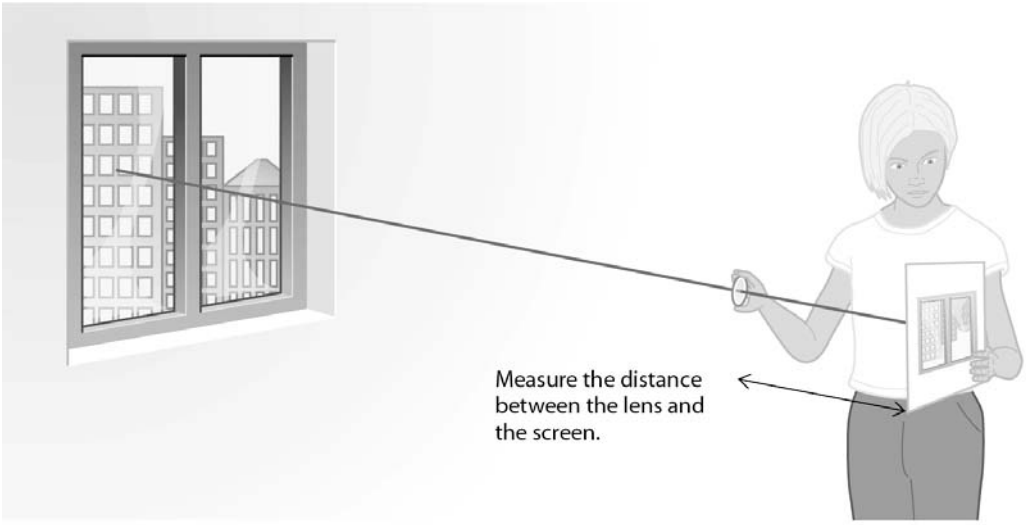
1 Measuring the focal length of a lens

The diagram shows how to measure the focal length of a lens.



Which of these is the correct distance for the focal length?

A from the window to the lens

B from the window to the wall

C from the lens to the wall

Tick the correct answer.

Draw an arrow like this ⟷ on the diagram to show the correct focal length.

Now get three different lenses from your teacher.

Working with a partner, measure the focal length of each lens.

Write your measurements underneath the diagrams below.

Lens shape			
Focal length (in cm)			

Complete these sentences:

The fatter the lens is, the _____ the focal length.

The image is always _____

2 Instruments that use lenses

Astronomers have used **telescopes** since the start of the 17th century to look at the Moon and the planets.

- Explain how telescopes help our eyes to see planets. Use words from the box to help you.

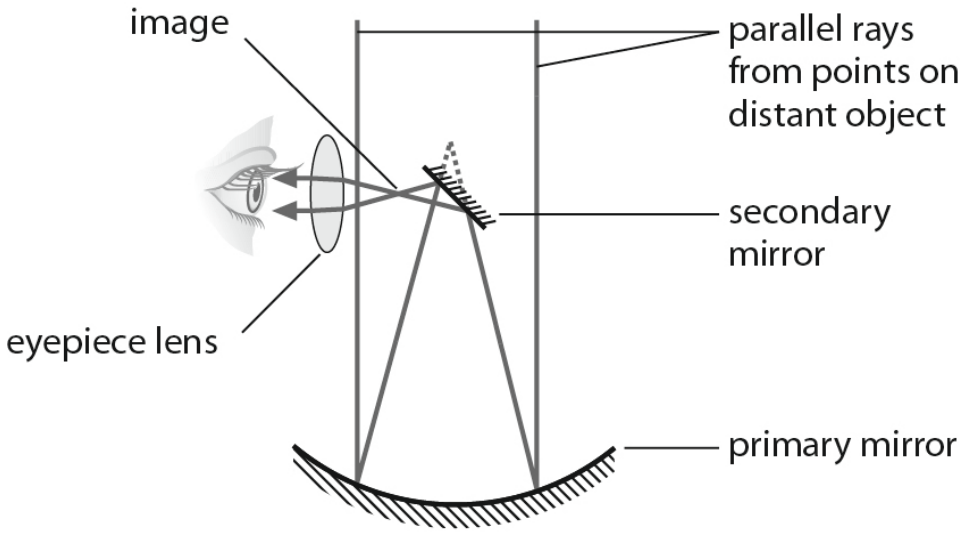
collects	**image**	**light**	**magnifies**	**more**	**the**

A telescope helps because it c_____ _____

and it m_____the _____ _____

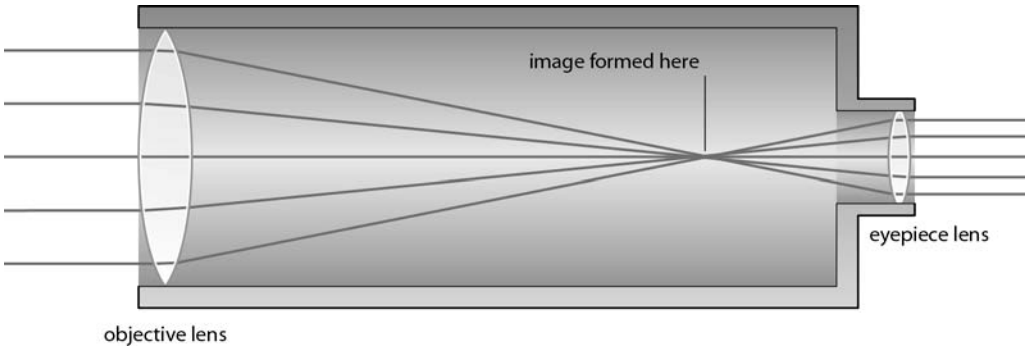
- Draw arrowheads (>)on both diagrams to show the direction the light rays are travelling.
- Write these labels on the diagram of a reflecting telescope.

light from star **primary mirror** **secondary mirror** **lens** **image**



- Write these labels on the diagram of a refracting telescope.

light from star **objective lens** **image** **eyepiece lens**



- Read the following about telescopes.

  There are two sorts of telescope – reflecting telescopes and refracting telescopes.

  Reflecting telescopes usually reflect the light twice. Refracting telescopes bend the light through two lenses.

  You have to position your eye in different places in these telescopes. In a refracting telescope, the eyepiece magnifies the image that is formed by the objective lens. In a reflecting telescope, the image is inverted – this means that the right side of the image is swapped over to the left.

- Complete the table to compare the two sorts of telescope.

Use the passage and the diagrams on the first page to help you find the answers. Two have been done for you.

	Reflecting telescope	**Refracting telescope**
Eye looks from the end		
Eye looks from the side		
Has lenses	no	yes
Has mirrors		
Image is inverted		
Image is magnified		
Image is upside down		
Light is bent		
Most light is reflected	yes	no

Cameras also use a lens.

The lens focuses light from an object to make an image.

1. The image is **smaller / bigger** than the object – circle the correct answer.
2. Write down three reasons why people use cameras.

1 _____

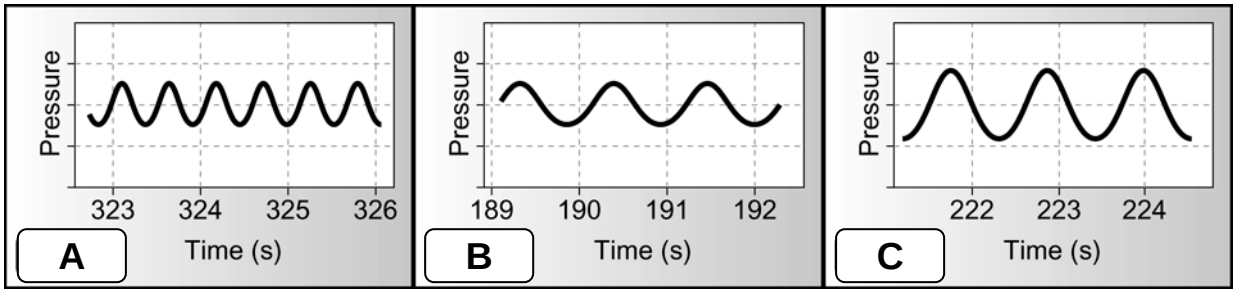
2 _____

3 _____

Put a tick next to the most important reason.

3 Waves

A student uses a computer program to listen to sounds and to look at their waveforms.



Answer these questions about these diagrams.

1. Which sound has the highest frequency?_____
2. Which has the biggest amplitude?_____
3. Which has the shortest wavelength?____
4. Which two will sound to have the same note (pitch)?_____ and____
5. Which will sound the loudest?____
6. Which will sound the highest note(pitch)?_____

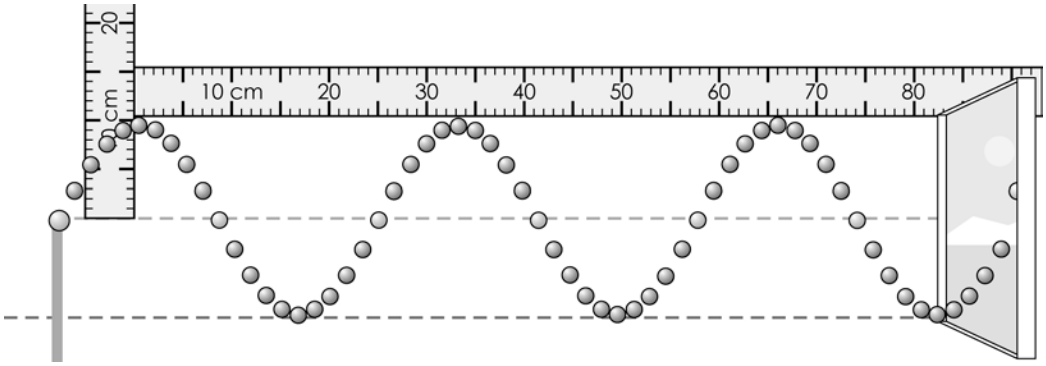
Complete the following pattern sentences.

1. Sound waves that are louder have a bigger_____
2. Sound waves that have the highest pitch(note)have the highest _____

Match these sound words with their correct meanings (draw connecting lines).

frequency	the length from one crest to the next crest
amplitude	the number of waves in a second
wavelength	the height of a wave from the middle to the top

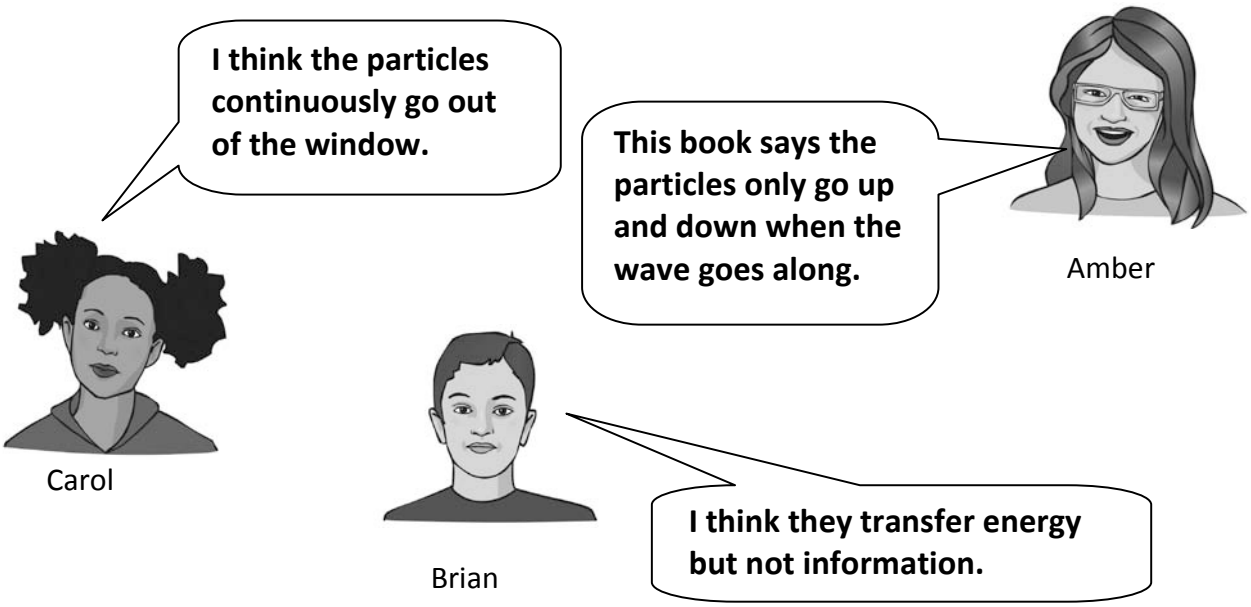
Three students use a different program about sound waves.



Use the diagram below to work out the wavelength and the amplitude.

wavelength = _____cm amplitude = _____cm

The students shares ideas about what the program says.



Amber and Brian have both made a mistake. Colin has forgotten about the particles in sound waves.

Write corrections for each student. Each has been started for you.

Amber: The particles in a wave only vibrate and do not _____

_____

Brian: All waves transfer both _____

Colin: The particles in a sound wave move _____

_____

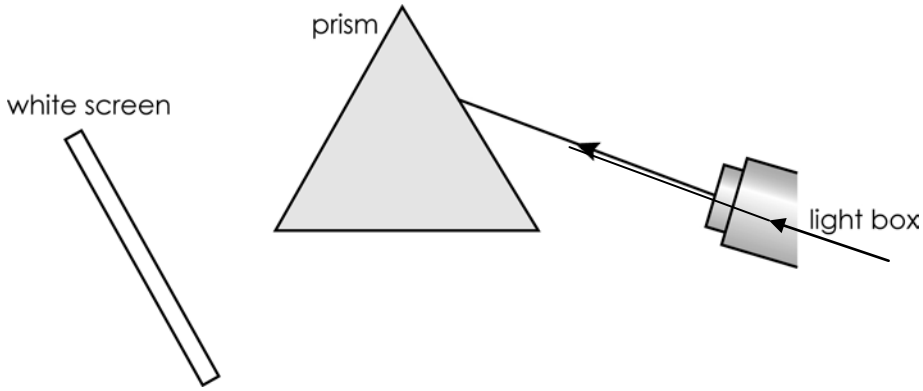
Teacher Note

Students should have viewed these free simulations as the diagrams are taken from them. It is better to do so with a data projector so that you can guide them to obtain clear ideas of waves.
http://phet.colorado.edu/en/simulation/wave-interference and
http://phet.colorado.edu/en/simulation/wave-on-a-string

4 Visible light

Use a prism and a light box to find out how many colours are in a rainbow.

The equipment you need is shown in the diagram.



Add labels to the diagram and draw in the colours leaving the prism.

1. How many colours could you see? …….
2. Which colour bent the most? …….

This sentence helps you to remember the colours and their order.

Write the colour under each word in the sentence.

Richard	**Of**	**York**	**Gave**	**Battle**	**In**	**Vain**
	.....	.....	.....	.....	.....	.....

Light waves are part of a family of waves called *electromagnetic waves*.

Why do scientists think that all these waves are related?

_____

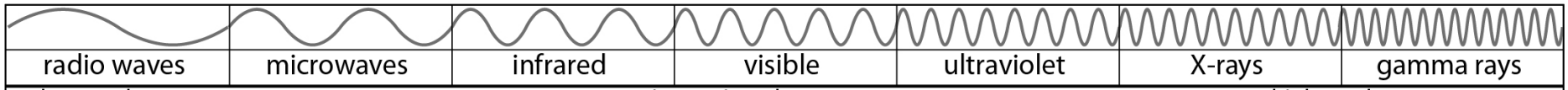
_____

There is another sentence to help you to remember all this family of waves.

Write the names of the waves under each word in the sentence.

Raspberry	**Made**	**Into**	**Very**	**Unlikely**	**Xmas**	**Goody**
	.....	.....	.....	.....	.....	.....

5 Waves in the electromagnetic spectrum



radio waves	microwaves	infrared	visible	ultraviolet	X-rays	gamma rays
lowest photon energy			increasing photon energy			highest photon energy
longest wavelength			wavelength decreases			shortest wavelength
lowest frequency			frequency increases			highest frequency
• emitted by radio and TV transmitters • used to send radio and TV programmes • detected by aerials and radios/TVs	• emitted by radio transmitters, mobile phones and microwave cookers • used to carry information and to cook food • can damage living tissue by heating the water in it • detected by aerials and radios/mobile phones	• emitted by warm and hot objects, and by TV remote controls or car locks • detected by skin and thermometers • too much infrared can burn the skin	• emitted by hot objects • detected by eyes and photographic film	• emitted from very hot objects including the Sun • causes human skin to tan but can also cause skin cancer • detected by photographic film	• go through flesh but not bone • used to look at bones inside the body • can cause cancer • detected by photographic film	• emitted from radioactive substances • used to sterilise medical instruments • can penetrate deep inside the body • can cause cancer

Use the chart to help you answer these questions.

1. Which wave has the shortest wavelength? _____
2. Which wave has a wavelength about the same size as an amoeba?_____
3. Which wave has the highest frequency?_____
4. Which wave has a wavelength as big as a skyscraper?_____
5. Which wave has the lowest frequency?_____
6. Waves with a high frequency have a _____ wavelength.
7. Waves with a low frequency have _____wavelength.

6 Energy and electromagnetic waves

All waves carry energy – which means that they are useful to us.

Match each use to a type of wave. One has been done for you.

killing cancer cells	radio
killing bacteria in the water supply	microwave
taking pictures of the inside of your body	infrared
broadcasting music	visible
taking photographs of people	ultraviolet
heat lamps for sore joints	X-rays
transmitting mobile phone signals	gamma

Some waves carry more energy than others – this can make them dangerous.

Complete the passage below using words from the box.

burn cancer energy frequency heating higher mutation sunburn

Radio waves have a low _____ and they don't carry a lot of _____

Waves with a _____ frequency have higher energy and can cause a lot of damage to human beings.

Microwaves can cause internal _____ of body tissues.

Infrared waves can cause your skin to _____ .

Ultraviolet waves can cause _____ .

Both X-rays and gamma rays can cause _____and _____ .

7 Investigating ultraviolet light and suncream

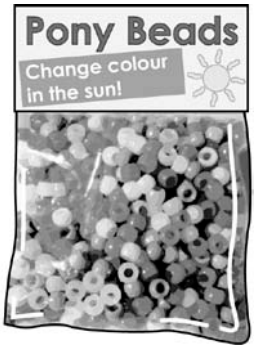
Write down what happens to people who have a pale skin when they are out in the sun for a long time.

_____

What do you think causes this to happen?

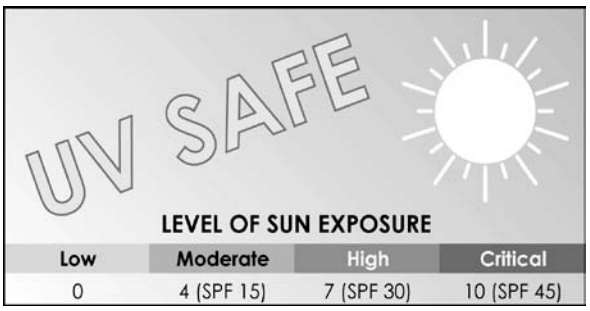
_____

In order to find out what causes this to happen, you can use some special beads instead of skin.



We also need:

- 2 suncreams that have different SPF values
- clingfilm
- a stopwatch or timer
- a sun-safe chart
- a results chart or camera to take photos



The correct method steps are listed below – but in the wrong order.

Indicate the correct order by putting numbers in the first column.
Some have been done for you.

1	Collect all the equipment
	Record the colour of each group of beads after 10 minutes
	Leave the beads out in bright sunlight for 10 minutes
	Cover each square with a different suncream
5	Put 5 beads under each square of clingfilm and place in bright sunlight
	Cut 2 squares of clingfilm
7	Record the brightness of the sun using a sun-safe chart
	Record the colour of the beads at the start
	Place 5 beads in bright sunlight
10	Sort the results in order

1. Which group of beads changed colour the most?

_____

2. What did the suncream do?

_____

3. What in the sunlight causes the beads to change colour?

_____

8 Invisible radiation

Waves that carry energy from their source to an object are called **radiation**.

Most of the radiation is invisible – we only know it's there because we can use something to detect it.

Complete the table below writing in the detectors and ticking the invisible waves (✓). Some have been done for you. You can use a text book or the internet to help you.

	Radio waves	Microwaves	Infrared	Visible light	Ultraviolet	X-rays	Gamma rays
Invisible?		✓		x			
Detector?	radio	mobile phone					X-ray film

Which is the only radiation that is *visible*? .....

There is another family of invisible radiation. It has three main members these are shown in the chart below.

Write in the shorthand symbols for each of these radiations. Use a text book or the internet to help you.

Name of radiation	Shorthand symbol
alpha	
beta	
gamma	

Every member of this family is dangerous to people. They can all damage cells in the body and cause cancer.

Use your text book or the internet to find out the answers to these questions.

1. Where do the names 'alpha', 'beta' and 'gamma' come from?

_____

2. What does 'ionising' radiation mean?

_____

3. What can we use to detect these radiations?

_____

9 Radiation lab

Some students used a computer program called *Radiation Lab*. The program lets them investigate three radioactive sources.

Write down the three types of ionising radiation.

Al_____ **Be**_____ **Ga**_____

Their teacher said it was much safer to use the program than actually do the experiments.

Explain why it is not safe to do an experiment using radioactive sources.

_____

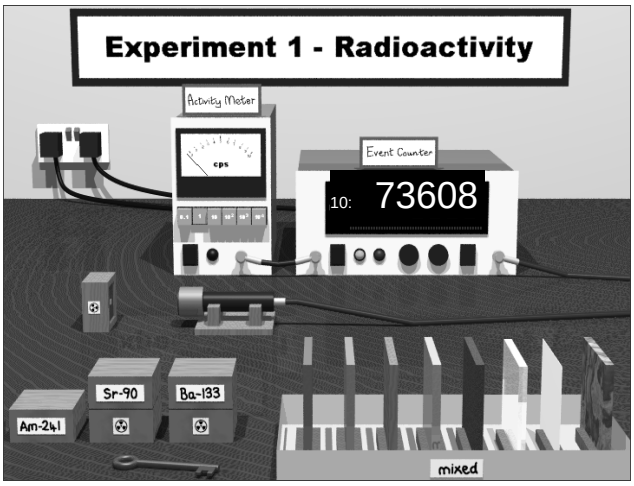
_____

What precautions should a person take when using radioactive sources?

_____

_____

This diagram below shows the program. The students changed the distance from the source to the detector in their first experiment. They showed their results in a table.



Source	Distance (cm)	Time (s)	Count
alpha	6	10	73597
	12	10	10
beta	6	10	73570
	12	10	40899
gamma	6	10	12101
	12	10	3335

Use the results table to answer these questions.

1. Which source has the shortest range? _____
2. What happens to the count from each source as the distance is increased?

_____

3. Which source gave the biggest reading? _____
4. What did the students keep the same all the way through the experiment?

_____

Another group of students used the same program to investigate what happens when you put a material between the detector and the source.

These are their results for a beta source and a gamma source.

Source	Material	Count	Distance (cm)	Time (s)
beta	air	73600	6	10
	paper	68100	6	10
	plastic	450	6	10
	aluminium	10	6	10
	lead	11	6	10
gamma	air	12100	6	10
	paper	12100	6	10
	plastic	11300	6	10
	aluminium	10000	6	10
	lead	5400	6	10

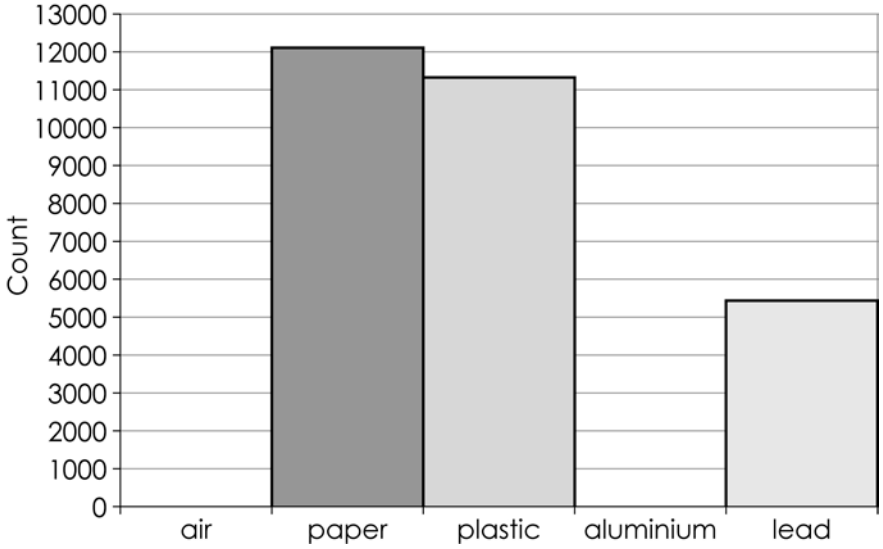
What materials stop beta radiation?

_____

What materials stop gamma radiation?

_____

The students started to draw a bar chart about the gamma radiation. Complete it.



What **two** things did they keep constant during their investigation?

_____

Complete a pattern sentence for this investigation:

The heavier the material, the less _____

Revision questions

Write down **two** instruments that use lenses. Say what you use each instrument for.

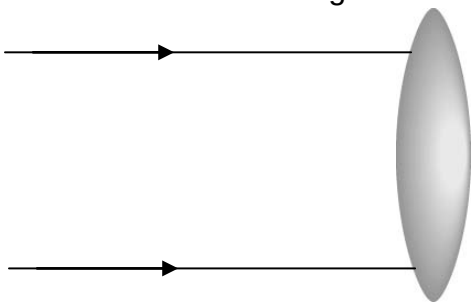
An instrument with **one** lens is a _____

It is used for _____

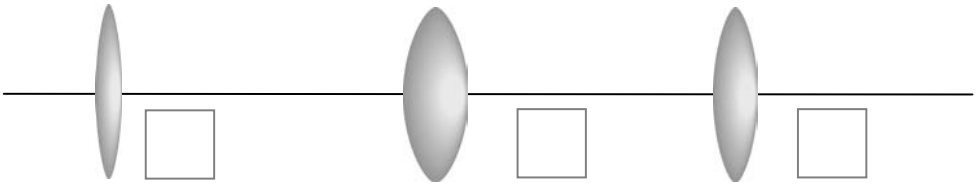
An instrument with **two** lenses is a _____

It is used for _____

Complete this diagram to show what happens to the rays of light as they pass through a lens. Mark in the focal length of the lens.

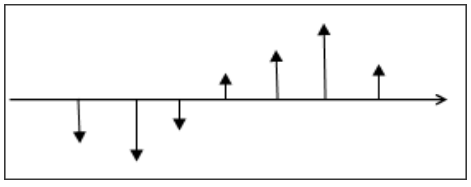


Which of these is the strongest lens? Put a tick in the box next to the lens.



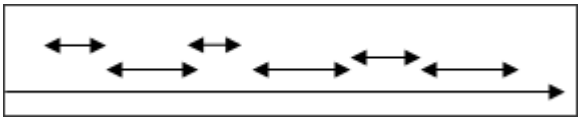
Write the name of each type of wave under its description.

Choose from'sound' wave or 'water' wave.



When the wave moves from left to right, the particles vibrate up and down

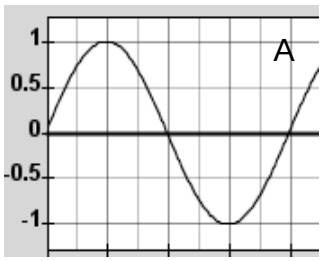
_____

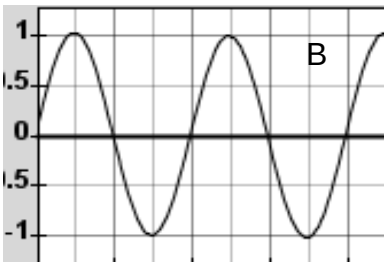


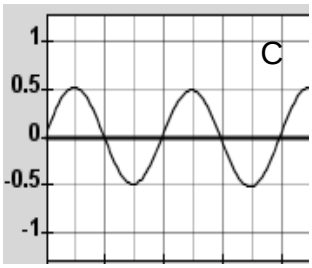
When the wave moves from left to right, the particles vibrate from left to right

_____

Look at these diagrams of waves and answer the questions below.



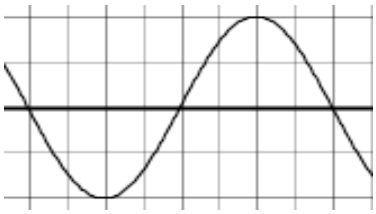




1. Which two waves have the same wavelength?
2. Which wave has half the frequency of wave B?
3. Which two waves have the same amplitude?

On this diagram of a wave (right), mark:

- a crest with a C
- a trough with a T



4. What is the physics word for 'pitch'? _____

5. What does the 'amplitude' of a sound mean?

_____

6. What can we use to make a spectrum of colours in a laboratory?

_____

Which of the colours below can be found in a spectrum of white light? Put ticks (✓) under colours that are in the spectrum and crosses (✗) under colours that are not.

Some have been done for you.

red	blue	pink	grey	green	violet	brown	black	indigo	yellow
				✓			✗		

Use the words below to complete the chart of the electromagnetic spectrum.

gamma **microwave** **ultraviolet** **visible**

radio		infrared			X-rays	

What can we use to detect ultraviolet radiation? _____

What do all waves carry? _____

WAVES AND RADIATION

Some electromagnetic waves are harmful. Name one type of radiation and say how it can harm you.

Name _____ How it can harm _____

Write down uses of these waves:

- microwaves for _____
- X-rays for _____
- gamma waves for _____

Which type of electromagnetic wave:

- has the longest wavelength? _____
- has the highest frequency? _____
- has the least energy? _____
- can cause the most harm to people? _____

Which of the words in the box can be used to describe radiation from a radioactive source? Draw a circle round the correct words.

alpha	**beta**	**gamma**
infrared	**invisible**	**ionising**
low energy	**radio**	**sound**
visible	**ultraviolet**	**microwave**