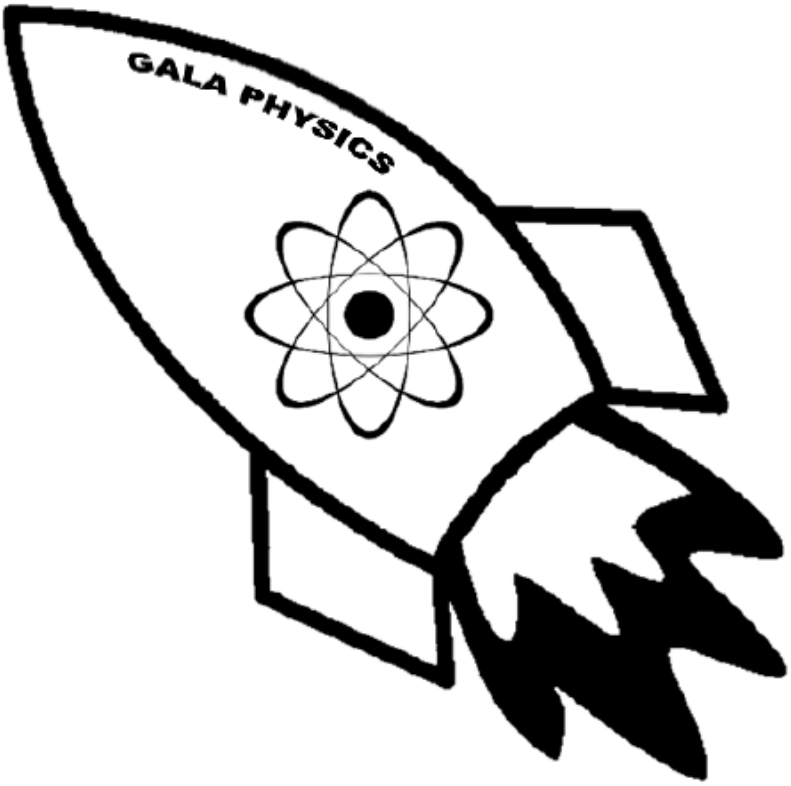
Galashiels Academy

National 4 Physics



Waves and Radiation
Consolidation and Revision Questions

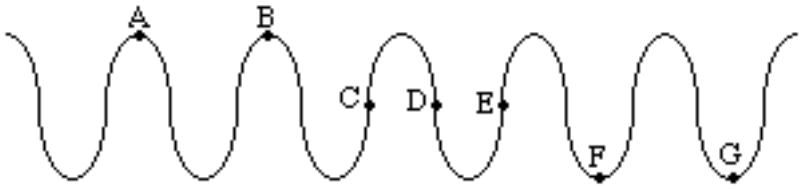
Name:	**Class:**

Waves and Radiation Questions

1. **Wavelength**
2. **Frequency**
3. **The Wave Equation**
4. **The Wave Equation, Distance and Time**
5. **Speed of Sound and Light**
6. **Oscilloscope Traces: Amplitude, Volume, Frequency & Pitch**
7. **Noise Levels and Frequency Ranges**
8. **Uses of sound**
9. **Electromagnetic Spectrum**
10. **The Eye: Long and Short Sight**
11. **Nuclear Power**

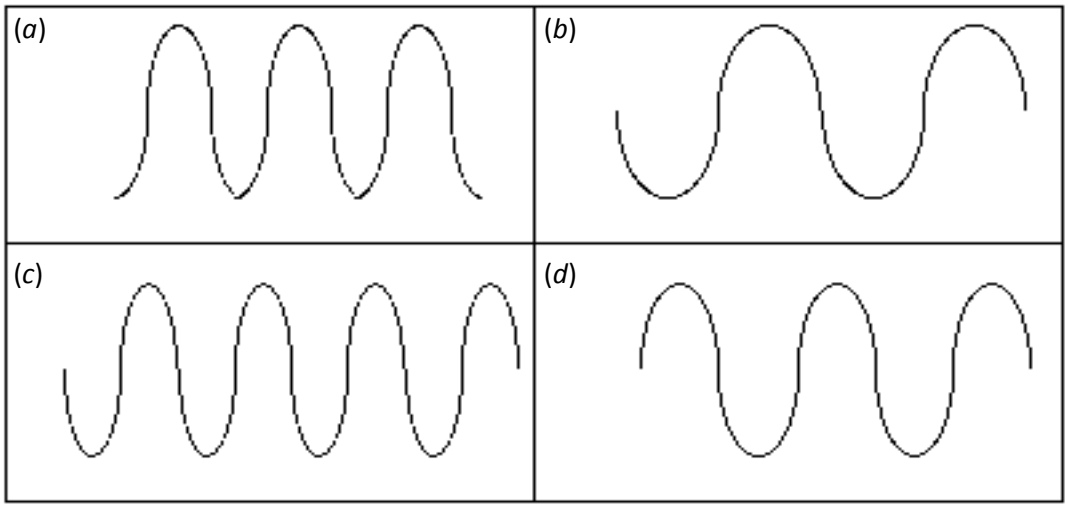
Exercise 1: Wavelength

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



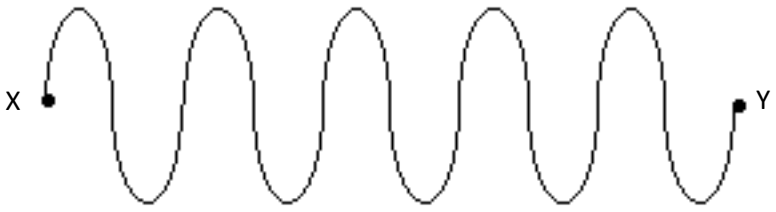
State two other pairs of letters which represent one wavelength.

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

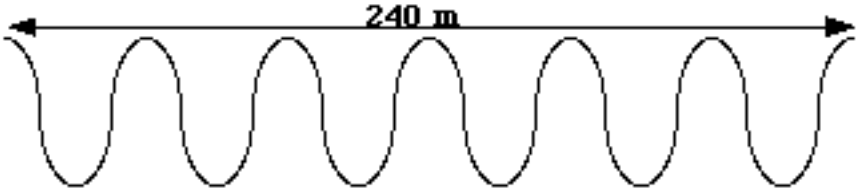


3. The wave train shown below is 20 metres long. How long is each wave?

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

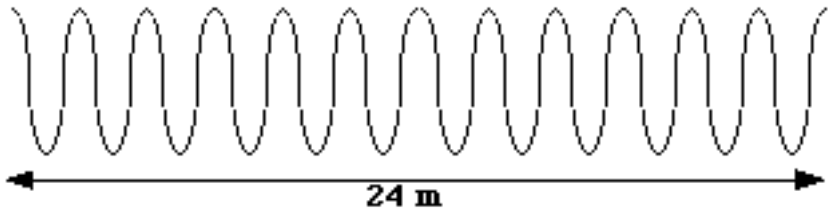


5. What is the wavelength of the waves in the diagram below?



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

7.

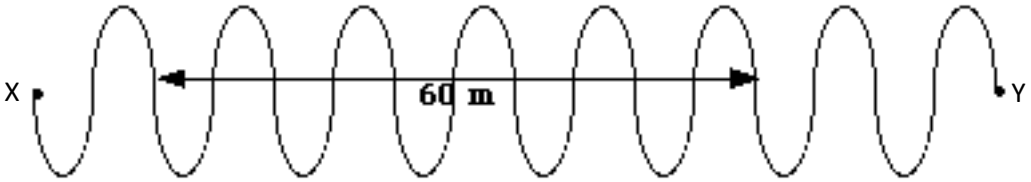


(a) How many waves are shown in the diagram above?

(b) What is the wavelength of each of these waves?

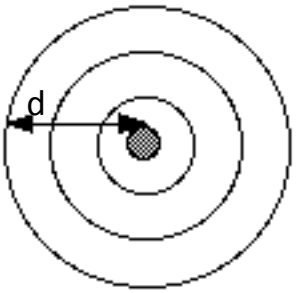
8.

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



(b) What is the distance from X to Y in this wave train?

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



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

Exercise :– Frequency

1. Calculate the missing values in the following table. Show all working.

	Frequency (Hz)	*Number of Waves*	*Time* (s)
(*a*)		10	5
(*b*)		30	60
(*c*)	800	3 200	
(*d*)	12	9 600	
(*e*)	50		90
(*f*)	20 000		15

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

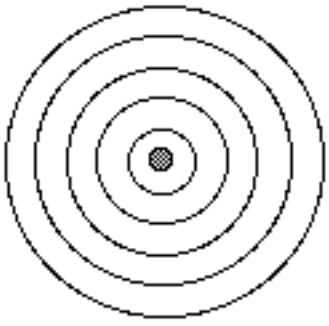
3. A man stands on a beach and counts 40 waves hitting the shore in 10 seconds. What is the frequency of these waves?

4. In 100 seconds a particular smoke alarm emits 1 000 000 sound waves. What is the frequency of the sound waves?

5. A girl is sitting on the edge of a pier. It takes 0·625 seconds for one complete wave to pass underneath her. What is the frequency of the waves?

6. A girl stands on a beach and counts 15 waves crashing onto the shore in a time of 1 minute. What is the frequency of the waves?

7. 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.

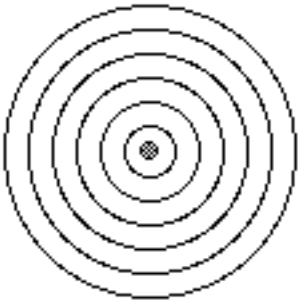


What was the frequency of these water waves?

8. In a swimming pool a wave machine creates waves with a frequency of 2 Hz. How many waves are produced in 5 minutes?

9. A smoke alarm sends out high-pitched sound waves with a frequency of 12 000 Hz. If the alarm is on for 30 seconds how many waves does it emit?

10. 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?

Exercise 3: The Wave Equation

1. Calculate the missing values in the following table. Show all working.

	Frequency (Hz)	*Wavelength* (m)	*Speed* (m/s)
(*a*)	5	3	
(*b*)	50	0·02	
(*c*)	2		0·5
(*d*)	20 000		340
(*e*)		20	600

2. Water waves in a swimming pool are travelling with a speed of 2 m/s and have a wavelength of 0·8 m. What is their frequency?

3. The musical note 'E' has a frequency of 320 Hz. If sound travels with a speed of 340 m/s in air calculate the wavelength of this sound in air.

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

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

6. 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?

7. 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?

8. 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?

9. How fast will waves with a frequency of 15 000 Hz and a wavelength of 2·2 cm travel?

10. What is the wavelength of waves which have a frequency of 6 000 000 Hz and a speed of 1800 m/s?

11. A boy counts 40 complete waves along the length of a swimming pool. The pool is 50 m long and the waves are travelling with a speed of 3·75 m/s. Calculate:

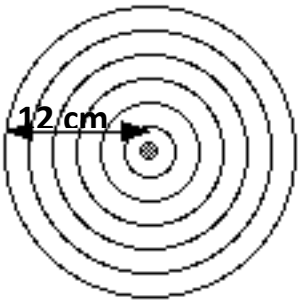
    (a) the wavelength of the waves.

    (b) the frequency of the waves.

    (c) the number of waves produced in 1 minute.

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

13. 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) What was the frequency of the waves?

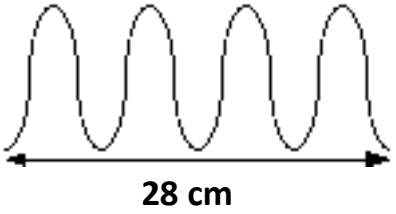
(c) What was the wavelength of the waves?

(d) Calculate the speed of the waves.

14. 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 in metres.

(b) Calculate the wave speed.

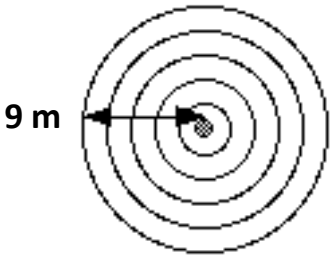


15. The waves shown in the diagram below were produced at a rate of 30 waves per minute.

(a) What is their frequency?

(b) What is their wavelength?

(c) Calculate the speed of these waves.



Exercise 4: The Wave Equation, Distance and Time

1. It takes 25 seconds for a wave in a swimming pool to travel from one end of the pool to the other end. The wave has a frequency of 2·5 Hz and its wavelength is 0·4 m.

   (a) What is the speed of the wave?
   (b) What is the length of the pool?

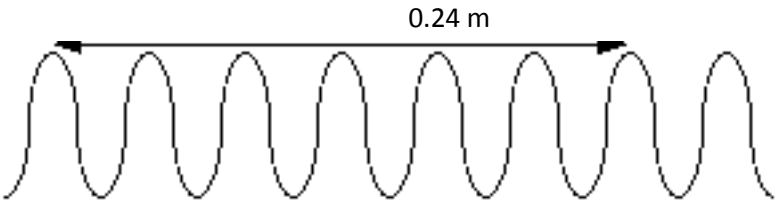
2. An alarm is set off creating sound waves of frequency 10 000 Hz. It takes 0·6 seconds for the sound to reach a man who is standing at a distance of 204 m from the alarm.

   (a) Calculate the speed of the sound waves.
   (b) Calculate the wavelength of the sound waves.

3. A wave generator in a ripple tank creates waves, which have a wavelength of 0·025 m, at a rate of 6 waves per second. The ripple tank is 0.6 m long.

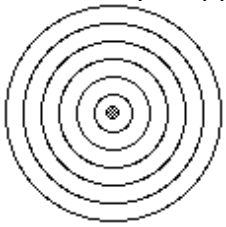
   (a) What is the frequency of the waves?
   (b) Calculate the speed of the waves.
   (c) How long will it take for a wave to travel the length of the ripple tank?

4. Consider the waves in the following diagram:



   (a) What is the wavelength of these waves?
   (b) Calculate the speed of the waves given that it takes 0·001s for one complete wave to pass a point.
   (c) Calculate the frequency of the waves.
   (d) How many of these waves would pass a point in 1 minute?

5. The pond waves represented in the diagram below have a frequency of 24 Hz and a wavelength of 10 cm. The pattern was formed by dropping a stone into the water.



   (a) Calculate the speed of the waves.
   (b) How long did it take for this pattern to form from the moment the stone made contact with the water?

Exercise 5: Speed of Sound and Light

1. Find the missing values in the following table.

	Distance (m)	*Average speed* (m/s)	*Time* (s)
(*a*)		3×10^8	5
(*b*)		340	5
(*c*)	500		1·47
(*d*)	8 600		25·3
(*e*)	6 500	3×10^8	
(*f*)	255	340	

2. Calculate how far light travels in:
   (*a*) 1 second (*b*) 3 seconds (*c*) 10 seconds.

3. Calculate how far sound travels in:
   (*a*) 1 second (*b*) 3 seconds (*c*) 10 seconds.

4. A golfer is worried about the dangers of being out on the course during a thunder and lightning storm. He suddenly sees a flash of lightning and then counts 4 seconds before he hears the clap of thunder. How far away is the storm?
5. A group of physics students measure the speed of sound. The pupils stand 200 metres from the teacher who has a flash gun and starter pistol. The pupils start their stopclock 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 below. Calculate the speed of sound for each time recorded.

Distance from gun to pupils (m)	*Time recorded* (s)	*Average speed* (m/s)
200 m	0·58	
200 m	0·56	
200 m	0·59	

6. Spectators are told to stay behind a barrier which is 100m away from where fireworks are being set off at a display. How long will it take spectators to hear a 'banger' after they have seen it explode?

7. During the Edinburgh Tattoo, tourists on Princes Street see the cannon smoke from the castle 3 seconds before they hear the bang. How far are they from the castle?
8. A plane spotter sees a military jet and then 4·5 seconds later hears the roar from its engine. How far away is the jet?

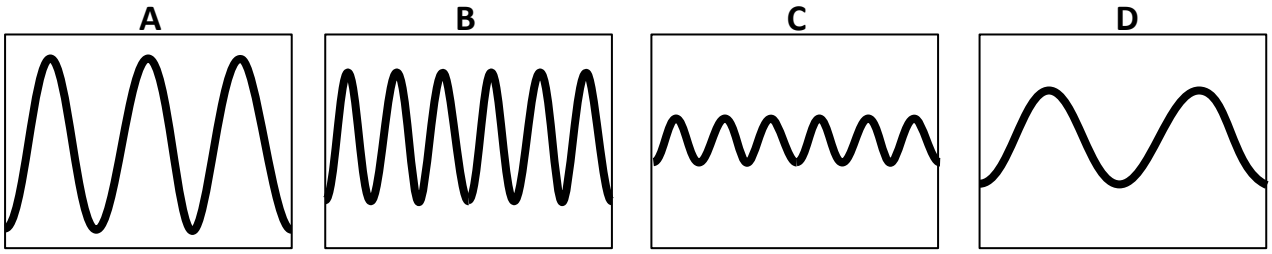
9. In a 100m sprint race the timers start timing when they hear the starter pistol and stop timing when they see the sprinters cross the finishing line.
   (a) Does this method overestimate or underestimate their sprint times? Explain your answer.
   (b) How could the accuracy of the timing be improved?

10. During the demolition of the high rise flats in the Gorbals, spectators saw the explosion first and heard it 7 seconds later.
    (a) Why was there a delay?

    (b) How far from the explosion were they standing?

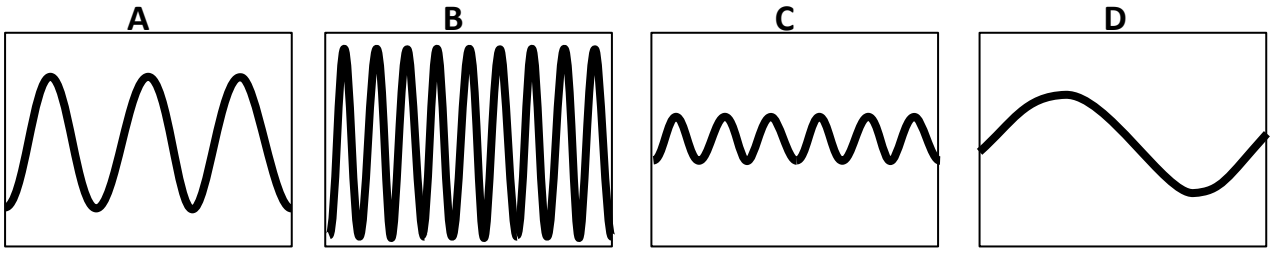
Exercise 6: Oscilloscope Traces: Amplitude, Volume, Frequency &Pitch

1. The electrical signals of 4 different sounds are displayed on an oscilloscope.



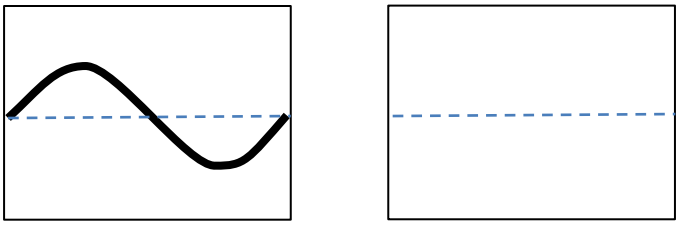
(a) Which wave has the smallest amplitude?
(b) Which wave would have the loudest volume?
(c) Which wave has the lowest frequency?
(d) What is the same about waves B and C?

2. Four more different sounds signals are displayed on an oscilloscope.

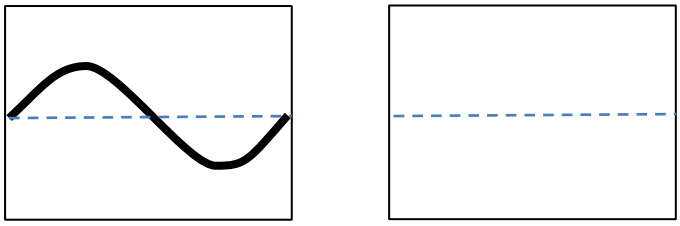


(a) Which wave has the largest amplitude?
(b) Which wave would have the loudest volume?
(c) Which wave has the highest frequency?
(d) Which wave has the highest pitch?

3. A sound signal is viewed on an oscilloscope and is shown below. If the volume of the sound is increased, but the frequency is kept the same, draw what the new wave would look like.



4. A sound signal is viewed on an oscilloscope and is shown below. If the volume of the sound is kept constant, but the frequency is increased, draw what the new wave would look like.



Exercise 7: Noise Levels and Frequency Ranges

1. Engineers working near aeroplane jet engines wear ear protectors. Explain why ear protectors are needed.

2. The numbers 130, 110, 90 and 60 are missing from the table below. Copy the table and fill in the missing numbers.

Sound	**Noise Level (dB)**
Pop group at 1m	
Heavy truck at 5m	
Jet engine at 50m	
Normal conversation at 1m	

3. What is the pain threshold of human hearing in decibels?

4. What is the threshold of human hearing damage in decibels?

5. What is the frequency range of human hearing?

6. What is the name given to frequencies of sound beyond the range of human hearing?

7. An ultrasonic whistle is used to call a dog.

   (a) Is the frequency of the sound 10 kHz, 18 kHz or 22 kHz?

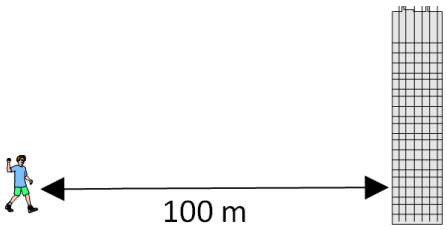
   (b) Explain your answer.

8. The following table shows the upper frequency limit of hearing for some different animals. Which animals would be able to hear a sound with a frequency of 35 000 Hz?

Animal	**Frequency of the upper limit of hearing (Hz)**
Cat	45 000
Dog	30 000
Human	20 000
Whale	80 000

Exercise 8: Uses of Sound

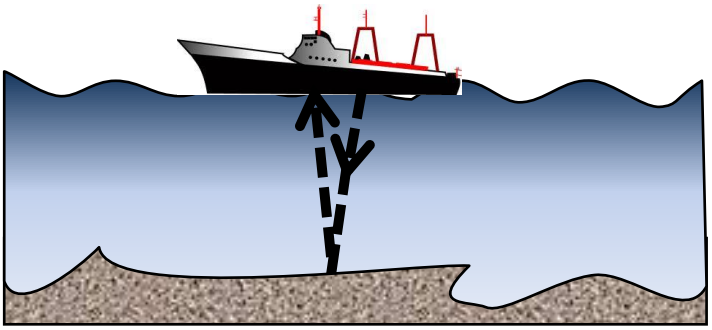
1. A boy is standing at a distance of 100 m from a large building. He shouts loudly and hears an echo.



(a) How far did the sound travel between leaving the boy and returning as an echo?
(b) If the speed of sound in air is 340 m/s, how long did it take to cover this distance?

2. A ship uses sonar to find the depth of the sea. The sonar system reflects ultrasound off the sea bed.

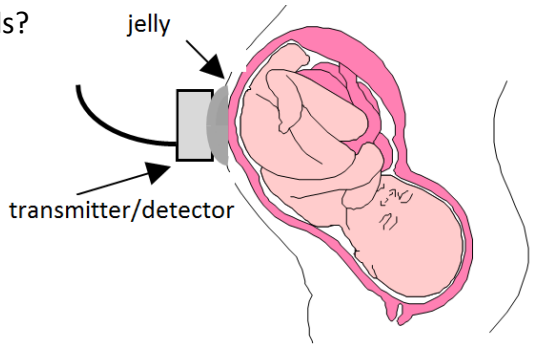
The time between the transmitted and received ultrasound signals is 0.5s. The speed of sound in water is 1500 m/s.



(a) Calculate the **total** distance travelled by the ultrasound pulse.
(b) What was the depth of the sea?

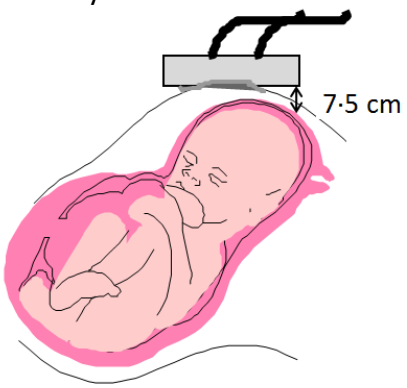
3. An ultrasound pulse is transmitted into an expectant mother's womb and reflects from baby's bottom. The pulse echo is detected 0·08 milliseconds (0.00008 s) after being transmitted. The speed of sound through the body tissue and fluid is 1 500 m/s.

(a) Calculate the **total** distance that the pulse travels?
(b) How far from the transmitter is the baby's bottom?
(c) Another pulse is reflected from the foot of the baby. If this reflected pulse is detected 0·15 milliseconds (0.00015 s) after being transmitted, how far from the transmitter is the baby's foot?



4. During an ultrasound scan, a baby's forehead is situated 0.075m from the transmitter. The ultrasound pulse travelling at 1 500 m/s is reflected from the baby's forehead.

(a) What is the **total** distance travelled by the pulse?
(b) What time elapses between the transmission of the pulse and the detection of the pulse echo?
(c) Why is ultrasound used to scan for the baby rather than x-rays?



Exercise 9: Electromagnetic Spectrum

1. Copy and complete the diagram shown below. You must:

   (a) Name all parts of the electromagnetic spectrum in the correct order.
   (b) Name one detector for each part of the electromagnetic spectrum.

Radiation		Microwaves			Ultraviolet		Gamma Rays
Detector							

2. Which part of the electromagnetic spectrum has the:
   (a) Highest frequency?
   (b) Lowest frequency?
   (c) Longest wavelength?
   (d) Shortest wavelength?

3. Copy and complete: The longer the wavelength the _____ the frequency

4. What can be used to split white light into the visible spectrum of colours?

5. List the 7 colours that make up visible light in order of frequency (low to high).

6.
   (a) What speed do microwaves travel at in air?
   (b) What is the speed of all parts of the electromagnetic spectrum in air?

7. Which part of the electromagnetic spectrum is used to carry signals for TV

8. What part of the electromagnetic spectrum is absorbed by bones and teeth but passes through flesh.

9. What part of the electromagnetic spectrum is used to send signals to and from a mobile phone?

10. What is the only part of the electromagnetic spectrum that humans can see with their eyes?

11. What part of the electromagnetic spectrum is emitted by any warm object?

12. Over-exposure to these rays can burn the skin and cause skin cancer.

13. What part of the electromagnetic spectrum is emitted by some radioactive substances and are often used in radiotherapy to kill cancer cells.

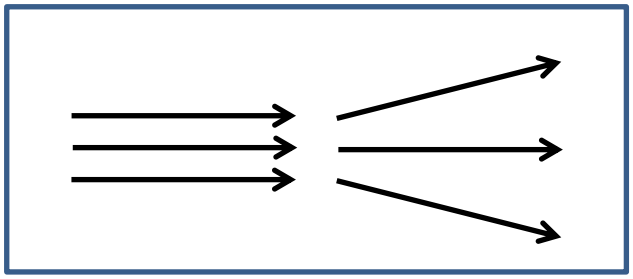
14. Can electromagnetic waves travel through a vacuum?

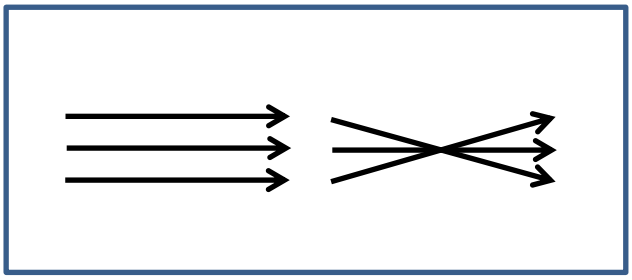
15. Is sound a part of the electromagnetic spectrum?

Exercise 10: The Eye: Long and Short Sight

1. The following ray diagrams have been drawn with the lenses missed out.

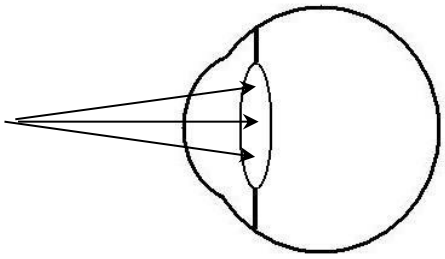
   (a) Copy and complete the following diagrams by inserting the correct shape of lens



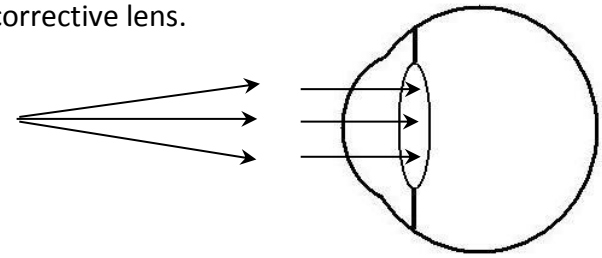


   (b) Label the lenses you have drawn with the correct name.

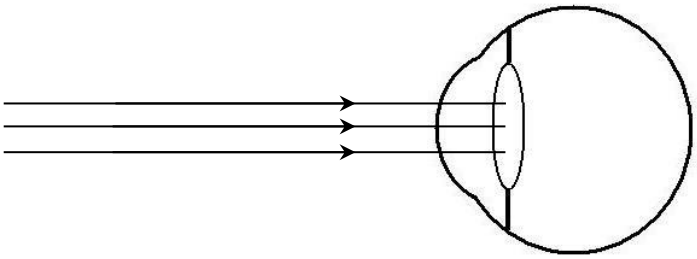
2. Copy and complete the following diagram to show a long sighted eye looking at a nearby object.



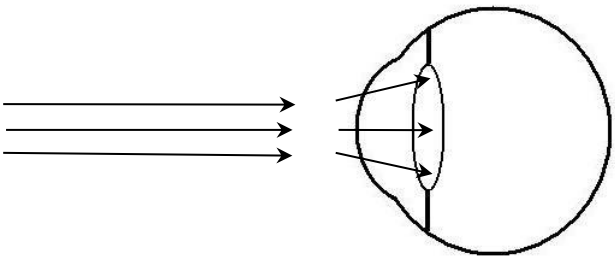
3. Copy and complete the following diagram to show a long sighted eye looking at a nearby object with a corrective lens.



4. Copy and complete the following diagram to show a short sighted eye looking at a distant object.

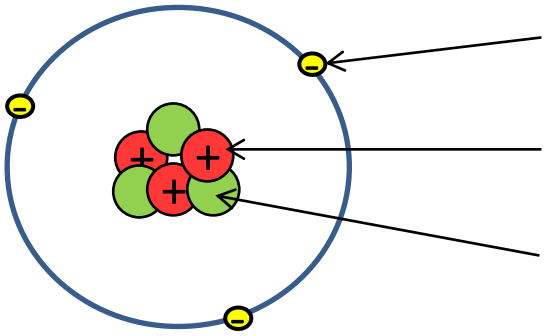


5. Copy and complete the following diagram to show a short sighted eye looking at a distant object with a corrective lens.



Exercise 11: Nuclear Power

1. Copy and complete the diagram of the atom, labelling each part.



2. Copy and complete:

   The _____ and _____ are found inside the _____ at the centre of the atom. The particles that orbit around it are called _____.

3. For each of the following statements, decide if it is either an advantage or disadvantage of using nuclear power.
   (a) Nuclear power plants don't require a lot of space (unlike wind farms)
   (b) No carbon dioxide gas emissions - does not cause global warming.
   (c) Does not produce smoke particles to pollute the atmosphere.
   (d) A lot of energy is produced from a small mass of fuel.
   (e) Operating costs are relatively low.
   (f) It is relatively easy to control the power output (although not as easily as fossil fuel stations).
   (g) It is reliable and does not depend on the weather.
   (h) There are security implications for radioactive material.
   (i) It produces a small volume of waste.
   (j) Disposal of nuclear waste is very expensive.
   (k) Some nuclear waste is highly radioactive.
   (l) Some nuclear waste remains radioactive for a very long time.
   (m) Products of nuclear reactors can be used for medical purposes.
   (n) Products of nuclear reactors can be used for nuclear weapons.
   (o) Decommissioning (closing) of nuclear power stations is expensive and takes a long time.
   (p) Nuclear accidents can release radioactive particles into the environment.