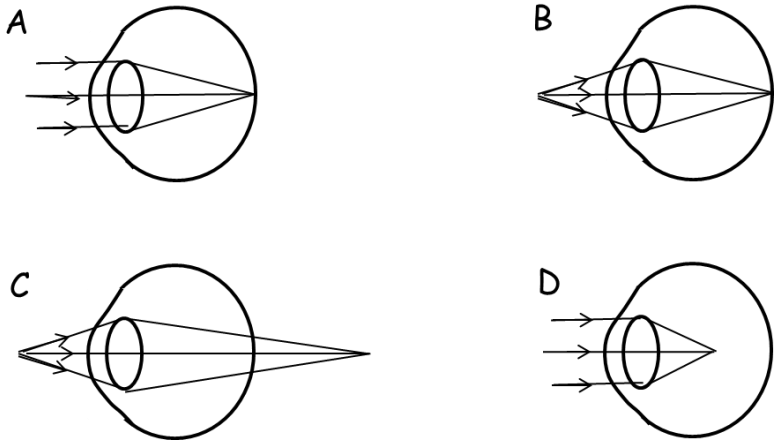
4. Look at this picture of a human eye looking at a tree.





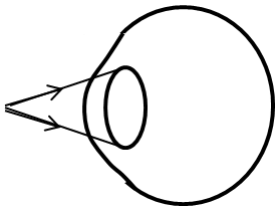
(a) Label the parts of the eye; A, B, C and D.
(b) Describe the image of the tree compared to the tree itself.
(c) What does part D do?
(d) Where, in the eye, should sharp images form, for us to see clearly?

5. Look at the following diagrams which show eyes collecting rays of light from near and far away objects.



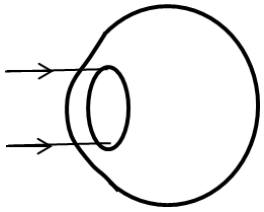
(a) Which 2 diagrams show light entering the eye from nearby objects?
(b) Which 2 diagrams show light entering the eye from far away objects?
(c) Which diagram could be the eye of a short sighted person looking at a far away object?
(d) Which diagram could be the eye of a long sighted person looking at a nearby object?
(e) Which diagram could be the eye of a short sighted person looking at a nearby object?
(f) Which diagram could be the eye of a long sighted person looking at a far away object?

6. David is **long sighted**.
   (a) Can David see nearby or far away objects clearly?
   (b) The following diagram shows light from a nearby object entering David's eye.



   Copy and complete the diagram to show where the rays of light would meet.
   (c) Draw and name the type of lenses that David's glasses would need.

7. Shona is **short sighted**.
   (a) Can Shona see nearby or far away objects clearly?
   (b) The following diagram shows light from a far away object entering Shona's eye.



   Copy and complete the diagram to show where the rays of light would meet.
   (c) Draw and name the type of lenses that Shona's glasses would need.

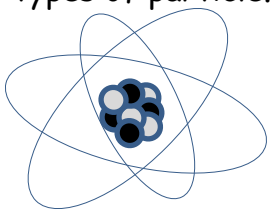
8. Caitlin's glasses contain concave lenses.
   (a) Is Caitlin short sighted or long sighted?
   (b) Explain what is meant by this sight defect.
   (c) What would Caitlin struggle to see clearly without her glasses; close up newspaper print or the number on a bus at a distance?

9. Gavin's glasses contain convex lenses.
   (a) Is Gavin short sighted or long sighted?
   (b) Explain what is meant by this sight defect.
   (c) What would Gavin struggle to see clearly without his glasses; close up newspaper print or the number on a bus at a distance?

10. A woman struggles to read a car registration plate at a distance, but can easily read her book.
   (a) What sight defect does she have?
   (b) What type of lens is used to correct this sight defect?

12. The Atom and Nuclear Energy

1. An atom consists of 3 types of particle.



   (a) Name the 2 types of particle that make up the nucleus, or centre, of the atom.
   (b) What are the particles that orbit the nucleus called?
   (c) What is the charge on each type of particle in an atom?
   (d) Why are atoms "electrically neutral"?

2. State the 3 types of nuclear radiation.

3. Big atoms, like Uranium, give off nuclear radiation.
   (a) What word do we use to describe these big atoms.
   (b) Big atoms become stable after they have emitted radiation. What do we say happens to the nucleus of a big atom when it emits radiation.

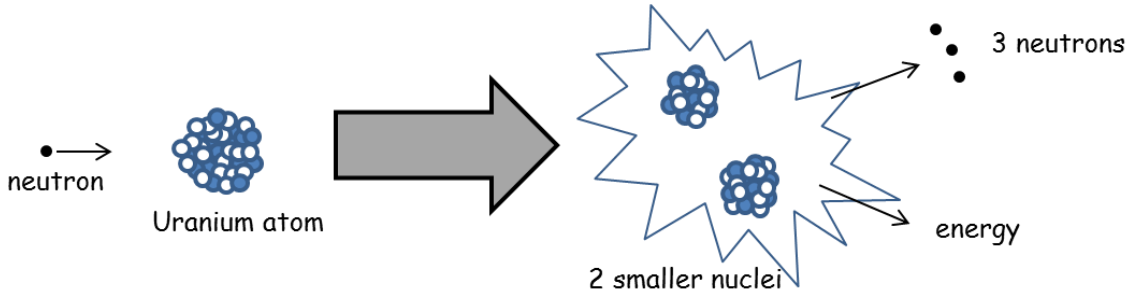
4. Sources of nuclear radiation occur naturally but they can also be man-made.
   (a) Give 2 examples of natural sources of nuclear radiation.
   (b) Give 2 examples of man-made sources of nuclear radiation.

5. What do we call the radiation which is around us all the time?

6. Nuclear radiation can be used in a variety of ways.
   (a) How can nuclear radiation be used for medical purposes?
   (b) How can nuclear radiation be used in industry?

7. There are 2 types of nuclear reaction. One, called "fusion", happens in the stars when the nuclei of small atoms join up to make big atoms and release lots of energy.
   The other type of reaction happens in nuclear power stations. Here, the nuclei of big atoms are split into smaller nuclei and lots of energy.
   What do we call this type of reaction?

8. Look at this diagram which shows a neutron being fired at the nucleus of a Uranium atom. The Uranium atom splits up to produce 2 smaller nuclei, 3 neutrons and energy.



(a) State the name of this type of reaction.
(b) What type of energy is released?
(c) Only a tiny amount of energy is release in one reaction. However the neutrons released can go on to split more Uranium atoms. This keeps happening until, very quickly, millions of reactions are happening and lots of energy is released.

What do we call this "knock on effect" process?

9. Electricity can be generated using nuclear fuel.
(a) What are the advantages of using nuclear fuel to generate electricity?
(b) What are the disadvantages of using nuclear fuel to generate electricity?

10. Many people think that the health risk of living beside a nuclear power station is very high. Consider the following activities and decide whether you think they have a higher or lower risk associated with them, than the risk of living beside a nuclear power station.

(a) Driving a car along the M8 from Glasgow to Edinburgh.
(b) Swimming in the sea off the coast of Spain.
(c) Flying from Glasgow to Florida.
(d) Having a chest x-ray.
(e) Eating a peanut butter sandwich on a regular basis.

Use the internet to find information that might help you answer these questions.