Kirkcaldy High School

BGE Science

Medical Science

The EM Spectrum and Light

Name:_____

Class:_____

Teacher:_____

Expectations and Outcomes Learner Evaluation
Topic: EM Spectrum and Light

Outcomes	**Date completed**	**Evaluation: How happy are you with this? (☺ ? ☹)**
I can state that waves have a wavelength.		
I can state that light is a wave.		
I can state that light is part of the electromagnetic spectrum.		
I can state that shorter wavelengths of EM Waves have more energy.		
I can state a use for each part of the electromagnetic spectrum.		
I can state what a thermogram is.		
I can explain how infrared is used in medicine.		
I can state the uses of ultraviolet light.		
I can explain the term fluorescent.		
I can state that ultraviolet can be used to treat some skin conditions.		
I can state the dangers of overexposure to sunlight.		
I can explain how to protect yourself from the damage caused by ultraviolet.		
I can explain what the sun protection factor number on sunscreen means.		
I can explain how we can use X-rays.		
I can describe how an X-ray photograph works.		
I can identify bones in an X-ray photograph.		
To state that light travels in straight lines.		
To state that objects either give out light or reflect it.		
I can state the rule of reflection.		
I can describe some applications of reflection.		
To state that refraction is when light changes speed when travelling from one material to another.		
To state that refraction can cause light to change direction.		
To investigate the refraction of light through convex and concave lenses.		

To identify applications of refraction, such as lenses to correct long and short sight.		
I can state the names and functions for parts of the eye.		
I can explain what the ‘blind spot’ is.		
I can describe how the pupil reacts to light.		
I can state that a visible spectrum is formed when light travels through a prism.		
I can state the colours of the visible spectrum.		
To learn how mixing colours can produce white light and other colours		
To learn what colour blindness is.		
I can describe how coloured light affects the appearance of different coloured objects.		
I can explain that our brain can be tricked by optical illusions.		

Date: _____

Visible Light

Starter

1. Name as many sources of light as you can.

_____

_____

_____

_____

Learning Intentions

- To learn how we are able to see objects
- To state that light travels in straight lines

Success criteria

☐ I can state that objects either give out light or reflect it

☐ I can explain how shadows are formed.

How do we see objects?

Light is often seen as narrow beams or rays and can only travel in _____ _____.

We see objects because they _____ _____ (emit) or they _____ light.

Task

Emit Light	*Reflect light*

Shadow Puppets

Aim: _____

_____

Method:

- Make a shadow puppet and leave it in a fixed position.
- Shine a light source onto your puppet.

Results:_____

_____

_____

_____

Conclusion:

Light travels in _____ _____ called rays.

Shadows form when light is _____ by an object.

Plenary: True or False

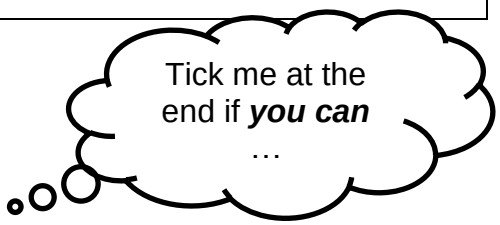
1. Light travels in **straight** lines. _____
2. Light can **pass through** any type of material. _____
3. We can only see objects that give out their **own** light. _____
4. A mirror is said to **reflect** light. _____
5. Objects blocking the path of light rays cause shadows. _____

Date: _____

Reflection

Starter

Objects which give out light	objects which reflect light



Learning Intentions

- To state the rule of reflection.
- To describe some applications of reflection.

Success Criteria

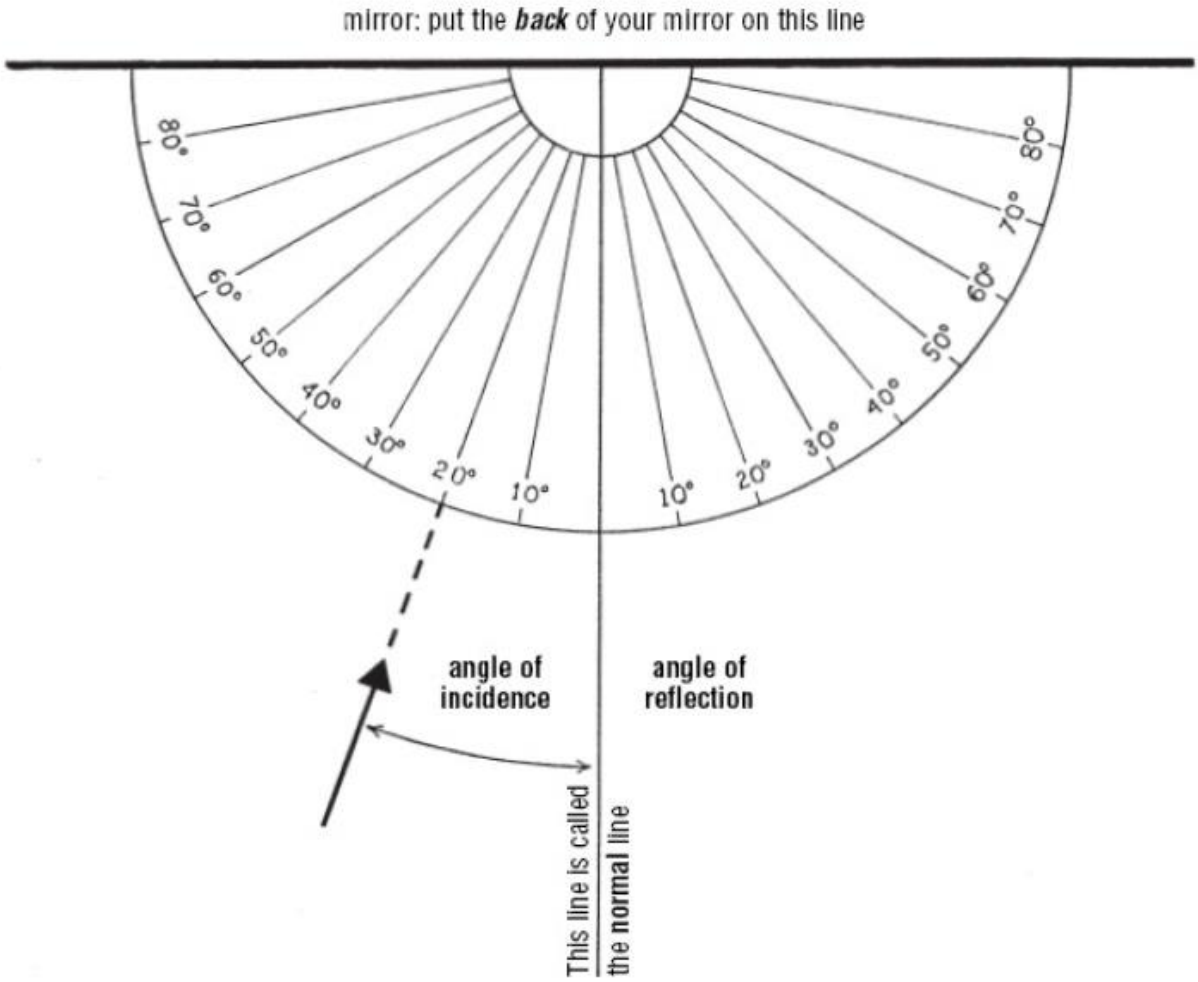
- ❑ I can explain the relationship between the angle of incidence and the angle of reflection.
- ❑ I can identify the terms: incident ray, reflected ray and normal.
- ❑ I can give examples of where I've seen reflected light.

Rule of Reflection

Aim: To investigate the relationship between the angle of _____ and angle of _____ using a plane mirror.

Method:

- Collect a mirror and a ray box.
- Shine a single ray of light against the mirror.
- Set the ray box to shine a single ray of light at an angle of incidence of 20˚ from the normal.
- Record the angle of reflection.
- Repeat with other angles.



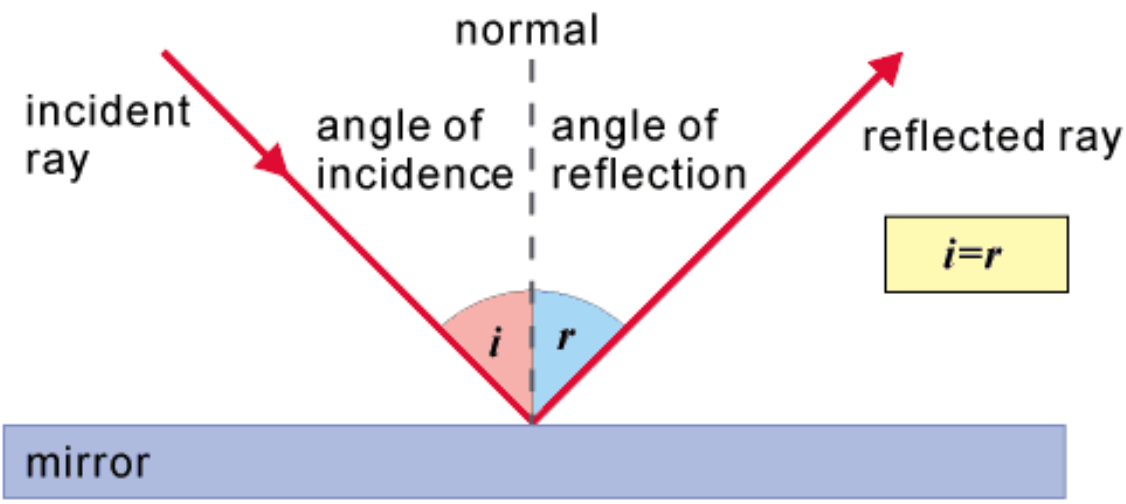
Results:

Angle of Incidence (˚) I	Angle of Reflection (˚) r
20˚	
30˚	
40˚	
50˚	
60˚	

Conclusion:

The **angle of incidence** is _____ to the **angle of reflection**.

Rule of Reflection Diagram



When light is reflected, the angle is always measured between the _____ _____ and the _____.

The normal is a reference line which is at _____to the surface of the block.

Using Reflection

The following objects use reflection in a useful way:

_____

_____

Extension task: *Questions to challenge your thinking:*

1. Why do you think mirrors are often used in telescopes?

_____

_____

2. If you were to design a room that uses the least amount of electric lighting during the day, how would you use the concept of reflection to your advantage?

_____

_____

3. Can you think of any animals or creatures that use reflection or light emission in nature? (Hint: Think about deep-sea creatures or insects that glow in the dark.)

_____

_____

Date: _____

Refraction

Starter

1. State the rule of reflection.

_____

2. What are the expected values for the matching angles of reflection?

Green = _____ Yellow = _____ Red = _____

Learning intentions

- To state that refraction is when light changes speed when travelling from one material to another.
- To state that refraction can cause light to change direction.

Success criteria

☐ To explain what happens to light when it passes through different materials.

☐ To explain what happens to light when it passes through different shapes

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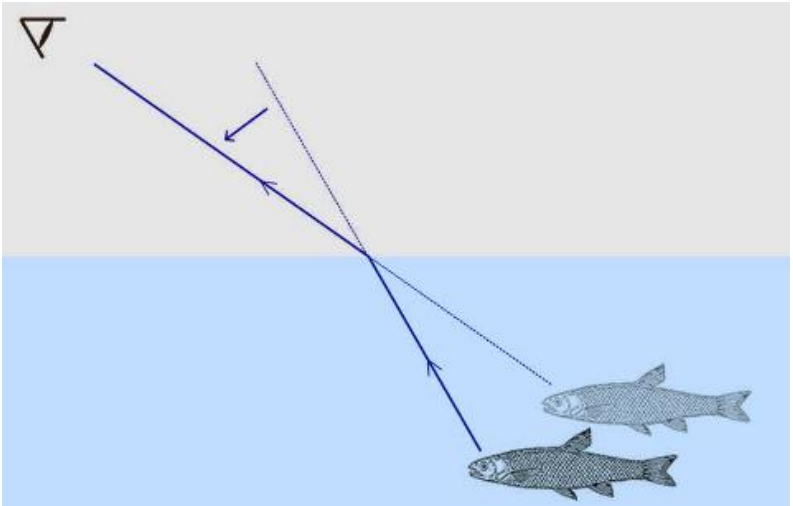
Refraction

Refraction is where light changes _____ when it moves from one _____ to another.

This often causes the light to _____and change _____.



Refraction Experiment

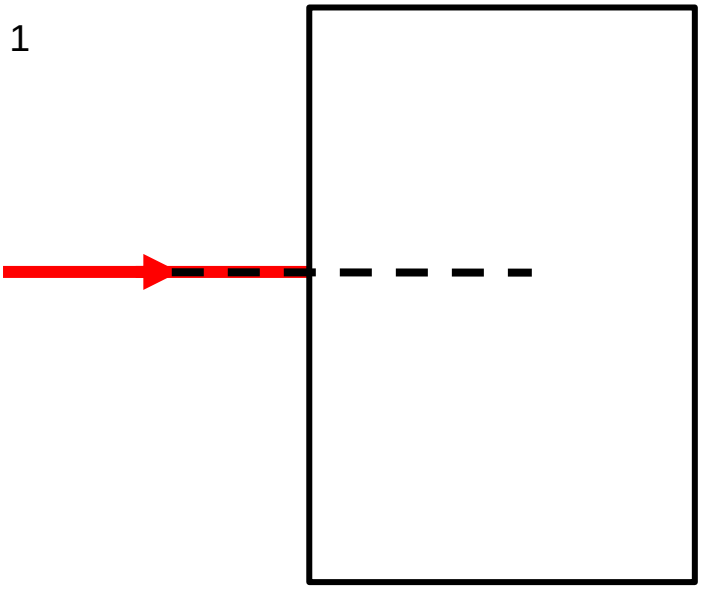
Aim: To investigate how light changes direction in two different shaped plastic blocks; a **rectangular block** and a **triangular block**.

Method: Use a **ruler** when you draw rays of light.

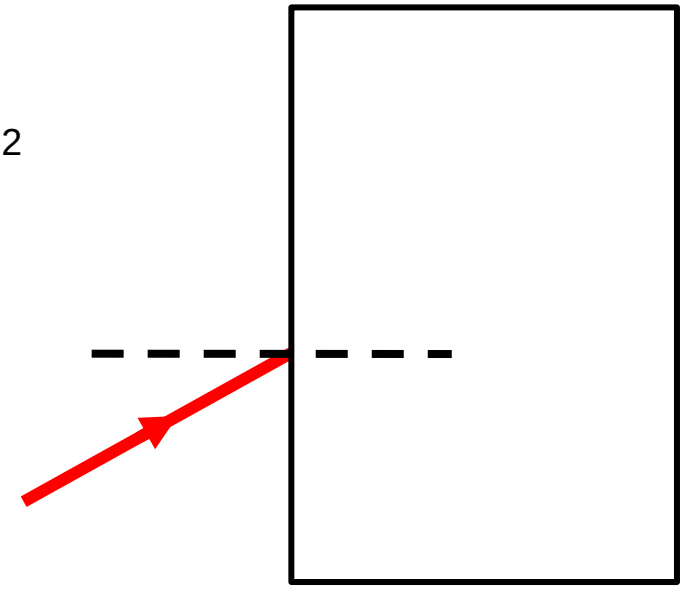
1. Draw around the block.
2. Draw a line to represent the incoming ray. This is called the incident ray.
3. Shine the laser through the glass block and mark where the beam of light exits the block.
4. Draw the ray of light as it leaves the glass block. This is the refractive ray.
5. Connect the rays together.
6. At the point of entry to the block, label the angle of incidence i and the angle of refraction r.

Results: rectangular block

1

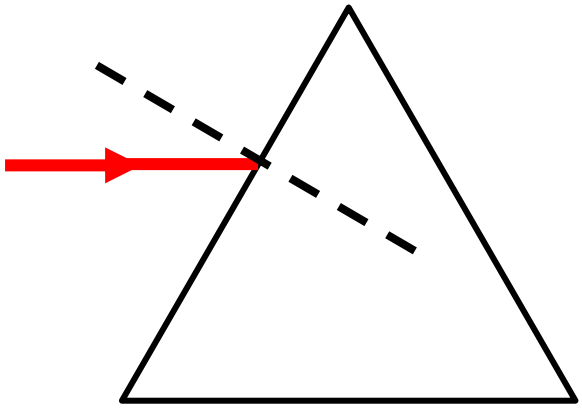


2



Results: triangular block

3



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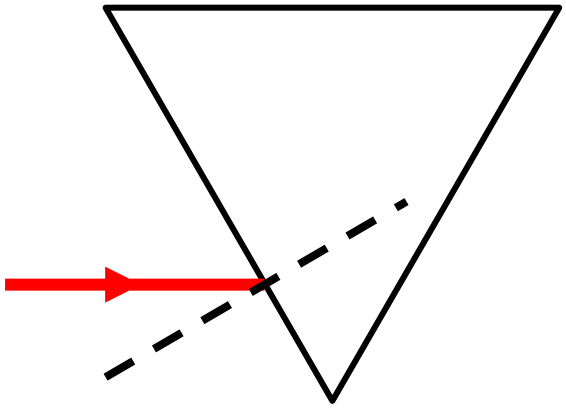


Conclusion:_____

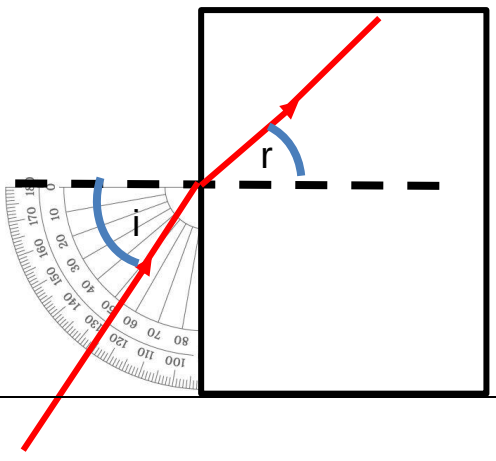
_____

_____

Extension Task

Using a protractor, measure the angle of incidence and the angle of refraction in diagrams 2, 3 and 4.

Example:

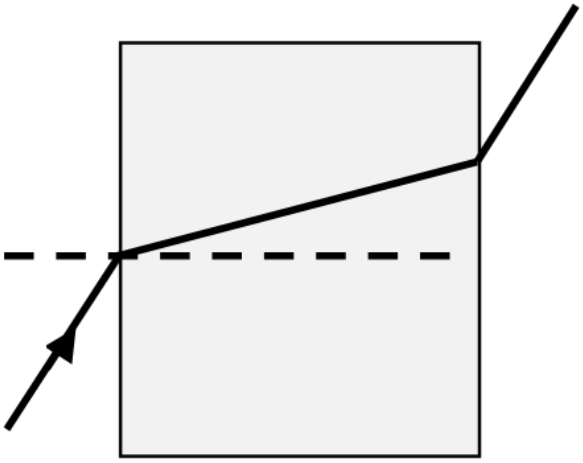


angle of refraction
r = 42˚

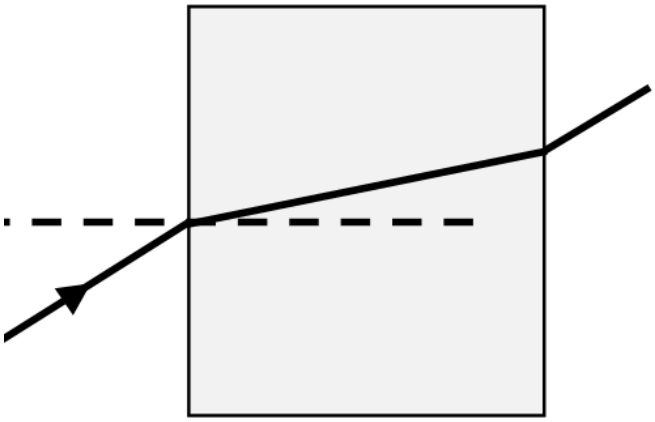
angle of incidence
i = 57˚

Extension Questions: Use a protractor to measure the angle of incidence and angle of refraction in each of the following diagrams, **<u>as the light enters the material.</u>**

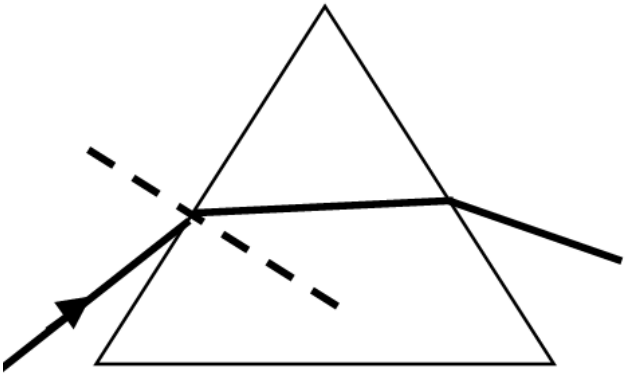
1



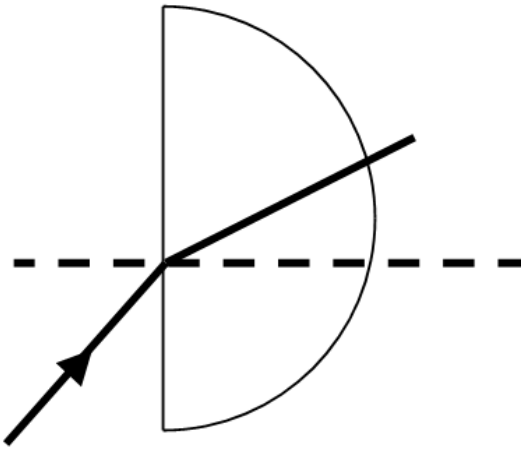
2



3



4



Date: _____

Lenses

Starter

1. State what is meant by “refraction of a wave”? (What is the “definition of refraction”?) _____

   _____

1. A pupil states that the direction of a wave always changes when it refracts. Is this statement true or false? Give a reason for your answer.

   _____

   _____

Learning intentions

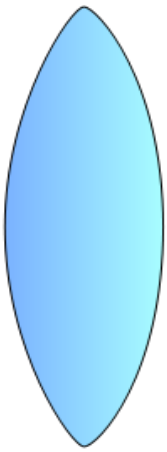
- To investigate the refraction of light through convex and concave lenses.
- To identify applications of refraction, such as lenses to correct long and short sight.

Success criteria

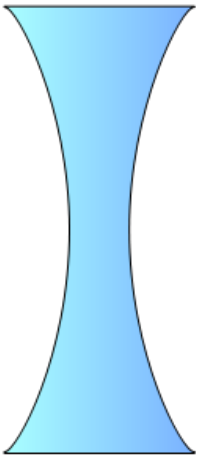
- ❑ To describe what happens when light travels through convex and concave lenses.
- ❑ To draw ray diagrams to show the effect of thick and thin lenses on light rays.

The Eye

Lenses bend light. They come in two basic shapes -



_____ ***or*** **converging lens**
(thicker in the middle than at the edges…)



_____ *or* **diverging lens**
(thinner in the middle than at the edges…)

Lenses Experiment

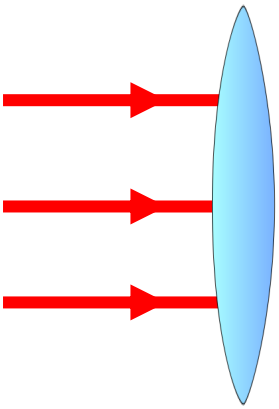
Aim:_____

_____

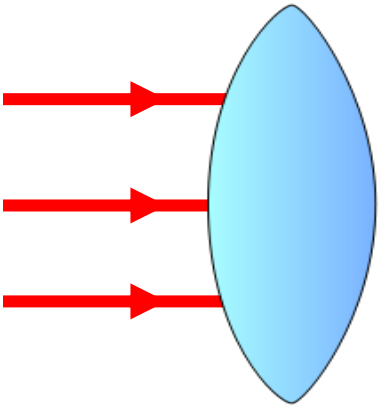
Method:

1. Using the ray box shine three rays of parallel light into each lens.
2. Draw around the lens and mark the path of the rays of light on both sides of the lens.
3. Repeat for each lens.

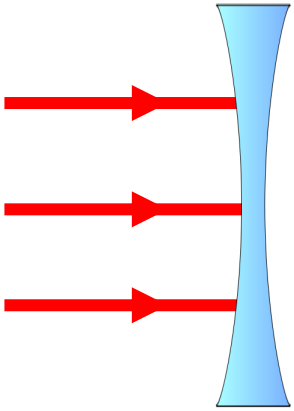
Results:



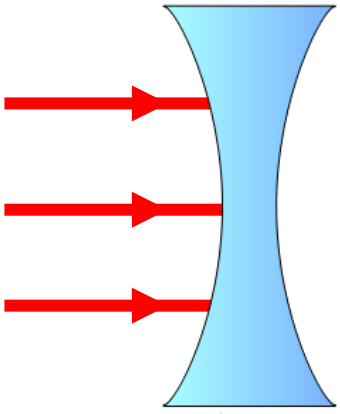
Thin convex lens



Thick convex lens



Thin concave lens



Thick concave lens

Conclusion:_____

_____

_____

Summary Note

_____ lenses bring the rays together to a focal point.

_____ lenses make the light spread out.

The more curved a lens is the _____ the effect on the light rays.

The thicker convex lens brings the rays to a focus _____ to the lens.

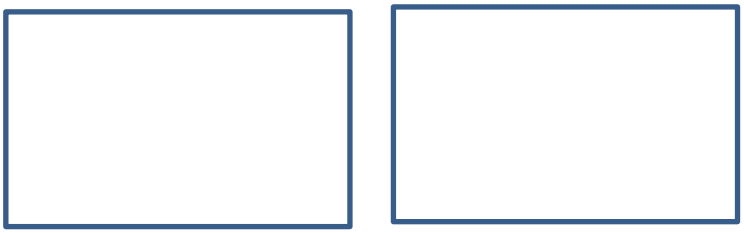
Plenary Question: Name **5** devices which use lenses.

_____

Date: _____

The Eye

Starter

1. The property of light is _____
2. The two lens shapes are 

Learning intentions

- To state the names and functions for parts of the eye.

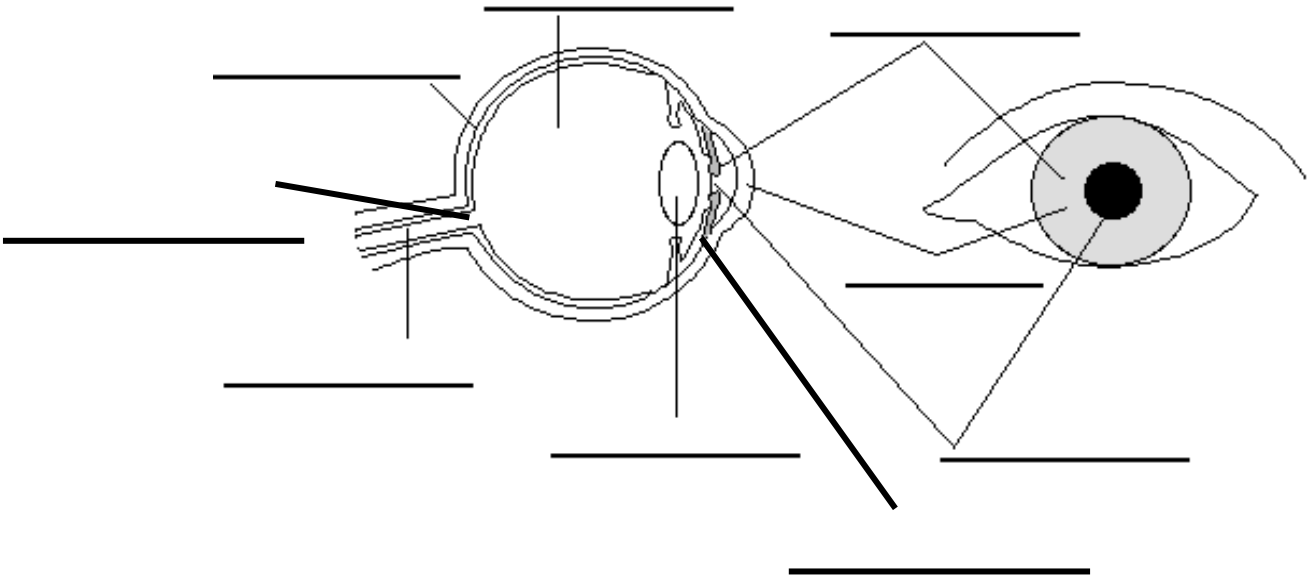
Success criteria

☐ I can state the names and functions for parts of the eye.

☐ I can explain the job of the lens.

The Eye

Fill in the parts of the eye from the board:

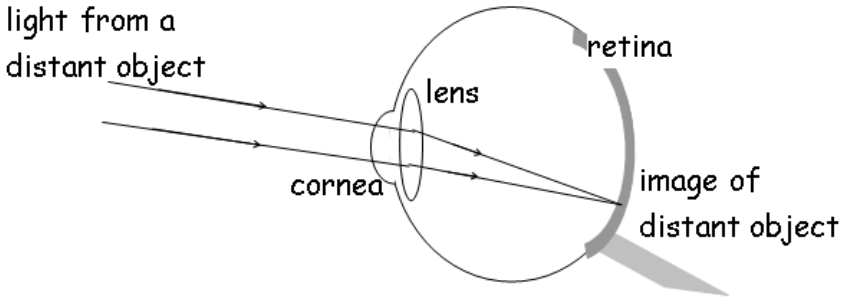


Put these words in the parts column under 'My Try'. Match them to the correct function.

Parts		
My Try	**Correct**	**Function**
		A hole which lets light through.
		Coloured part of the eye and controls the size of the pupil.
		Shape can be changed to focus the light.
		Receptor cells which convert light into electrical impulses.
		Transparent layer at the front of the eye which helps focus the light.
		A place on the retina where there are no receptor cells.
		Sends electrical impulses to the brain.
		Changes the lens shape to focus the light on the retina.
		A gel like substance which helps maintain the round shape of the eye.

Summary: How do we see?

Light from an object will enter the eye. This light is focused by the _____and _____. An image is produced on the _____ at the back of the eye. Special cells detect the light and send a signal to the _____.



Date: _____

Colour

Starter

1. The _____ turns light into electrical impulses
2. The _____ controls the size of the pupil
3. The _____ _____ is the name given to the area of the retina where the optic nerve leaves for the brain.

Learning intentions

- To learn that a visible spectrum is formed when light travels through a prism.

Success criteria

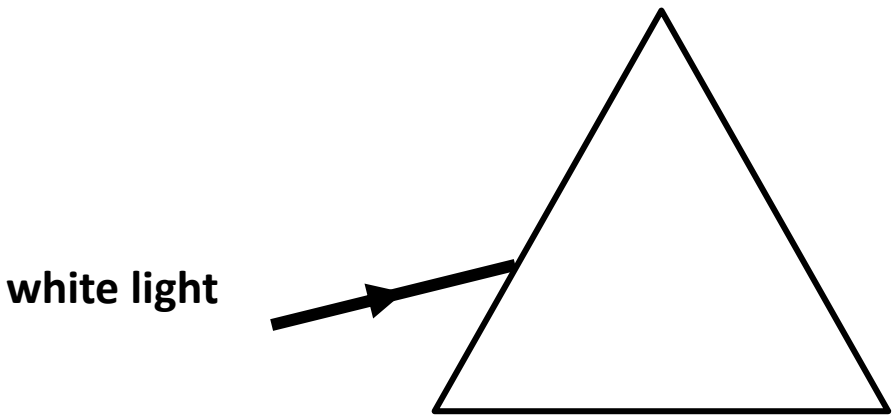
- ❑ I can describe what happens when white light travels through a prism.
- ❑ I can state the colours of the visible spectrum.

Triangular Prism Experiment

Aim:_____

_____

Method and Results:



Conclusions:

1. What happens to the direction of the beam of light?

_____

2. What name is given to this change of direction?

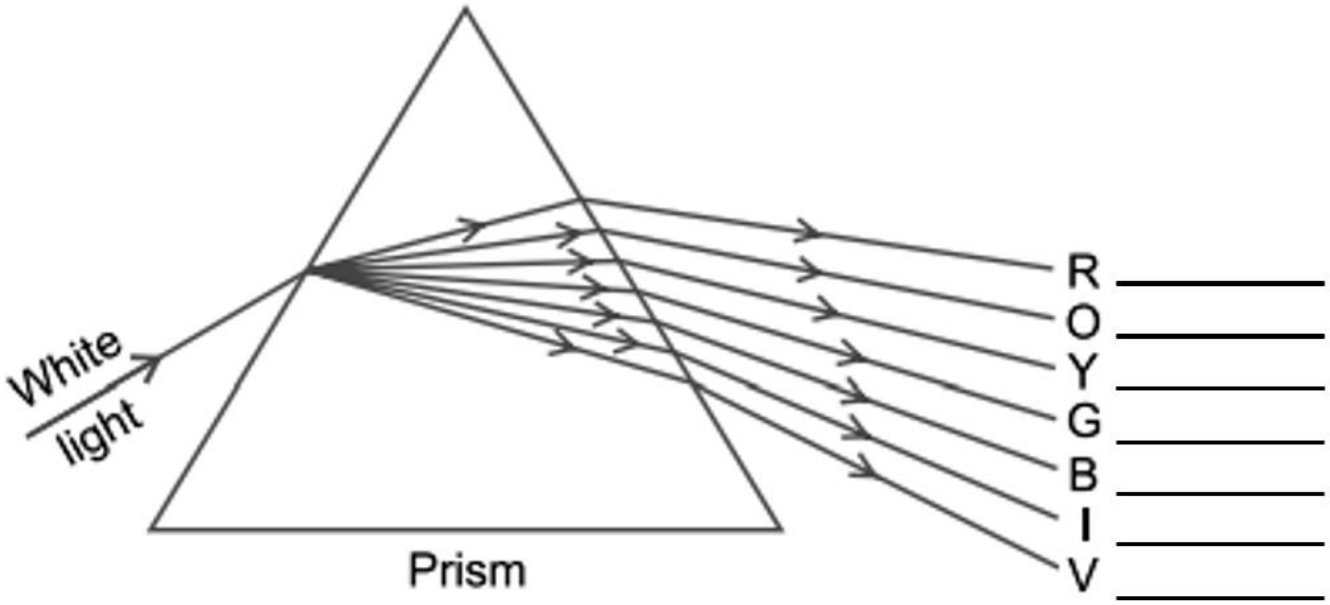
_____

3. What happens to the colour of the beam of white light?

_____

4. Is white light only one colour, or many?

_____



White light contains all the _____ of the _____ spectrum.

_____ refracts/bends least and _____ refracts/bends the most.

Extension:

Make up your own mnemonic to remember the colours of the visible spectrum.

_____

_____

Date: _____

Mixing Coloured Light

Starter

1. What happens to white light when it passes through a prism?

_____

2. List the colours of the visible spectrum in order starting with the longest wavelength - **red**.

_____

_____

Learning Intentions

- To learn how mixing colours can produce white light and other colours.

Success Criteria

☐ To name the primary and secondary colours of light

☐ To learn what colour blindness is.

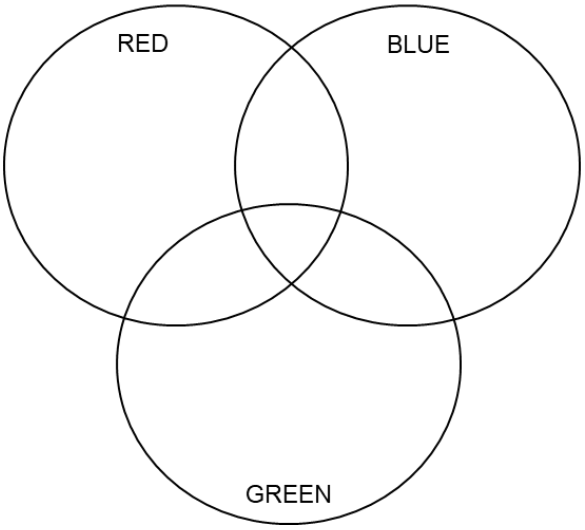
Mixing Coloured Light

Aim: _____

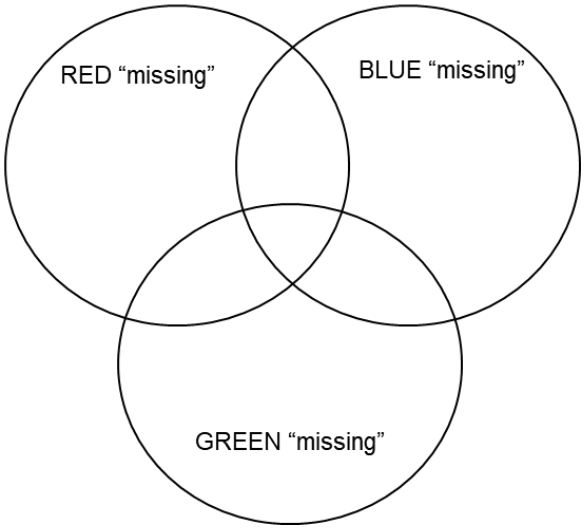
_____

Results:

COLOUR ADDITION



COLOUR SUBTRACTION



Conclusion:

The primary colours of light are _____, _____and _____

The secondary colours of light are _____, _____ and _____

_____ light can be made by adding together equal parts of red, green and blue light.

Colour Blindness

Colour blindness is when someone finds it difficult to _____and _____ between certain colours.

It is caused by faults in the colour receptive _____ in the _____ of the eye.

Extension activity 1:

Write down 3 pieces of information from the video – How do light waves make colour?

Extension activity 2:

Make a Newton's Colour Wheel

Date: _____

The Stroop Test

Starter

1. Name the three primary colours of light.

   _____

2. How is white light produced?

   _____

Learning Intentions

- To learn how coloured light affects the appearance of different coloured objects.

Success Criteria

☐ I can describe how coloured light affects the appearance of different coloured objects.

☐ I can plan and carry out a scientific investigation

☐ I can calculate an average

The Stroop Test

Aim: To name the colour of the ink the words are printed in, while ignoring the actual word meaning.

Results (group):

Name	Task A time (seconds):	Task B time (seconds):

Results (class):

Average time for task A: _____

Average time for task B: _____

Conclusion: What task was easier / quicker to complete? Why?

_____

_____

Evaluation: Think about: Are there any groups of people it would not work with? What could we investigate further?

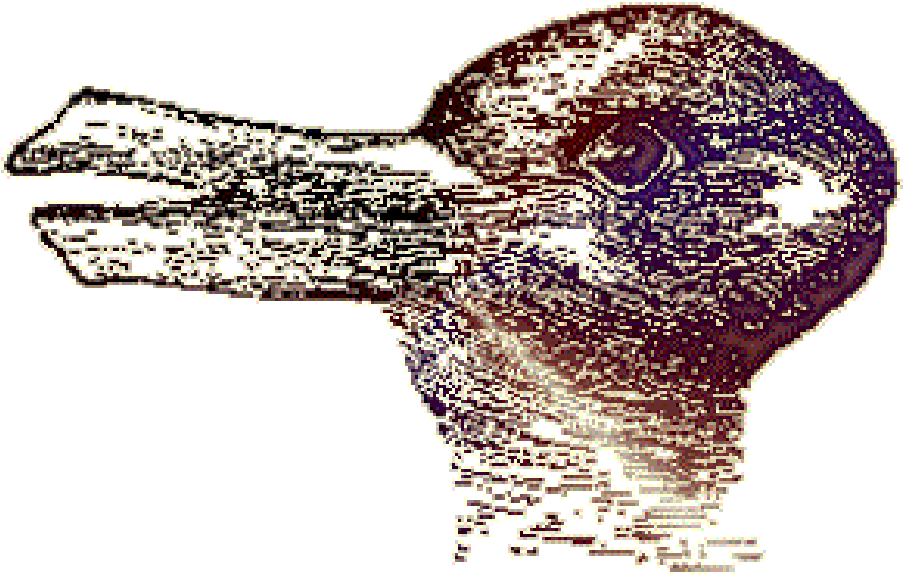
_____

_____

_____

Optical Illusions (Extension)

Your teacher will show you some optical illusions where the eyes are deceived by something that is not what it seems.



Task: Make a video of your dragon optical illusion!

Date: _____

Waves

Starter

1. Sketch a wave you might see at the seaside.

2. What words can you use to describe it?

_____

_____

Learning Intentions

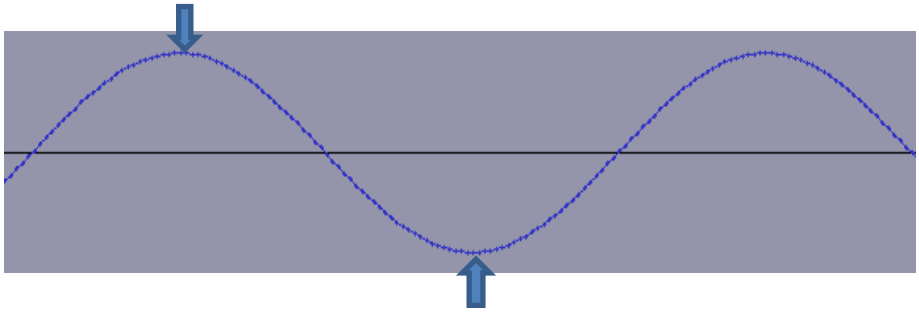
- State that light is a wave that transfers energy.
- Learn how wavelength is related to the energy the waves carry.

Success Criteria

- ❑ I can identify the wavelength of a wave.
- ❑ I can state that shorter wavelengths of EM Waves carry more energy.
- ❑ I can state that light is part of the electromagnetic spectrum.

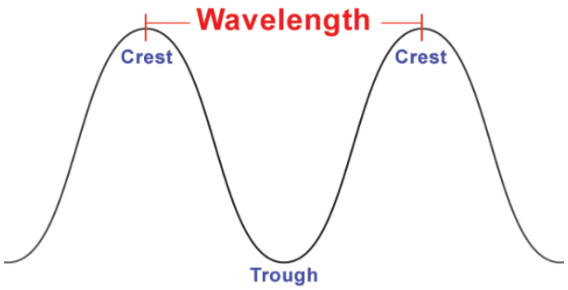
Waves

Light is an example of a _____. Just like waves in the sea they have two parts.

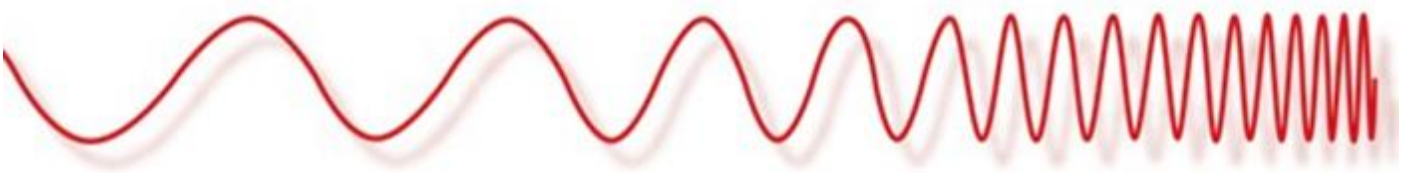


Wavelength

A wavelength is the _____ of ONE wave, in metres.



Class questions



1. As you travel left to right what factor about the wave changes?

   _____

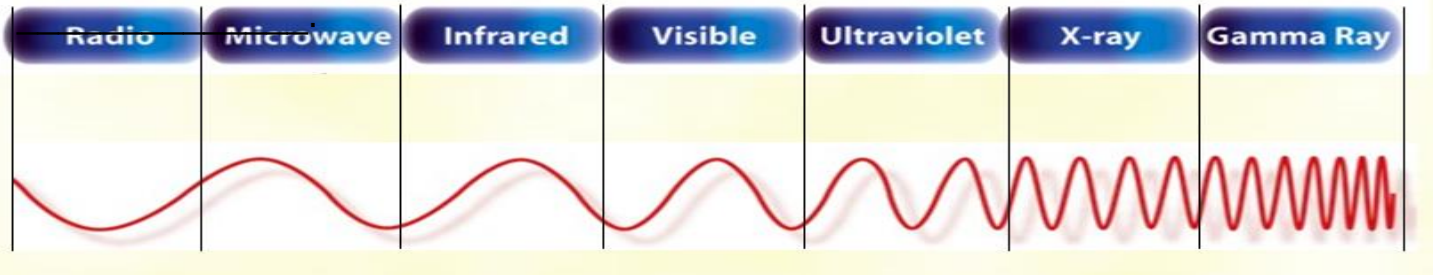
2. In what way does it change?

   _____

Family of waves

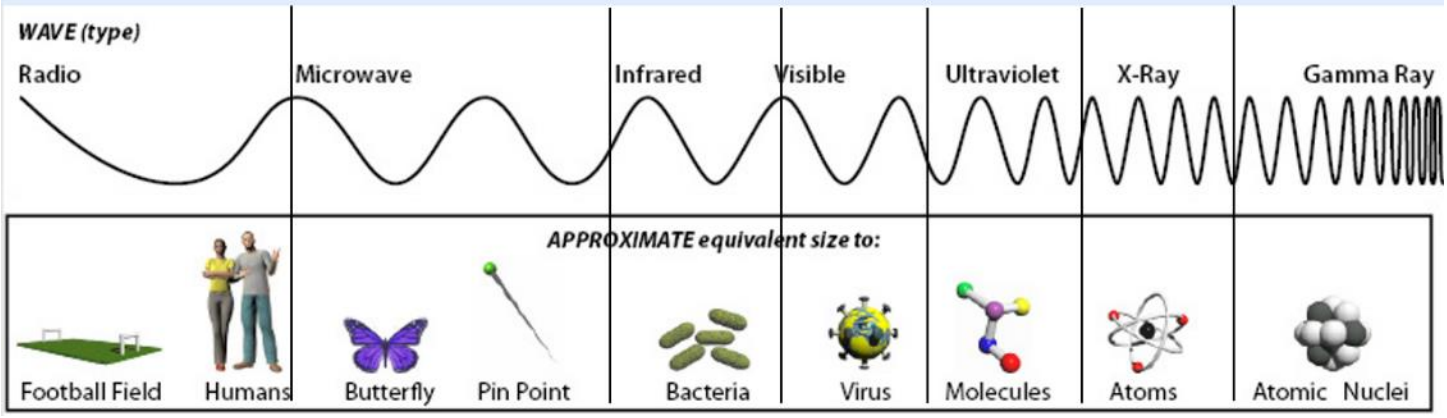
Light is part of a _____ of waves called the **electromagnetic spectrum**. This is shortened to the _____

The different types of electromagnetic waves have a lot in common. Each different type of electromagnetic wave has different _____ because they have different



As you go from left to right, the _____ of the waves gets greater. As you move from radio waves to gamma rays, the risk of _____ to living things gets bigger.

Wavelength Scale



Use the diagram above to complete the following questions.

1. Which waves have wavelengths of this size…
   a. between the size of a football field to the size of a person_____
   b. about the size of atoms _____
   c. between the size of butterfly and the size of a pin point? _____

Further thinking

2. Which wave is close in size to a grain in sand? _____
3. What wave is like the width of a hair? _____
4. Which waves are smaller than an ant? _____
5. Are radio waves bigger or smaller than a basketball? _____

Plenary:

True or False?

1. The wavelength of a wave is how tall it is _____
2. The electromagnetic spectrum has many different wavelengths _____
3. The shorter the wavelength of a wave gets, the more energy the wave has. _____

Date: _____

The EM Spectrum

Starter

1. The electromagnetic spectrum is a family of _____
2. Wavelength is the _____ between two crests
3. Gamma rays have a shorter_____ than radio waves

Learning intentions

- To state a use for each part of the electromagnetic spectrum.

Success criteria

- ❑ I can state a use for each part of the electromagnetic spectrum.

Uses for the EM Spectrum

Wave Name	Applications	Risks
radio		
microwave		
İnfrared		
visible light		
ultraviolet		
X-rays		
gamma ray		

Date: _____

Using Infrared

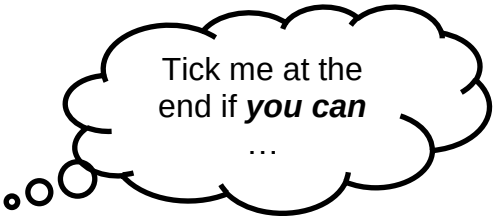
Starter

Draw a line to match the part of the E.M spectrum with its application.

Wave Type	**Application**
Microwaves	medical tracers
Infrared	mobile phones
gamma rays	thermograms

Learning intentions

- To state what a thermogram is.
- To explain how infrared is used in medicine.



Success criteria

☐ I can describe what a thermogram is.

☐ I can describe how infrared is used in medicine.

Infrared Camera

The image made when a thermal camera is used is called a _____.

With an infrared camera or thermograms given to you, complete the following tables.

Thermogram of a face:

Area of Face	Colour in Thermogram	Hot, Warm or Cold
Nose		
Cheek (front)		
Cheek (back)		
Side of mouth		

Thermogram of a house:

Place	Colour	How much heat is escaping?
roof		
windows		
doors		
walls		

Thermograms show how the _____ can change across different parts of an object.

Different _____ represent different temperatures.

The intruder looks brighter in a thermogram because

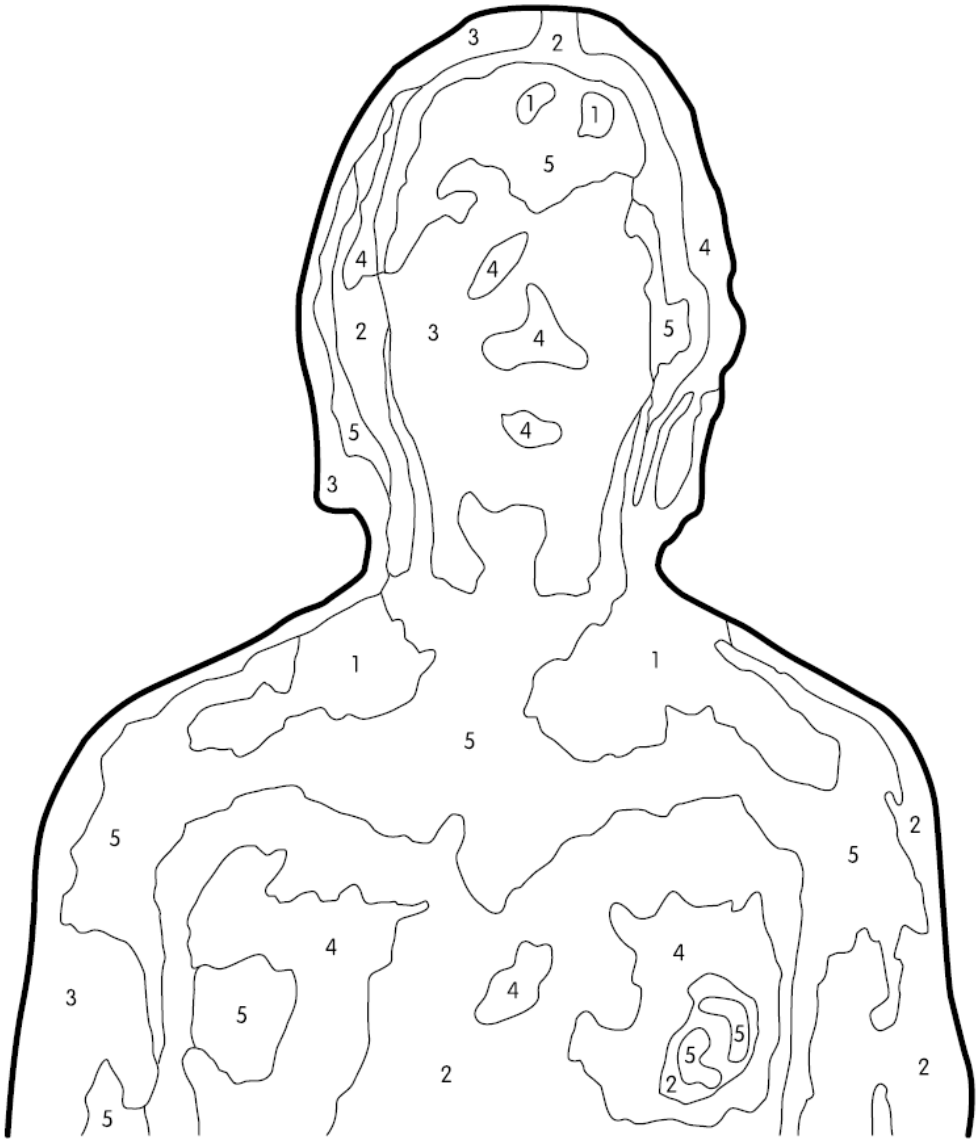
_____

_____

Using Infrared

Infra-red can be used to help speed up the healing of_____. The warmth encourages _____ to flow freely.

Extension: colour in the thermogram using the key



number	colour	appropriate temperature (°C)
1	blue	23 – 26
2	green	27 – 29
3	red	30 – 32
4	orange	33 – 35
5	yellow	35 – 37

Date: _____

Ultraviolet

Starter

1. What do thermograms show?

   _____

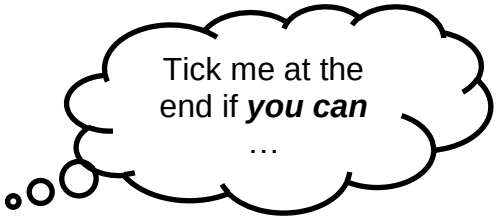
2. Give a use for infrared radiation.

   _____

Learning intentions

- To state the uses of ultraviolet light.
- To explain the term fluorescent.
- To state that ultraviolet can be used to treat some skin conditions.

Success criteria



☐ I can state the uses of ultraviolet light.

☐ I can explain the term fluorescent.

☐ I can state that ultraviolet can be used to treat some skin conditions.

Ultraviolet Light

UV light is invisible to the eye, but _____ materials can absorb the energy in UV light and re-emit it as _____ light.

Other Uses of UV Light

Aim:_____

_____

Method:

- Collect a variety of objects.
- Turn the classroom lights off
- Turn the UV lamp on and shine it on the object.
- Record what objects fluoresce or ‘glow’

Results:_____

_____

_____

Conclusion:_____

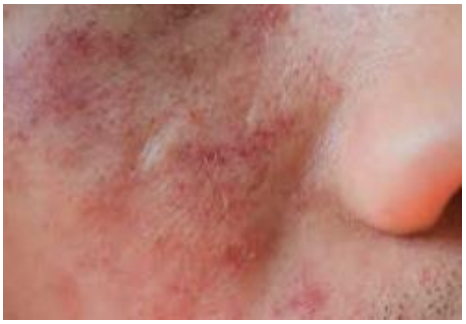
_____

_____

Ultraviolet light can be harmful to human skin, however, in the right dose it can help heal some _____ _____ such as psoriasis and eczema.

psoriasis

eczema



Date: _____

Ultraviolet

Starter

List three uses of UV radiation:

1. _____
2. _____
3. _____

Learning intentions

- To state the dangers of overexposure to sunlight.
- To explain how to protect yourself from the damage caused by ultraviolet.
- To explain what the sun protection factor number on sunscreen means.

Success criteria

Tick me at the end if ***you can***

- ☐ I can state the dangers of overexposure to sunlight.
- ☐ I can explain how to protect yourself from the damage caused by ultraviolet.
- ☐ I can explain what the sun protection factor number on sunscreen means.

Ultraviolet Light

Three facts from the video – Dear 16 year old me.

1. _____

2._____

3._____

Sunlight contains _____.

Ultraviolet causes human _____ to darken or tan.

Too much exposure to the ultraviolet in _____ can cause

_____ or even _____ _____.

_____types of human skin can get sunburn or skin cancer.

Protection from UV Light

What can be done to protect your skin from exposure to UV light?

_____

_____

_____

Sunscreen SPF

1. SPF stands for _____ _____ _____

2. As the SPF number gets bigger the amount of UV that is

   blocked _____

3. Two other things that can affect how long you can stay out in the sun

   _____

   _____

Extension Task:

The UV Index measures the strength of sunburn-producing ultraviolet radiation at a particular place and time. Research and note down today's UV Index for your location and two other cities/countries from different continents. Then, categorize each UV Index value: Low, Moderate, High, Very High, or Extreme.

- Your Location:
  - Today's UV Index: _____
  - Category: _____

- City/Country 1: _____
  - Today's UV Index: _____
  - Category: _____

- City/Country 2: _____
  - Today's UV Index: _____
  - Category: _____

Considering the differences in UV Index between these locations, discuss the importance of being aware of daily UV Index values, especially when traveling.

_____

_____

_____

Date: _____

X-rays

Starter

1. What is the danger of overexposure to ultraviolet?

   _____

2. What should you use to block ultraviolet?

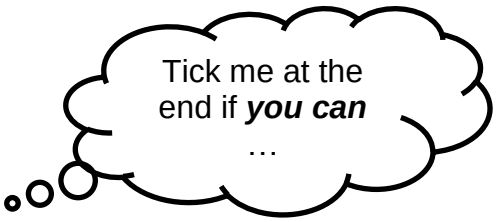
   _____

3. What does sunscreen “SPF” stand for?

   _____

Learning intentions

- To explain how we can use X-rays
- To describe how an X-ray photograph works
- To identify bones in an X-ray photograph.



Success criteria

☐ I can explain how we can use X-rays.

☐ I can describe how an X-ray photograph works.

☐ I can identify bones in an X-ray photograph.

Paper Man Experiment

1. Were you able to see the “bones” when it was sitting on the table?

   _____

2. What had to happen to the light waves for you to see the bones?

   _____

3. Looking through the paper man how did the bones appear?

   _____

4. What must have happened to the light waves when they tried to pass through the bones? _____

X-ray Photographs

1. Bones look _____

2. Organs look _____

3. X ray photographs can tell us

   1._____

   2._____

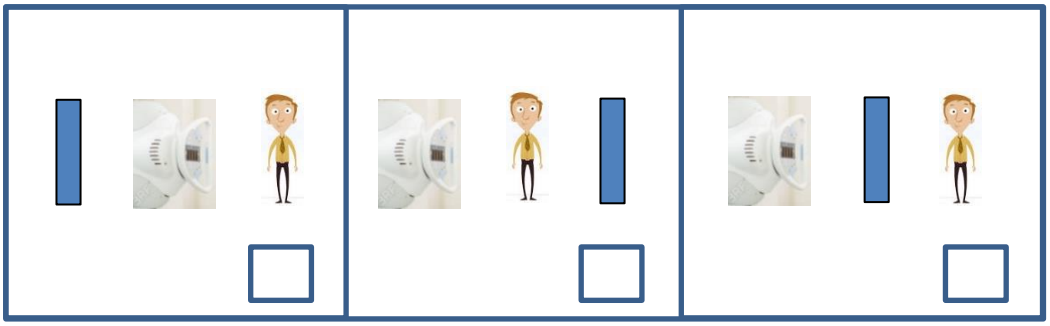
How X-Ray pictures work

X rays can pass through soft tissue, like organs. These areas appear _____.

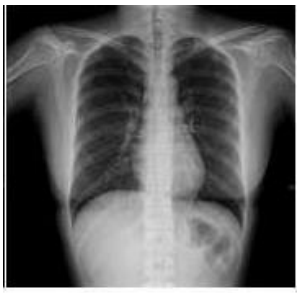
X rays can't pass through _____ so they appear white or clear.

X rays have a shorter wavelength, so we get more _____.

Tick the picture that shows the correct order.



X-RAY IMAGES
Write down what the x-ray image shows.

Picture	What it is…	Picture	What it is…
			
			
			
			
			
			

Extension Task: Literacy

The sun is a star 150 000 000 km from Earth which produces enormous amounts of energy in the form of electromagnetic waves. We can detect the visible light from the sun with our eyes, but we cannot detect the invisible ultraviolet light which also reaches Earth. Exposure to the ultraviolet light from the sun can produce a change in the colouring of the skin which we call a suntan.

There are three types of ultraviolet radiation. We are constantly exposed to UVA, and we need this for healthy growth and to make vitamin D in our bodies. UVA light has wavelengths in the range 315 to 400 nm. UVB light has wavelengths in the range 280 to 315 nm. Most of the UVB light from the sun is removed by the layer of ozone in the atmosphere around the Earth. Scientists have found that there is a hole in the ozone layer which is allowing more UVB to reach us on the surface of the earth. UVB can cause a skin cancer called melanoma. The third type of UV light, with wavelengths in the range 200 to 280 nm, is called UVC.

People who are going to be exposed to the sun for any length of time should protect their skin with suntan cream.

1. State the distance from the Sun to the Earth.

   _____

2. Construct a table giving the wavelengths of UVA, UVB and UVC light.

3. State why we need to be exposed to UVA radiation.

   _____

4. State what type of radiation can cause skin cancer. _____

5. What range of wavelengths does Bronzage suntan cream block?

   _____

6. Describe what other steps you can take to protect yourself from UV radiation.

   _____

Extension Tasks: Gathering Information

Watch the following documentaries and take some notes.

Spectrum of Colour

Richard Hammond – Invisible Worlds

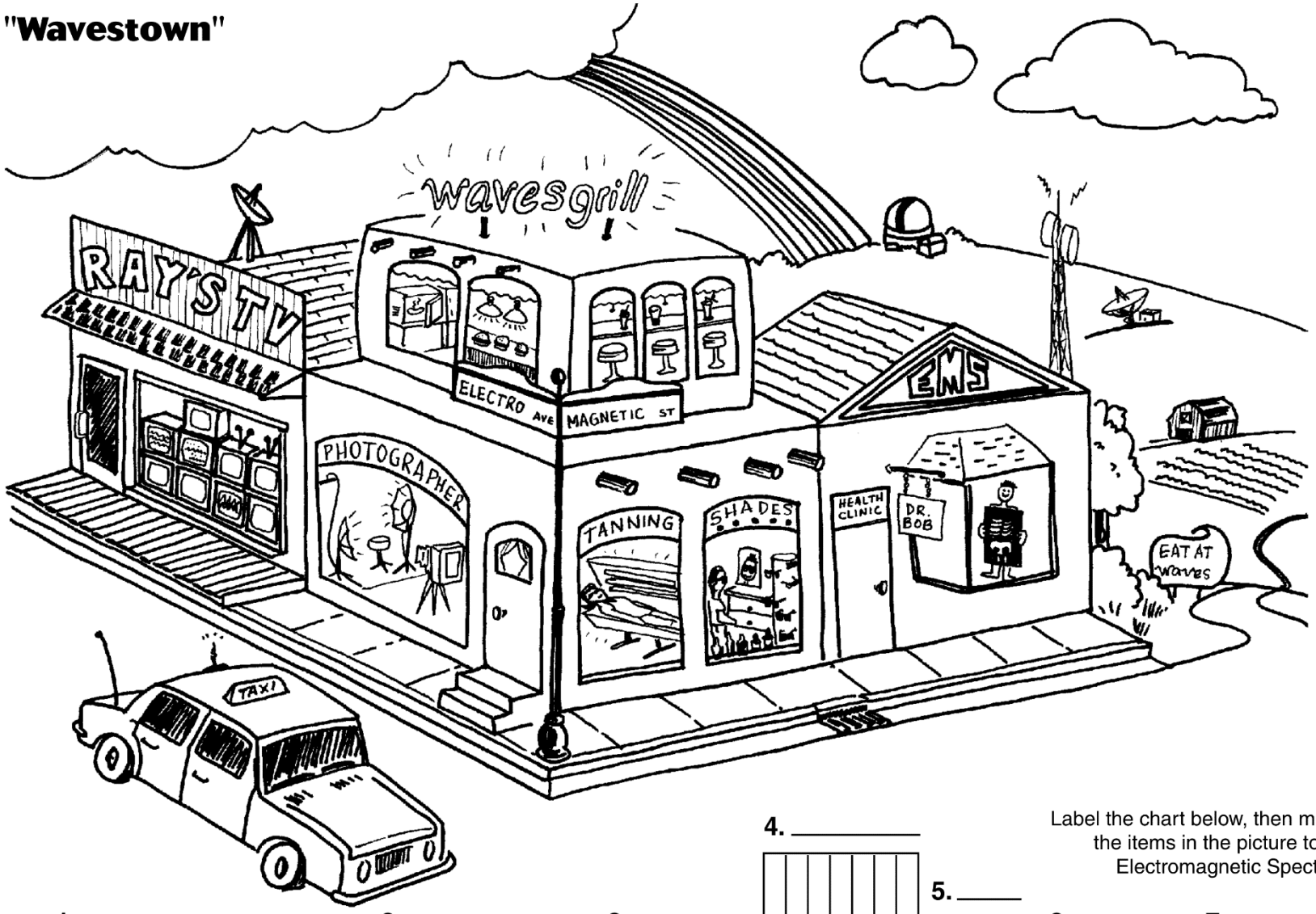
Word Search

Light and Electromagnetic Spectrum

A	M	M	T	H	G	I	L	I	G	V	E	U	A
R	P	U	L	T	R	A	V	I	O	L	E	T	C
A	E	A	I	H	T	G	N	E	L	E	V	A	W
D	A	N	N	O	I	T	C	E	L	F	E	R	N
I	M	I	C	R	O	W	A	V	E	I	E	L	O
O	V	T	A	C	A	M	M	A	G	T	I	S	E
I	R	E	F	R	A	C	T	I	O	N	T	L	O
D	E	R	A	R	F	N	I	E	E	O	W	H	T
R	L	U	N	L	W	N	A	V	X	R	A	Y	A
I	T	F	R	A	N	A	P	U	S	L	R	I	C
R	R	A	L	S	N	R	V	U	R	R	E	P	L
I	N	C	E	E	A	E	H	E	P	X	R	N	R
S	P	C	T	R	U	I	G	U	S	I	L	N	S
A	P	R	I	S	M	S	L	R	R	V	L	T	I

WAVELENGTH
RETINA
PUPIL
WAVES
ULTRAVIOLET
PRISMS
INFRARED
GAMMA
REFLECTION
IRIS
MICROWAVE
LASER
LIGHT
XRAY
LENS
RADIO
REFRACTION

"Wavestown"



Label the chart below, then match the items in the picture to the Electromagnetic Spectrum