Name:

Junior Science

Light and Sound

Downloadable Resource

Tina Youngman

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Published by ABA Resources Ltd.
Cover and inside pages designed and typeset by Celeste Thomas.

Hearing Impairments

There are many ways that a human's hearing can be impaired. This article will focus on two main types that cover most of what we experience in terms of hearing loss.

Conductive Hearing Loss

This is an inability to **conduct** (pass along) sound waves from the outer ear through the ear drum to the middle ear. **Conductive** hearing loss can be **temporary** or **permanent** and ranges in its severity from mild to complete deafness. Some causes include:

- Build-up of ear wax
- Ear infection
- An object blocking the ear canal
- **Abnormal** bone growth in the middle ear
- Tumour in the ear canal or middle ear
- Burst ear drum
- Fluid build-up in the middle ear
- Narrow ear canal

All of these things prevent the sound wave vibrations from being passed from the outer ear to the middle ear, so hearing either doesn't occur or it is limited. Some of these causes have simple treatments such as removing excess wax or treating the infection but others are not so easy to fix and require complicated surgery. Some internal and external hearing aids can be used, with the most effective being bone conduction hearing aids which bypass the outer and middle ear taking sound waves straight to the cochlea.

Case Study One: Phyllis, a 37-year-old Dental Hygienist

Describe your hearing loss: I am completely deaf in my right ear. I lost my hearing overnight suddenly and it was very frightening. It has taken me many years to get used to the hearing loss.

When did the hearing loss occur? I was 25 years old.

What caused you to lose your hearing? A virus in my brain formed a blood clot. The clot eventually dissolved but the lack of oxygen in the auditory nerves meant that the nerves connecting my ears to my brain no longer functioned. My ears and brain were fine, they just didn't connect. A bit like having a computer and a mouse but no connecting wire.

What type of hearing loss do you have? Nerve damage.

Are there/have you had any treatments for the hearing loss? No.

What is the most difficult thing about having a hearing impairment? The most difficult part is twofold. Getting a sense of direction when you hear a noise. Even crossing the road is hazardous as you don't know where the cars are. Secondly, it is very difficult to hear people speaking if they are on my deaf side. I have to stare at them and watch their lips moving. Quite often I don't quite get what they are saying but am too embarrassed to ask, so I just fill in the blanks myself.

Sensorineural Hearing Loss

This is due to problems in the nerves, inner ear or brain that can result in mild hearing impairment through to total deafness. The ear conducts sound waves as normal but the electrical messages either are not made properly, do not reach the brain or they cannot be interpreted inside the brain.

Sensorineural hearing loss includes the standard age related decline that we will all experience. From the ages of 25-30 a human's hearing starts to **deteriorate** and we lose the ability to hear higher pitched sounds. This is a natural decrease usually due to the damage that higher pitched sounds do to the workings of the inner ear over time. However, excessive noise is the most common cause of this type of hearing loss and a recent medical report states that 16% of teenagers have some form of hearing loss from the constant exposure to loud music via headphones. This occurs because the tiny hairs inside the cochlea that turn the sound energy into **electrical impulses** are easily damaged and destroyed by loud noise and once they die they never grow back.

Apart from age and loud noises, there are many other causes of hearing loss, such as:

- Birth **defects**
- Brain damage
- Limited blood flow
- Drugs
- Viruses like measles
- Meningitis
- Brain tumours
- Head injuries

Hearing aids can be used to help some people with sensorineural hearing loss. These small devices can be worn inside the ear opening and **amplify** sounds at the **frequency** that the person's own hearing doesn't respond to. So, for age related deafness, the hearing aid would be set to increase the volume of higher pitched sounds.

Case Study Two: Lionel, a 68-year-old Farmer

Describe your hearing loss: I have been getting steadily worse and worse over the years. High pitched noises are almost impossible to hear (like the phone ringing and doorbell chiming) and I also find it hard to hear when there are lots of people talking at once or if there is loud music playing. My family sometimes have to tell me to stop shouting as I try to be heard. The thing is, it is actually just me that can't hear!

When did the hearing loss occur? Over the last 15 years or so but I have really started to notice it more over the last 5 years.

What caused you to lose your hearing? My job as a farmer involves working with lots of loud machinery and vehicles. The milking shed machinery is really loud and while milking I am always close to the machinery. I have been farming for 50 years so that is a lot of time spent near loud machinery. Back in my day, we never thought about wearing ear protection so would mow the lawns, use the chainsaw and drive the tractors with no ear muffs. No doubt all that noise caused some damage.

What type of hearing loss do you have? Age-related I suppose because as I am getting older, it is getting worse.

Are there/have you had any treatments for the hearing loss? To help me hear, I am supposed to wear hearing aids in both ears when I am around other people. I never used to wear them but nowadays I need them more and because they are much smaller and more effective now, I don't mind so much.

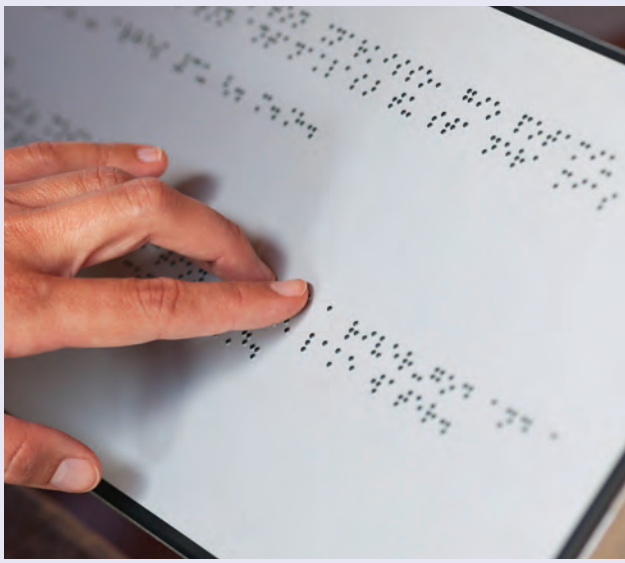
What is the most difficult thing about having a hearing impairment? I am still farming and lots of my day is spent on my own, so that doesn't matter too much. The worst part is not being always able to hear my family and not quite getting the whole conversation when with friends. My bad hearing really annoys my wife who has to shout and repeat herself when I am not wearing my hearing aids.

Many technologies can be used to treat deafness and hearing loss and the advances being made each year are **astounding** but it is still a difficult issue to fix.

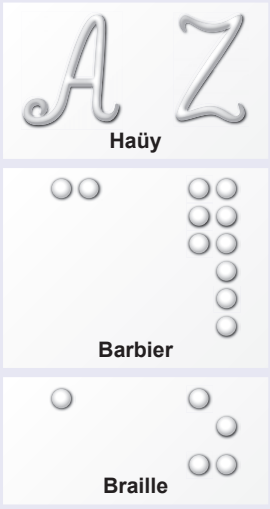
If you have hearing that is in good working order then look after your ears now and reduce the amount of damage being done by loud noises through limiting your exposure to it and using ear protection when possible.

Prevention is the best method of treatment. Stop the damage before it starts!

Louis Braille



In the early 1800's, Charles Barbier developed a special type of writing for soldiers to use in the dark. It was called night writing. It consisted of 36 different sets of 12 **embossed** dots and dashes placed into two columns that represented different sounds of the French language. He designed it so that soldiers wouldn't need to use lights at night in order to read **communications**. This system failed and wasn't really accepted by the army because it was too difficult to learn. Another key reason why it wasn't used was that it required the reader to shift their finger over each individual symbol in order to interpret what the symbol was, this made it very hard to read and often people forgot the first part of the symbol before they felt the second half. Even though it never took off, his idea wasn't a bad one and he never gave up on it. While he was visiting the French Institute for the Blind, he met a fifteen year old blind boy who took his idea, developed it further and gave people with poor eyesight the ability to read and communicate with the written word.



The three types of writings developed for the blind, showing A and Z.

That boy was Louis Braille. At the age of three he suffered an accident in his father's workshop where an **awl** (sharp pointed metal tool for forming holes in materials like leather) he was playing with, slipped and caused severe damage to one of his eyes. Over the following weeks an infection set in and this lead to both his eyes being affected. By the age of five he had gone completely blind in both eyes. He was a bright boy and through his determination and **perseverance**, gained a spot in the first school for the blind in France. Here they had special books that had been designed by the school's founder Valentin Haüy. These books had raised letters of the alphabet that spelt out words and then sentences. The reader ran their fingers over each letter to spell out each word which was a very slow process. It would be like having one letter on each page of a book and having to spell the words as you turned the pages. Not only were they slow to use but they were also large and heavy due to the large amount of space that each symbol took up, so there would be very few words on a single page. Each letter was bent from wire then pressed under wet paper in the correct order, so that it dried in a raised **fashion**. Because the books were all hand-made they were very expensive and even the school where the designer worked only owned a few. Braille became determined to develop a system which was much simpler and accessible to all vision-impaired people. Eventually he learnt of Barbier's system and spent much time thinking about how it could be improved. The two previous systems (Barbier's and Haüy's) had been designed by people who could see and Braille felt that this was why their success was so limited.

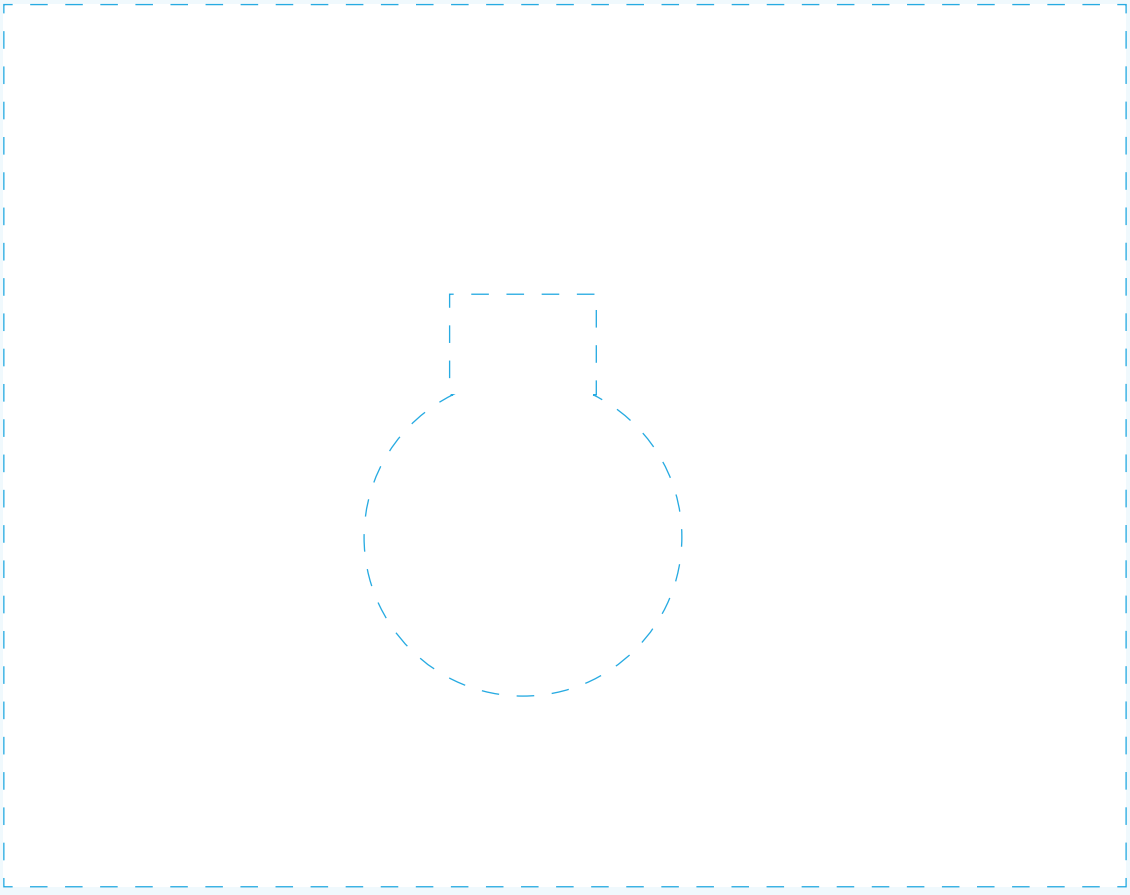
Braille, who had now started working at the school for the blind as a teacher's aide, started simplifying the night writing system and reduced it to a series of 6 dots in two equal columns. The smaller size meant that each letter could be read with one touch of a single finger, making reading much faster. Because each symbol was much smaller, it allowed for greater volumes to be written and many more symbols could fit per page. He released his first edition of braille at just fifteen but this included dots and dashes which he found to be too difficult to interpret. By 1837 he had published his second edition of the system (without dashes) and it was starting to become more common but still not widely used. In fact, the school where he worked refused to use his system until well after he died. Braille also developed a way of writing in braille by pressing the paper with a blunted awl. This meant that poor-sighted people could now also write as well as read.

In 1932, long after he had died, Braille was finally **universally** accepted and an English code was developed. Today, developments in technology have made braille even easier to use and have kept it alive with the dramatic changes in human life such as the creation and acceptance of computers. There are printers that print braille, braille terminals and even an application called RoboBraille. Braille terminals are computers without screens (a person with a vision impairment can't read from a screen). They have a flat surface, similar to a keyboard, that has pins that **protrude** forming the braille symbols. This allows the user to read the information by running their fingers along the board. The symbols change as the information changes, which allows people to access the internet easily. RoboBraille is an email application that **converts** the text of an email into braille. Despite the development of other technologies such as talking computers, the use of braille as a **tactile** language has continued to be widely used. Louis Braille opened the world of the written word to thousands of people who would have otherwise been in the dark.

My Human Eye

1. Follow the instructions below to make your own human eye.
   a. Cut out parts A-E by cutting along the dotted lines and discarding all of the blue-coloured sections.
   b. Colour the blood vessels shown on the retina red.
   c. Glue part A in place to the marked area in your workbook.
   d. Cut out small circles of plastic to cover parts 5 and 11 that you cut out – make sure they are slightly larger than the hole. Glue around the back of 6 and 10 and attach the plastic to the backs, to provide a transparent layer.
   e. Colour part 8 the same as your eye's iris colour, the eyebrow and eyelashes the same as yours and the inner eyelid and tear duct in pink.
   f. Glue the back of the tab on part B and stick this over part A in your workbook so that it can fold up.
   g. Glue the back of the tab on part C and stick this over part B in your workbook so that it can fold up.
   h. Glue the back of the tab on part D and stick this over part C in your workbook so that it can fold up.
   i. Lastly, glue a strip along one edge of part E and place it over the rest of the eye so it can be folded open and closed.

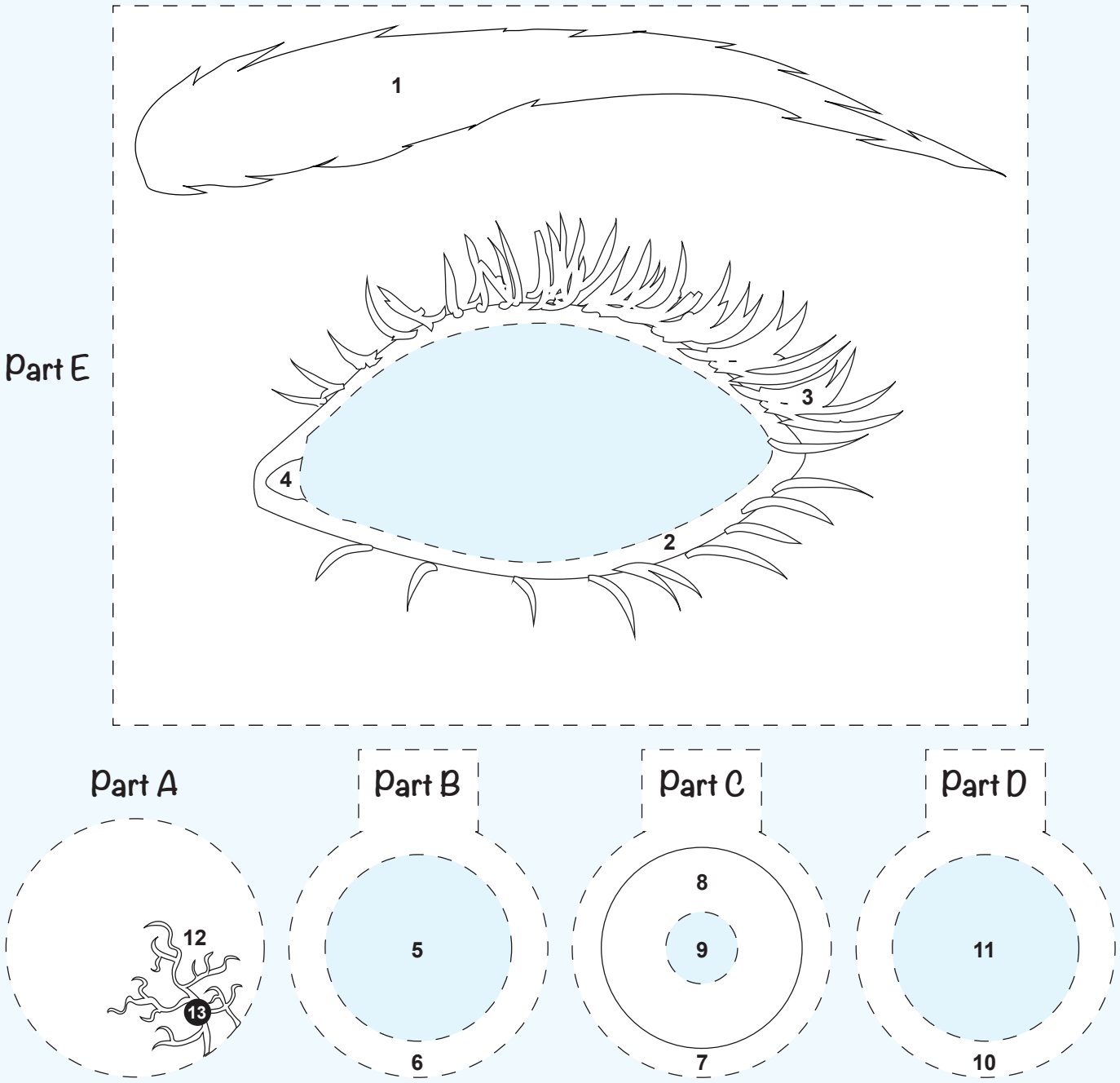
Key	
1	eyebrow
2	inner eyelids
3	eyelashes
4	tear duct
5	cornea
6	sclera
7	sclera
8	iris
9	pupil
10	sclera
11	lens
12	retina
13	blind spot



2. Use your model to answer the following questions.
   a. Between which two layers is the aqueous humor found? A B C D E (Circle your answer.)
   b. Which is the layer most associated with sight? A B C D E (Circle your answer.)
   c. There are four parts that refract the light coming into the eyeball. These include the aqueous humor, vitreous humor, _____ and _____.

3. Use the part names from the model to match them with their key function.

Part/s	Function
	The tough white layer that gives the eyeball shape and protection.
	Transparent covering part at the front of the eye that allows light to enter and also prevents other substances entering.
	Muscular ring that opens and closes, making the size of the pupil bigger or smaller. It is the coloured part of the eye.
	Hole that lets light into the eye and changes size depending on light levels.
	Globular shaped part that refracts light so it focuses onto the retina. Its shape is changeable in order to help vision become clearer when looking at near or far objects.
	Contains rods and cones that detect light and transform the information into electrical impulses that can be interpreted by the brain.
	Area lacking rods and cones, so doesn't respond to light.
	All protect the eye by stopping foreign substances such as dust and water from entering the eye.
	Tube that carries tears to the eye so that they can be used to rinse the eyeball and keep it lubricated.



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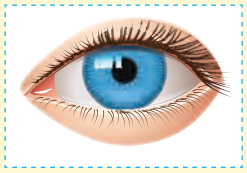
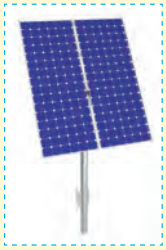
Light

These are usually shiny, smooth, opaque surfaces that allow light rays to bounce off. An image can be seen in them, especially if their surface is smooth and shiny.



These can sense light and in some cases react to it. They can come in many forms such as chemical, electrical and biological. The chemicals in film react when exposed to light and they produce an image.



These produce light energy usually by transforming another type of energy such as chemical into light. The Sun transforms nuclear energy into light.

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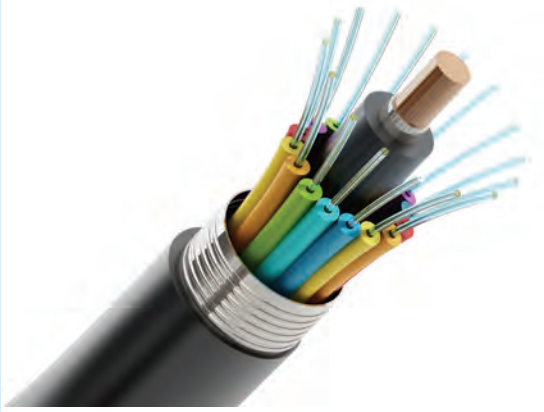
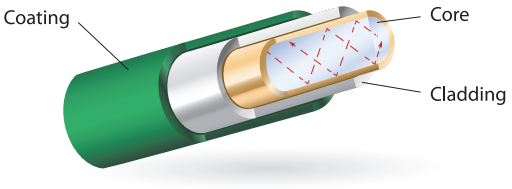
Fibre Optics

When you use the internet or a landline phone you are most likely using fibre optics. 'Fibre' refers to a filament or hair-like structure and 'optics' to light energy. In simple terms, this is a form of communication that uses light energy to transmit messages through thin tubes, by sending pulses of light. The benefits of this method are that data and information can be sent quickly over long distances in a very efficient way. The structure of a fibre optic cable is very important as it allows the light to bounce along in a controlled manner without being lost or absorbed along the way. There are four key parts to the cable:

1. **Thin glass strands**: Only as thick as a human hair and are bundled together to make a light-channelling core. Glass is transparent so it allows the light to move through it.
2. **Cladding**: A layer composed of silica acts as a giant reflector around the glass core. This bounces the light back in so no light (data) is lost.
3. **Plastic fibre-filled coating**: This protects the cable and allows it to bend. It is only semi-flexible because the glass would break if the cable was bent too much.
4. **Cable jacket**: A waterproof, rubbery plastic layer that adds further protection and holds the internal structures together.





It might seem weird that messages made of light can bring you the internet or a phone call but that is exactly how this marvellous system works. The data or information is entered into a transmitter which converts the electrical signal into a light energy signal. The information is produced by changes in strength and pulse speed. It then bounces through the core of the cable much the same as the light from a torch shone down a dark narrow pipe, except that the cladding stops any losses along the way. If the data has to move a very long distance then it will go through an optical regenerator. This boosts the light energy by copying the message and sending a more powerful (re-energised) duplicate. When the signal reaches its destination it is decoded and turned back into a format that can be understood by whatever device it has been sent to (e.g. computer or telephone). When you search something on the internet, let's say 'dancing cats', coded light is sent speeding off at around 300, 000 km/s to bring you a result.

The use of fibre optics allows quick, speedy data communication much faster than previous methods. The precursor to fibre optics was copper wire. Data was sent as a series of electrical impulses through the wire. This is comparatively slow and also there is a high rate of data loss along the way, making it much more inefficient. Apart from its main function in the world of communication, it is also used for lighting and viewing the inside of a person during surgery due to its small flexible nature. This has eliminated the need for some large cuts to be made and has allowed surgery to occur in some delicate, complex, hidden places like deep in the brain. Because the surgery is far less intrusive, people heal a lot faster. Machinery can also be inspected easily without having to take it apart. Fibre optics is being used to look inside intricate machines for faults and to check on wear and tear. While fibre optic cabling is very expensive and can break easily if not properly cared for, the positives of speed, efficiency and quantity of data carried far outweigh the costs.

Optical Illusions

Either select **two** different optical illusions from the list provided by your teacher or find two different illusions yourself. Then use the internet to find out the following information about each illusion.

- Name of illusion.
- Type of illusion.
- History of illusion.
- Picture of illusion.
- Explanation of how it works.
- Other interesting information.

Illusion One

Illusion Two

Mirror Maze

Introduction

You are trapped in the dungeon of an evil, mad, insane science teacher for not doing your homework. You are strapped tightly to a table and have only limited movement in your hands and feet. Your shackles and the exit door are controlled by a control panel beside the exit door. The control for your shackles is a light detector that the mad science teacher uses a small laser to operate. Luckily for you, you also have a small laser pointer that you borrowed from your friend but unluckily for you, you can't angle your hand to hit the sensor switch.

But not all hope is lost! The science teacher has lots of mirrors positioned around the room fro the crazy experiments they conduct. You know that if you hit the correct mirror, the angle should be able to send your laser beam around the room off the other mirrors back to the sensor switch.

Experiment

You Will Need

Light/ray box, single light slot and a flat mirror.

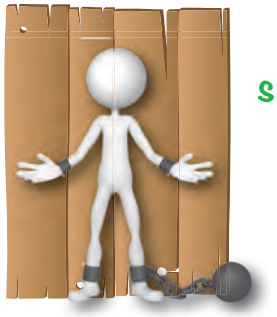
Method

1. Position the light box at the start so the light ray passes through the green dot.
2. Place the mirror onto one of the lines shown with a related letter.
3. Move the light ray so it hits your mirror on the dot given. It should travel to another lettered mirror.
4. Your mission is to keep moving your mirror and light box so that the light travels from mirror to mirror in the correct order and reaches the sensor switch at the exit.
5. As you go around the room, record the order of letters in the results table below.

Results

Start	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Exit



start

H

R

A

S

E

X

B

T

exit

M

Y

Word Games

1. Terminology Tornado

Using the following science term, see how many words of 3 or more letters you can make in 10 minutes.

Points
3-4 letters = 1 point
5+ letters = 2 points

Scores
0-5 points = awful
6-10 = average
10+ = amazing

2. Six Word Scramble

Use the clues to work out what the 6 key science words are and then spell the word in the grid by colouring in the squares that make up the word. Use different colours for each answer.

MAL	PLI	ER	NDS
DE	QUE	ELS	AM
CIB	GY	BE	NOR
EN	DE	OPA	TU

Clues

a. The height of a sound wave. (9) _____
b. Light and sound are both types of this. (6) _____
c. Units of loudness of sound. (8) _____
d. When light enters a more dense material it … (5) _____
e. The imaginary line 90° to a flat mirror. (6) _____
f. The opposite of transparent. (6) _____

3. Block Buster

Cross out each of the words that fit with one of the clues. You will be left with one word that doesn't fit; this is your answer.

lens cochlea optic nerve blind spot green aqueous humor
red eardrum ultraviolet sclera pinna oval window
indigo iris blue malleus tympanic membrane stapes
retina orange violet yellow fovea cornea

Clues

a. Parts of the human ear.
b. Parts of the human eye.
c. Parts of the visible spectrum.

Answer

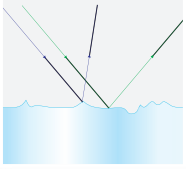
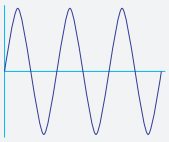
4. Lingo Lattice

All of the answers to the questions are in the lattice below, either as a word or picture. Once you have found each one, there will be one left over, this is the final answer.

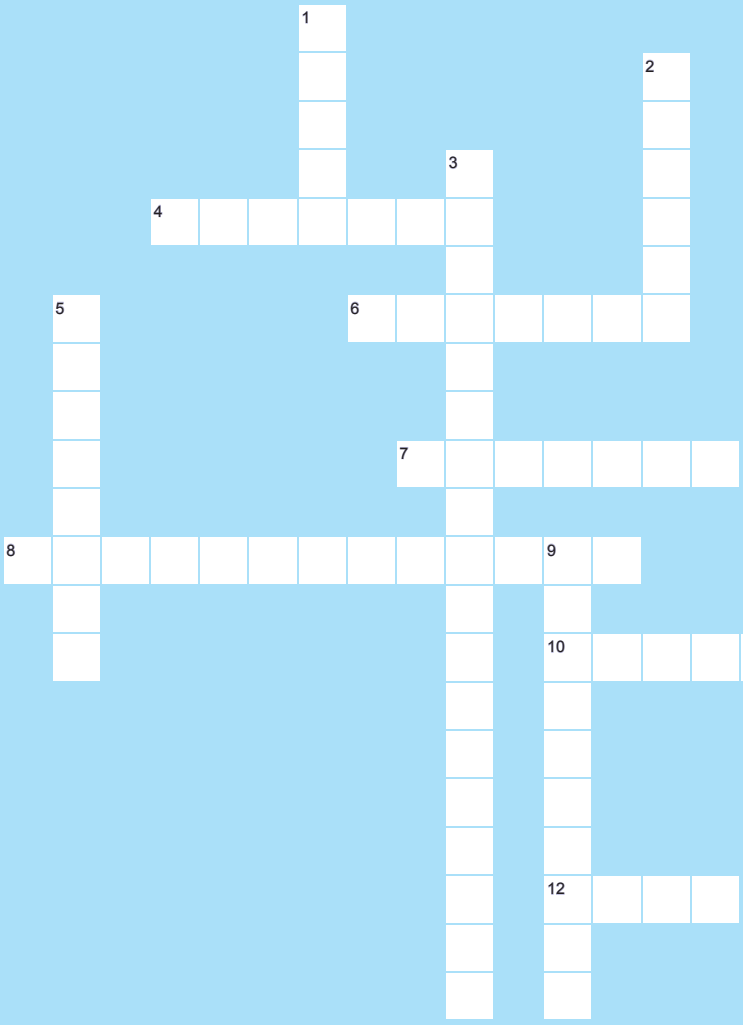
Questions

1. Diffuse reflection.
2. If the angle of incidence is 80° then the angle of reflection would be …
3. The name of the light ray hitting the mirror's surface.
4. An example of refraction.
5. The noise produced with a short wavelength.
6. Used to correct hypermetropia.
7. Light energy that has a longer wavelength than red light.
8. A loud sound.
9. Has trouble seeing objects in the distance.
10. An object that light rays bounce off.
11. How an object appears on the back of the retina.

Final Answer

80°		high pitched
incident	concave	
	infrared	myopia
upside down	reflector	

5. Crossword



Across

4. When light rays spread apart, they are said to …
6. This is made when white light is dispersed in a raindrop.
7. Special bumps and dips that blind people can read with their hands.
8. A thick solution that gives the eyeball its shape.
10. Releases tears into the eye.
12. Part of the retina.

Down

1. The colour of natural sunlight.
2. The area where light has been blocked by an opaque object.
3. Part of the ear involved in balance.
5. If refraction is light bending, then reflection is light …
9. Carries messages from the eye to the brain.
11. Made when you combine equal amounts of green and blue light.