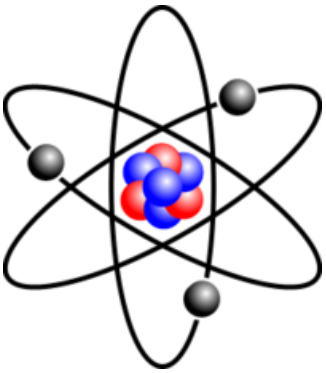
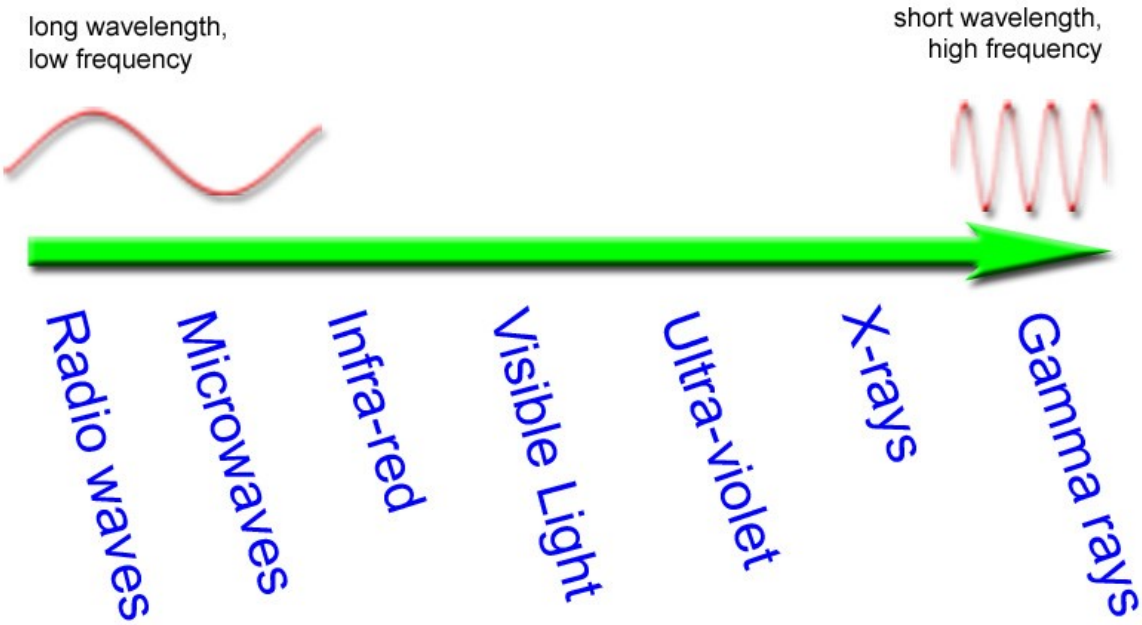


Waves and Radiation Homework



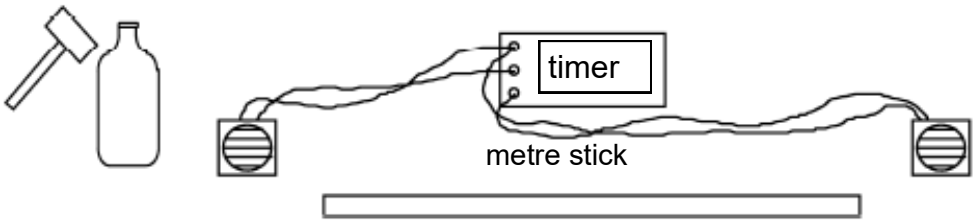
Homework 1

1. (a) What is the speed of sound in air?
   (b) What is the speed of light in air?

2. Calculate how far sound travels in:

   (*a*) 1 second (*b*) 3 seconds (*c*) 10 seconds.

3. Describe how you would use the laboratory apparatus, shown below, to determine the speed of sound in air.



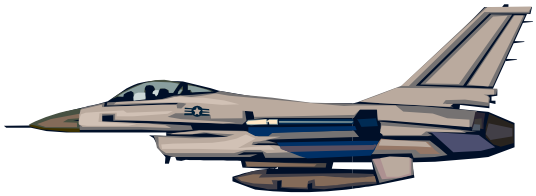
4. In an experiment similar to the one shown above, a timer records a time of 0.005s and the distance through which the sound travels is 1.65m. Calculate the speed of sound.

5. A girl who ventures out in a storm, hears thunder 5s after she sees lightning.

   (a) How far is the girl from the centre of the storm?

   (b) Explain why the girl sees the lightning before hearing the thunder.

6. 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?



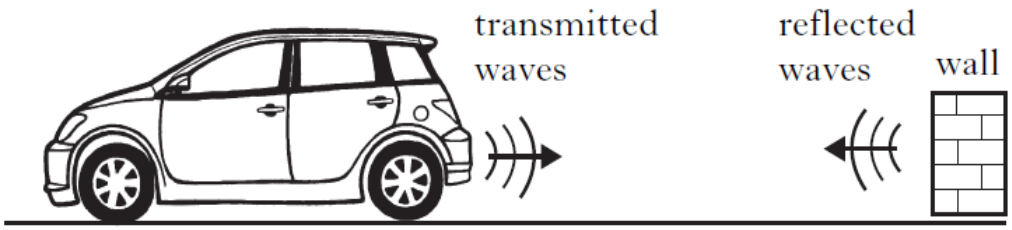
Homework 1 Continued

7. A group of physics students set 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 their 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 (m)	*Time recorded* (s)	*Speed* (m/s)
200 m	0·58	
200 m	0·56	
200 m	0·59	

Calculate the speed of sound for each time recorded.

8. A car is fitted with a parking system. This warns how close objects are behind the car. Equipment on the back of the car sends out ultrasound waves and receives the reflected waves.



There is a **5 ms** gap between a wave being transmitted and received. How far away is a wall from the back of the car? (Ultrasound waves travel at $340ms^{-1}$).

Homework 2

1. What do all waves transfer?

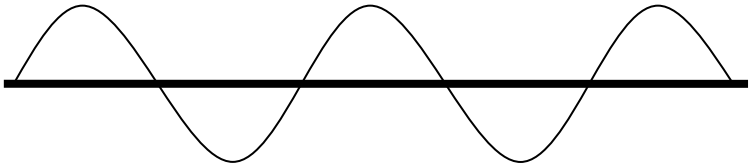
2. (a) State the difference between transverse and longitudinal waves.
   (b) Give an example of each.

3. Redraw the table below, matching the terms and definitions correctly.

Terms	***Definitions***
Amplitude	the time it takes for one wave to pass a point
Frequency	the distance from a point on one wave to the same point on the next wave
Period	the height of the wave from the middle to the peak (or crest)
Wavelength	the number of waves which pass a point in one second

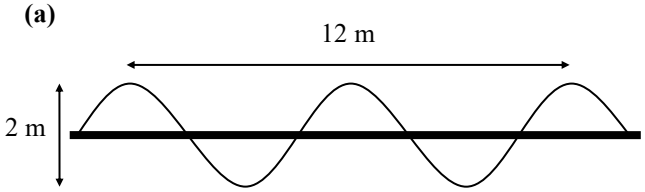
4. Copy the diagram of a wave shown below and label it with the following terms:

Amplitude, Wavelength, Crest, Trough

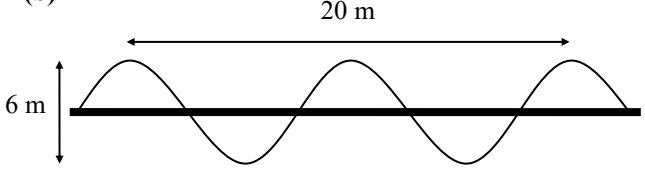


5. Calculate the wavelength and the amplitude for each of the waves shown below.

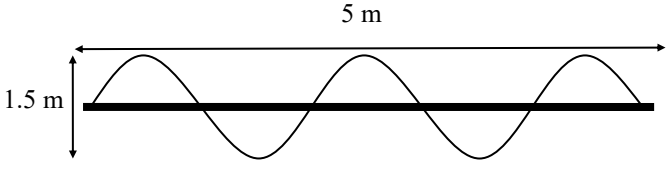
(a)



(b)



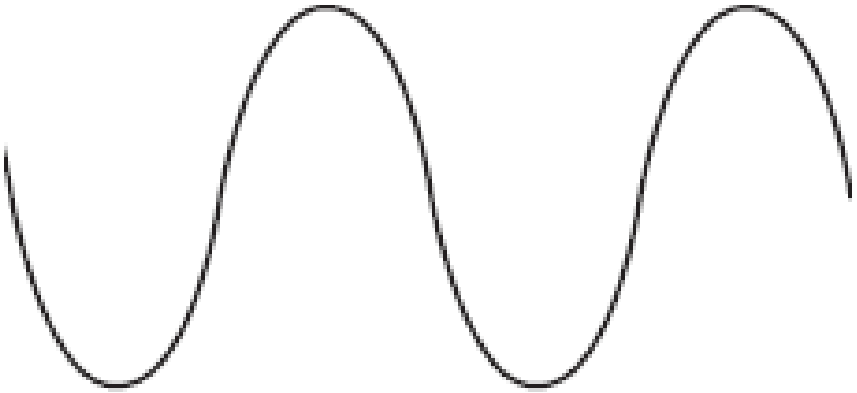
(c)



Homework 2 continued

6. The wavelength of the waves shown below is 3cm. What is the distance between X and Y?

7. The diagram below shows a wave with a frequency of 2 Hz and a wavelength of 1m.



(a) ***Re-draw*** the above trace to show what it would look like if the following changes were made.

(i) The wavelength was doubled.
(ii) The frequency was doubled.

Homework 3

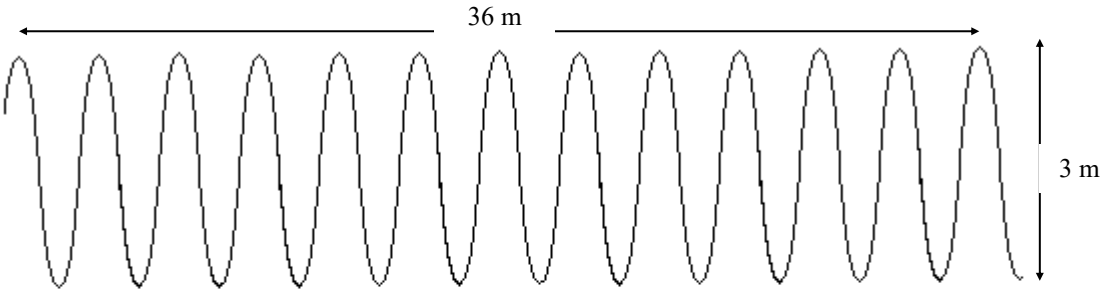
1. Change the following frequencies into hertz or wavelengths into metres:

   (a) 340nHz (b) 0.5MHz (c) 3GHz
   (d) 300mm (e) 400km (f) 70µm

2. A signal generator produces a wave with a frequency of 450kHz. Calculate the period of one wave.

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. 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?

5. 

   (a) What is the amplitude of the waves shown above?
   (b) What is the wavelength ?
   (c) Calculate the frequency if the complete waves, in the diagram above, were produced in 6 s.
   (d) Calculate the period of the waves.
   (e) Calculate the speed of the waves.

6. Using a signal generator, a sound wave of wavelength 16mm is produced. The sound wave is then transmitted from a loudspeaker into the air.

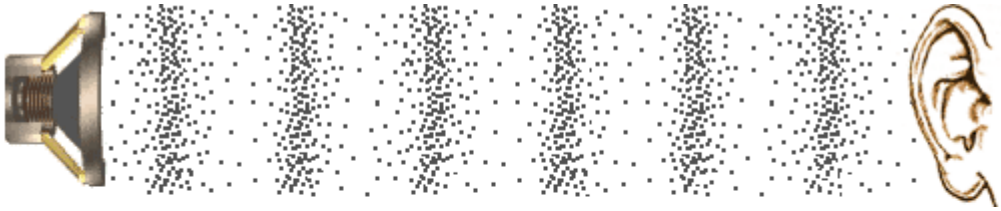
   (a) What is the frequency of the wave produced.
   (b) Will someone be able to hear the sound wave? Explain you answer.

Homework 3 continued

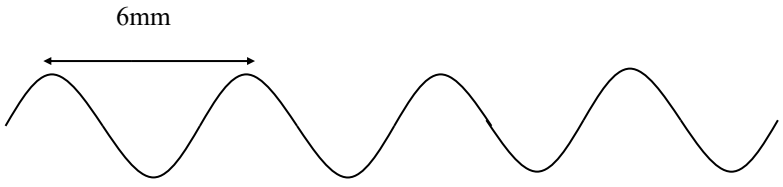
7. What is the speed of a water wave that has a frequency of 0.5 Hz and a wavelength of 3.6 metres?

8. A wave moving through water has a speed of 2.8 m/s and a wavelength of 7.0 cm. What is the frequency of the wave?

9. A sound wave of frequency 8.5 kHz has a speed of 340 m/s in air. What is the wavelength of the wave?



10. A wave of wavelength 6mm has a frequency of 50kHz. What is the speed of the wave?



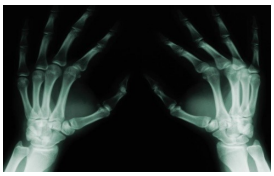
Homework 4

1. The parts of the electromagnetic spectrum are shown below.

Visible Light	Infrared Radiation	Gamma Rays	Ultraviolet Radiation	
	X-Rays	Radio Waves	Microwaves	

   (a) Rearrange these electromagnetic waves so that they are in order of **increasing frequency**.
   (b) What happens to the wavelength of electromagnetic waves as frequency increases?
   (a) What happens to the energy of electromagnetic waves as the frequency increases?
   (a) What speed do all electromagnetic waves travel at (in a vacuum)?

2. Briefly describe an application of the following types of electromagnetic radiation in medicine:
   (a) Ultraviolet
   (b) X-Raya
   (c) Gamma Rays



3. Briefly describe an application of the following types of electromagnetic radiation in telecommunications:
   (a) Radio waves
   (b) Microwaves

4. A microwave of frequency 300MHz travels for a distance of 4500km.

   (a) Calculate the wavelength of the wave.
   (b) Calculate how long it takes for the wave to travel this distance.

5. A radio carrier wave is sent out from BBC Radio 1 in London with a frequency of 97.5 MHz. A student in Edinburgh (which is 670 km away) is listening to the broadcast.

   (a) What is the wavelength of this radio wave?

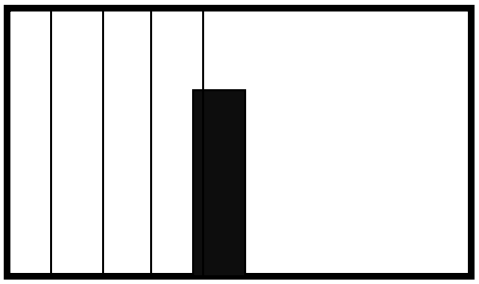
   (b) How long will it take the wave to travel from London to Edinburgh?

Homework 4 continued

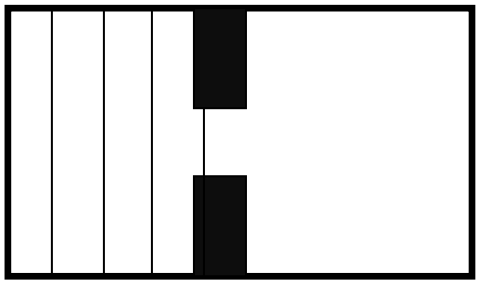
6. What is meant by the term ‘diffraction’?

7. Copy and complete the diagrams below to show how waves would bend around the objects.

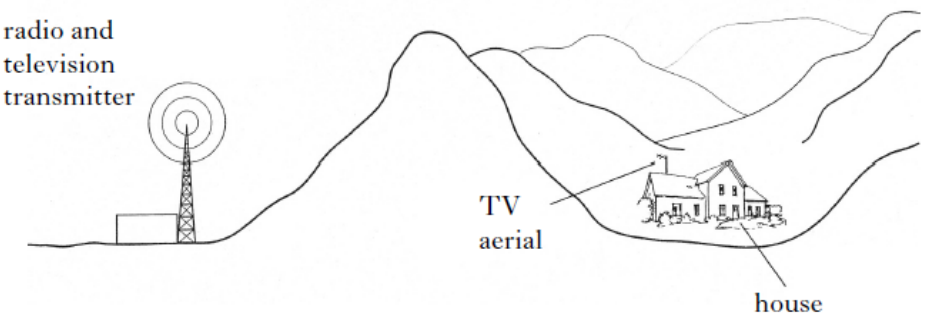
(a)



(b)



8. A hill lies between a radio and television transmitter and a house. The house is within the range of both the radio and television signals from the transmitter.



The house has a good radio reception but a poor television reception.
Suggest an explanation for this.

9. The sun emits both infrared and visible light.

(a) State which of these two has the greatest wavelength.

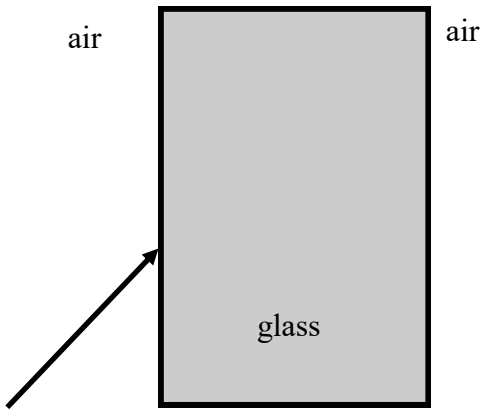
(b) How does the speed of red light compare with infrared?

(c) Red light has an approximate wavelength of 690 nm (690×10^{-9}m). Calculate the frequency of red light.

Homework 5

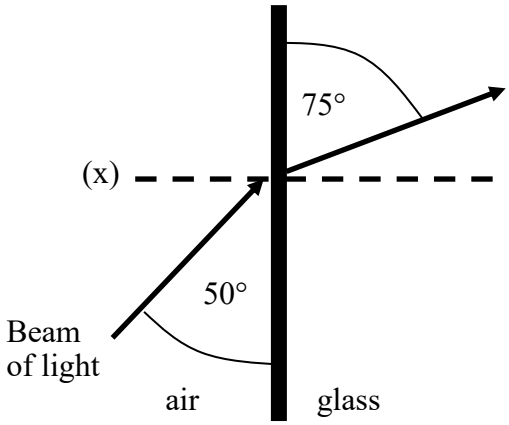
1. What is the refraction of light?

2. A beam of light passes from air into a glass block as shown below.



(a) Neatly copy and complete the diagram showing what happens to the light as it enters and leaves the glass block.
(b) On your diagram, clearly label the normal, the angle of incidence and the angle of refraction.

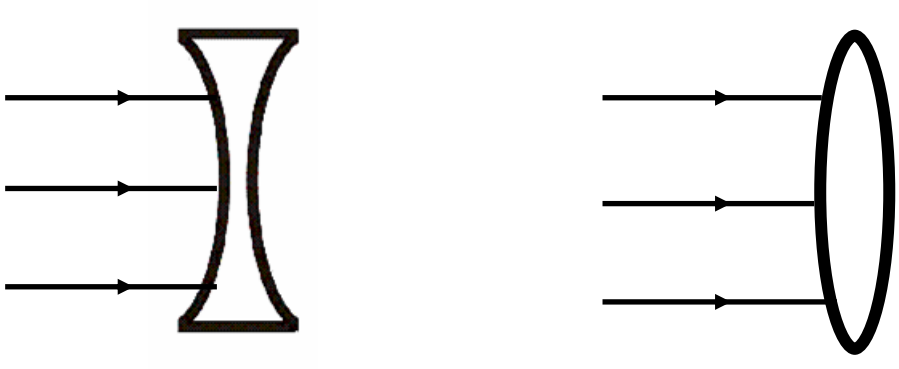
2. Using the diagram below, find:



(a) The angle of incidence
(b) The angle of refraction
(c) Identify the feature labelled (x)

Homework 5 continued

3. The diagrams below show two different lenses:

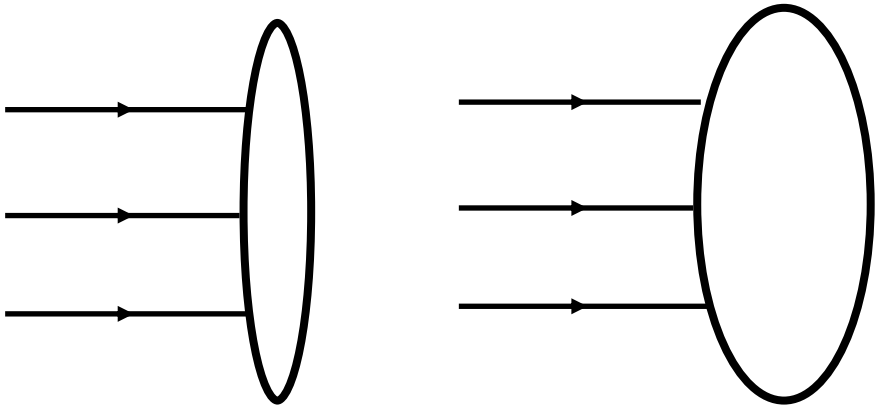


(a) Identify which lens is a converging lens and which is a diverging lenses. State another name for each lens.

(b) Copy and complete the diagrams showing the affect each lens has on the light rays.

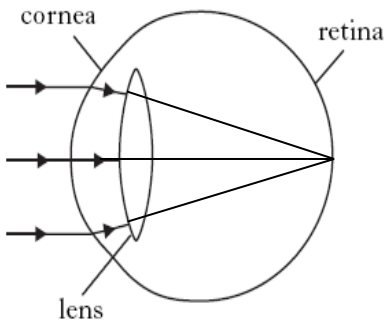
4. Using your diagrams for question 3, clearly mark the focal point and the focal length of each lens.

5. The below diagrams show two convex lenses, both with different thicknesses. Copy and complete the diagrams clearly showing the affect each lens has on the parallel rays of light.



Homework 6

1. Many people suffer from eye defects, but the two most common defects are known as long and short sight. Below shows the effect a “normal” eye has on light entering the eye.

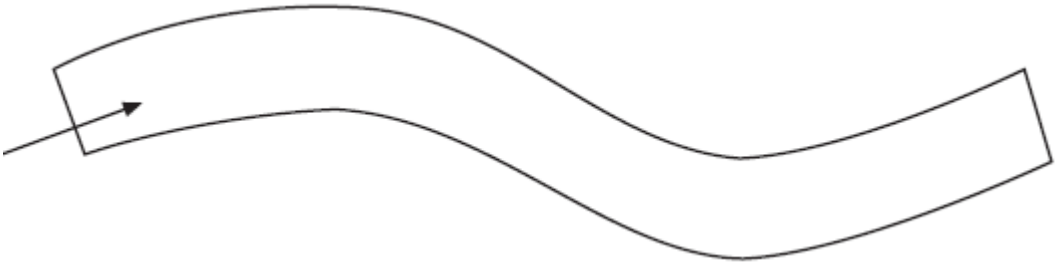


(a) State what is meant by long and short sight.
(b) With the aid of diagrams, describe how these defects affect the light entering the eye.

2. Convex and concave lenses can be used to correct the above mentioned eye defects.

(a) State which lens can be used to fix long and short sight.
(b) With the aid of diagrams, explain how these lenses correct the defect.

3. Below shows a fibre optic cable. A ray of light can be seen entering the fibre optic cable.



Copy and complete the diagram showing the path the light ray will take.

Homework 6 continued

4. Explain, with the aid of a diagrams, what is meant by:

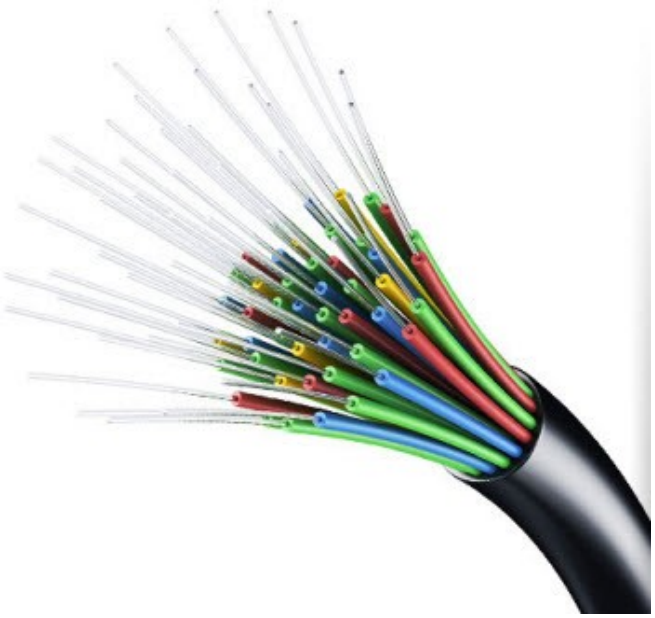
   (a) The critical angle
   (b) Total internal reflection.

5. Fibre optic cable are commonly used during surgery.

   (a) What is the name of the piece of equipment that uses fibre optics?
   (b) Why is this method preferred to other techniques of surgery. Give two examples.

6. Fibre optic cables are replacing copper cables in communication systems. Give two examples of:

   (a) Advantages of using fibre optics to copper cables.
   (b) Disadvantages of using fibre optics to copper cables.



Homework 7: Revision

1. A wave travels at a speed of 5m/s for a total of 45 seconds. How far does the wave travel?

2. A wave travels a total distance of 300m in a time of 55s. What is the speed of the wave?

3. A wave travels a total distance of 450m while travelling at a speed of 3.5m/s. How long does it take for the wave to travel this distance?

4. A sound wave travels through the air in a time of 1 minute 15s. How far does the sound wave travel?

5. A sound wave travels 180km in a time of two minutes.

   (a) Calculate the speed of the wave.
   (b) Is the wave travelling through air? Explain your answer.

6. A wave that is travelling at a speed of 60 m/s has a frequency of 45kHz. What is the wavelength of the wave?

7. A light wave has a wavelength of 5m. What is the frequency of the wave?

8. A wave has a wavelength of 32mm. Calculate the speed of the wave if the wave has a frequency of 55kHz.

9. Gamma Rays and Radio Waves are two members of the electromagnetic spectrum. Describe which of the waves:

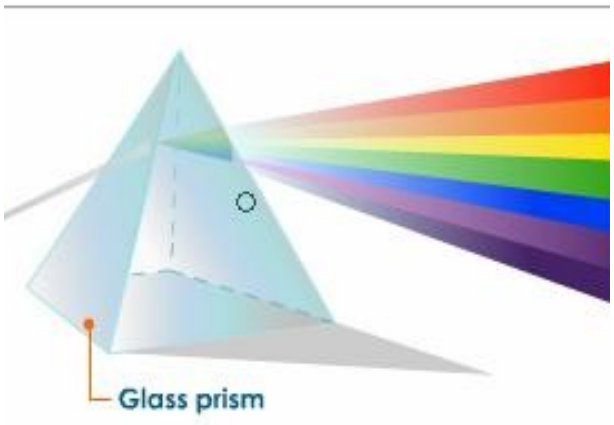
   (a) Has the greatest frequency
   (b) Has the greatest wavelength
   (c) Travels the fastest.

Homework 7: Revision continued

10. The following table shows the wavelength of different colours of light:

Colour of Light	Wavelength of Light (nm)
Red	700
Orange	650
Yellow	600
Green	550
Blue	500
Violet	420

A device that only works with light with a frequency between $5x10^{14}$ Hz and $4.5x10^{14}$Hz has been created. Suggest, using calculations, which colour of light would be best suited for the device.



Homework 8

1. Copy and complete the following table:

Particle	Type of charge	Position in atom
Proton		
Electron		
Neutron		

2. (a) State what is meant by the term "ionisation".
   (b) Give a reason as to why an atom will become ionised.

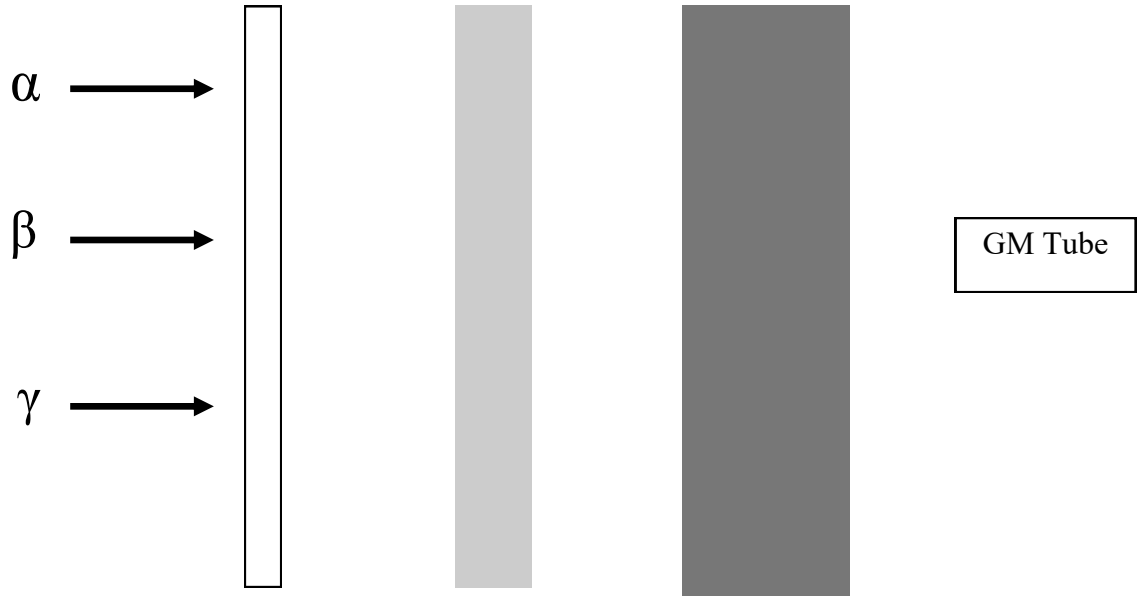
3. Look at the following table below.

	Alpha Particle	**Beta Particle**	**Gamma Ray**
A	Neutron	Helium Nucleus	Electromagnetic Radiation
B	Helium Nucleus	Electron	Electromagnetic Radiation
C	Hydrogen Nucleus	Electromagnetic Radiation	Electron
D	Helium Nucleus	Electromagnetic Radiation	Neutron
E	Hydrogen Nucleus	Electron	Electromagnetic Radiation

   (a) Which of the rows correctly describes the three different types of ionising radiation?
   (b) Which form of radiation is the most ionising?

Homework 8 continued

4. The student has set up an experiment to investigate how different types of materials affect different types of radiation. The experiment set up is shown below:



(a) State three different materials that the student could use in her experiment.
(b) Describe the results she will receive from the experiment.

5. Background radiation is constantly present around us.

(a) Give three examples of natural background radiation
(b) Give three examples of man-made background radiation.
(c) Which form of radiation has the greatest affect on us?

6. Give two examples of pieces of equipment that can be used to detect radiation.

Homework 9

1. State what is meant by the half-life of a radioactive substance.

2. A sample of a radioactive isotope is left to decay for 3 minutes. If the source has an activity of 1800 Bq, how many decays take place during this time?

3. A radioactive isotope is left to decay for 6 minutes. If the isotope decays 720 times, what is the activity of the isotope?

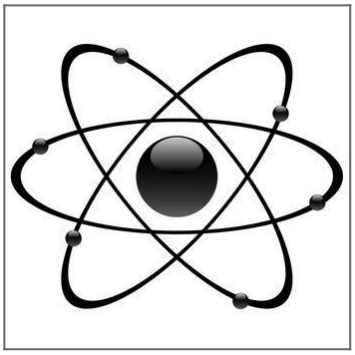
4. A radioactive isotope has an activity of 50 Bq. How long will it take the isotope to decay 7000 times?

5. A radioactive tracer has an initial activity of 4kBq. The source has a half life of 2.5 minutes and is left to decay for 10 minutes. What is the final activity of the source?

6. A radioactive source has an initial activity of 2800kBq. The source is left to decay for 12 hours. What is the final activity of the source if its half life is 3 hours?

7. A radioactive source has an initial activity of 120MBq. If the source is left to decay for 20 days and the final activity of the source is 7.5MBq, what is the half life of the source?

8. Uranium is most commonly used in nuclear power stations. Once it has been used, the
Uranium has to be buried underground. If a source of Uranium has an initial activity of 4000kBq when buried, and has a half life of 704 million years, how long will it take to reach a “safe” level of 125kBq



Homework 9 continued

9. The table below shows how a radioactive source decays over a given time.

Activity (Bq)	Time (hours)
64	0
46	1
32	2
22	3
18	4
11	5
8	6
6	7
4	8
3	9
2	10

(a) Using the information from the table, draw a graph of the radioactive decay.
(b) What is the half life of the source.

Homework 10

1. State what is meant by absorbed dose, state the symbol and the units .

2. Calculate the absorbed dose if a sample of mass 250g receives 5J of energy.

3. An object of mass 1.2kg has an absorbed dose of 3Gy. How much energy does this object receive?

4. An object of a certain mass is given 330J of energy. If the absorbed dose of the object is to be 6 Gy, what must be the mass of the object?

5. What are the three factors does the possible biological harm from radiation depend on?

6. State what is meant by the weighting ratio of a radioactive source. State the symbol of the weighting ratio.

7. An object has an absorbed dose of 3mGy and an equivalent dose of 0.3Sv when in contact with a radioactive source. What is the weighting factor of this source?

8. An object of mass 400g receives a total of 0.06J of energy. If the radioactive source nearby has a weighting factor of 3, what is the equivalent dose?

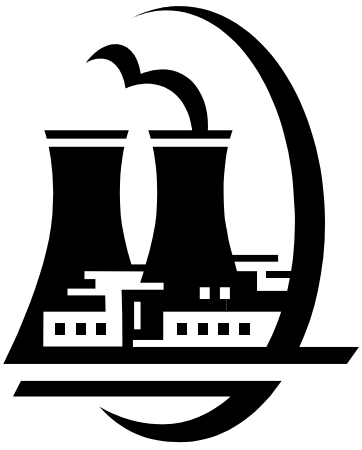
9. A nuclear power plant worker receives the following absorbed doses each year:

   45mGy of slow neutrons, weighting factor of 2
   150mGy of gamma radiation, weighting factor of 4

   Calculate the equivalent dose the worker receives each year.

10. A nuclear power plant worker works with fast neutrons and gamma radiation. In a year, he receives a total equivalent dose of 45mSv.The fast neutrons provide an equivalent dose of 15mSv per year.

    If the gamma radiation has a weighting factor of 4, what is the absorbed dose of gamma radiation?



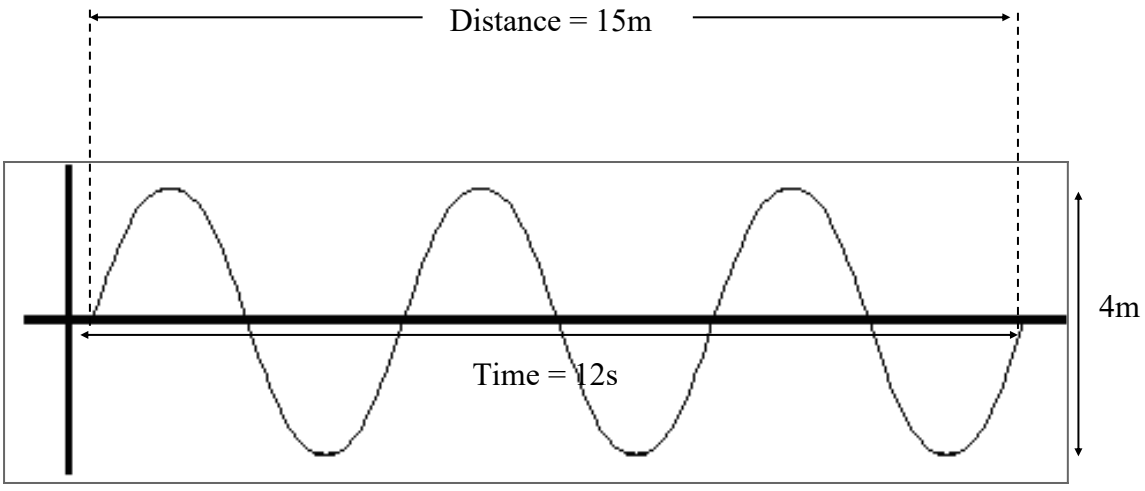
Homework 11: Topic Revision

1. (a) A wave travels for 35 minutes at a constant speed until it reaches the beach, 4km away. Calculate how fast the wave is travelling at.
   (b) How long will it take the wave to get to the same destination if it was travelling at 25 m/s?

2. (a) A sound wave (speed 340m/s) is emitted and travels through the air for a distance of 400m.
   Calculate how long it will take for the sound wave to travel this distance?
   (b) Calculate how far the same sound wave will travel in water in the same time. (Speed of sound in water: 1500m/s)

3. (a) State the speed of light.
   (b) Which travels faster - Ultraviolet Waves or Violet Light?
   (c) State which members of the electromagnetic spectrum have the longest and shortest wavelengths.

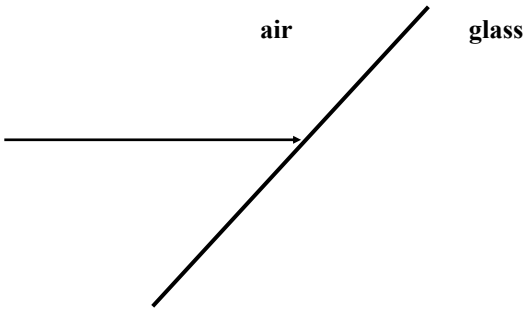
4. (a) From the diagram, correctly state the amplitude, wavelength and frequency of the wave.



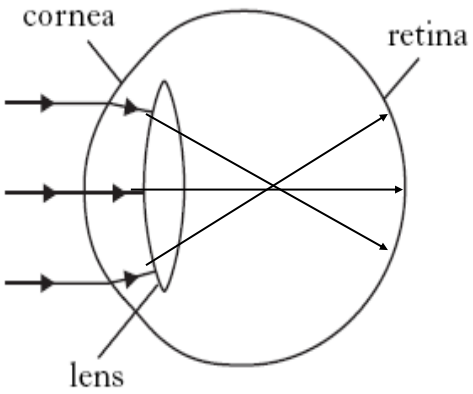
   (b) Calculate the speed of the above wave.
   (c) How long will it take the above wave to travel 100m?

Homework 11 continued

5. A ray of light passes from air to glass as shown. Neatly copy and complete the diagram showing the direction of the beam of light in the glass. Add the **normal** to the diagram and label the **angle of incidence** and the **angle of refraction**.



6. The diagram below shows the eye of someone who has short sight. Using a diagram, show how a lens can be used to correct this defect.



Homework 11 continued

7. A radioactive isotope has an initial activity of 200Bq. The half life of this isotope is 20days. Calculate how long it will take for the isotope activity to fall to 12.5Bq

8. A radioactive substance has been left to decay for a number of days. Readings were taken every day and the results are shown below:

Day(s)	Activity (kBq)
1	500
2	460
3	420
4	380
5	340
6	300
7	260
8	220

Using the information from the table, plot and graph and estimate the half life of this substance.

9. An object of mass 250kg receives 300MJ of energy. Calculate the absorbed dose.

10. A nuclear power plant worker works with fast neutrons and gamma radiation. In a year, he receives a total equivalent dose of 50mSv. The fast neutrons provide an equivalent dose of 15mSv per year. If the gamma radiation has a weighting ratio of 5, what is the absorbed dose of gamma radiation.

Waves and Radiation