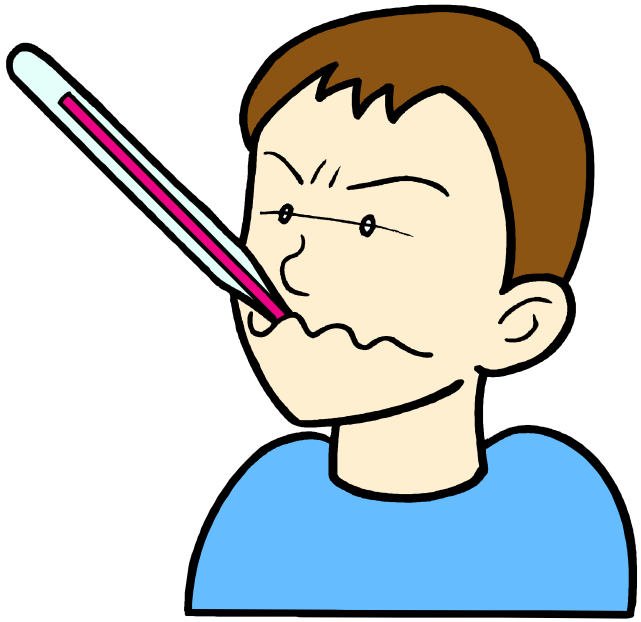
Standard Grade Physics

Medical Physics



Name: _____ **Class:** _____ **Teacher:** _____

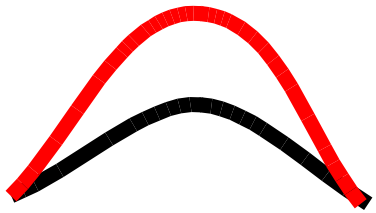
TEMPERATURE and THERMOMETERS

The **temperature** of an object is a measure of how **h** _ _ or **c** _ _ _ it is. Unit: **d** _ _ _ _ _ _ **C** _ _ _ _ _ _ **(ºC)**.

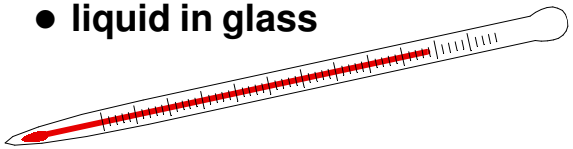
We measure **temperature** with a **t** _ _ _ _ _ _ _ _ _ _ _.
This requires some measurable **p** _ _ _ _ _ _ _ **q** _ _ _ _ _ _ _ which changes with **temperature**.

The **word bank** contains **measurable physical quantities which change with temperature**.
By drawing lines, match these to the correct **thermometer**.

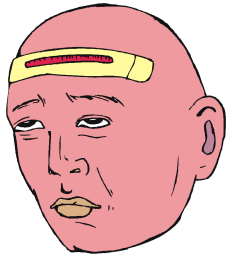
- **thermocouple**



- **liquid in glass**

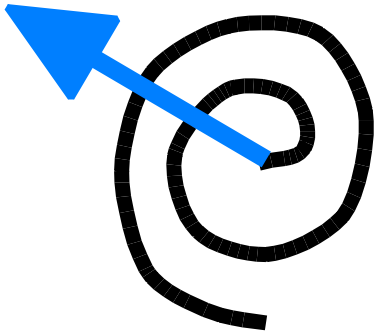


- **liquid crystal**



- **Electrical resistance of metal wire.**
- **Volume of liquid.**
- **Two metals expand by different amounts.**
- **Colour of crystals.**
- **Voltage difference between ends of 2 metals joined together.**
- **Resistance of temperature sensitive resistor (thermistor).**

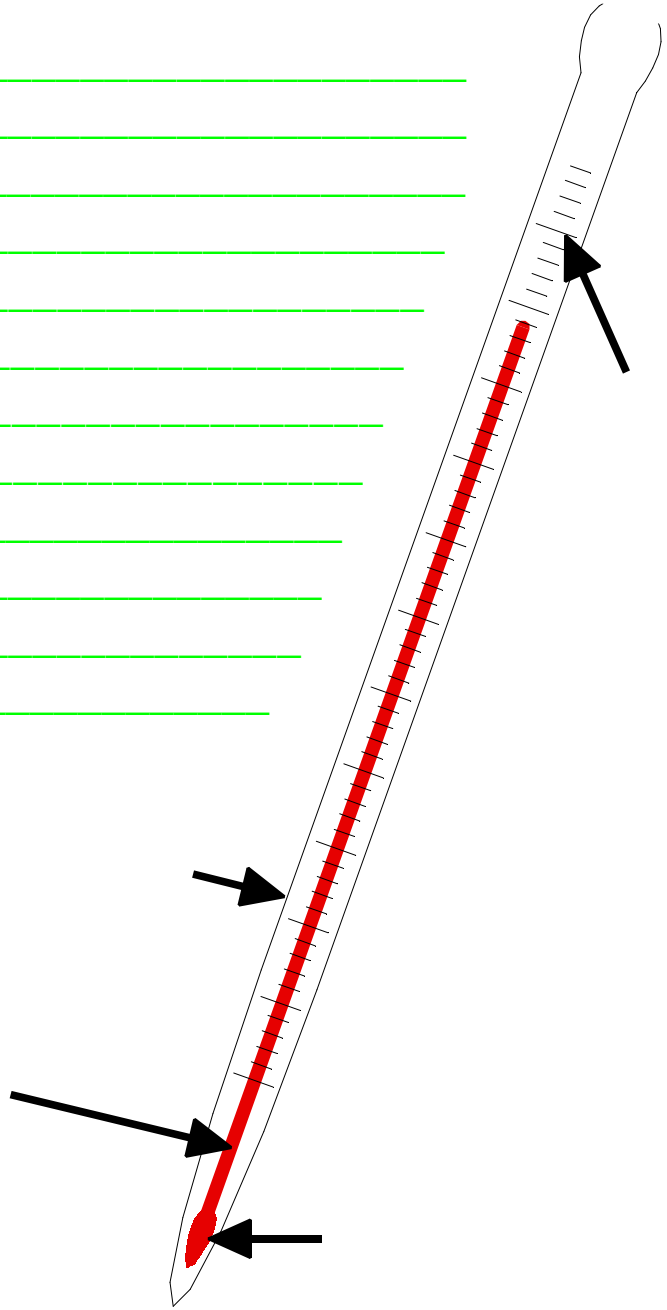
- **rotary (bimetallic strip)**



- **digital (thermistor) thermometer**

- **resistance thermometer**

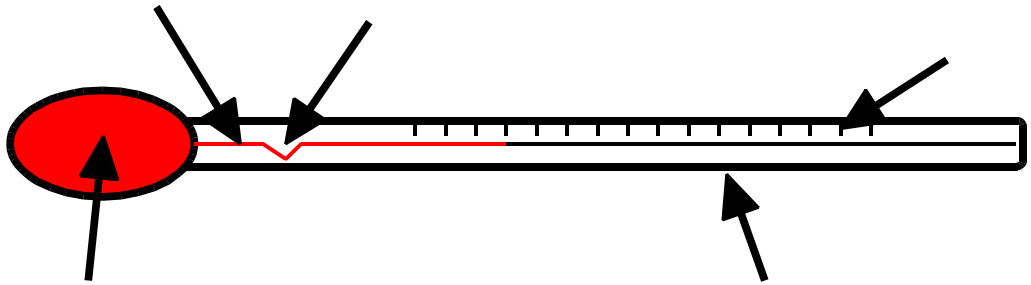
- Label the parts of the **liquid in glass thermometer**.
- Describe how it works.



A **clinical liquid in glass thermometer** is used to measure the **temperature** of the **human body**.

- Label the **clinical liquid in glass thermometer**.
- Explain what is special about the **tube** inside this **thermometer**?

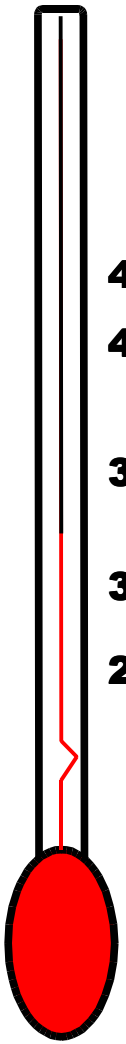
- Write down any **other** differences between a **clinical liquid in glass thermometer** and an **ordinary liquid in glass thermometer**:



Human Body Temperature

Doctors use **body temperature** to tell if a patient is **ill**.

- By drawing lines, match the terms in the **word bank** to the temperatures shown on the **clinical liquid in glass thermometer**.



43 °C

41 °C

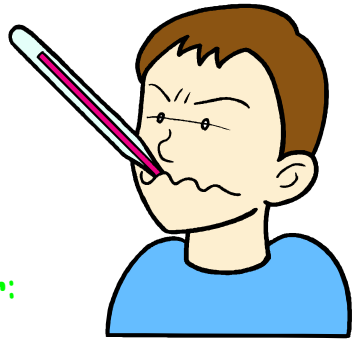
37 °C

32 °C

28 °C

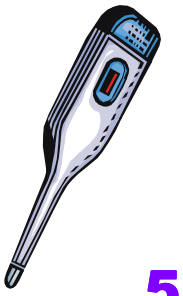
- **death**
- **death**
- **severe fever / poor blood flow round body/ unconsciousness**
- **hypothermia**
- **normal healthy body temperature**
- **shivering / reduced heart rate**

Measuring Human Body Temperature



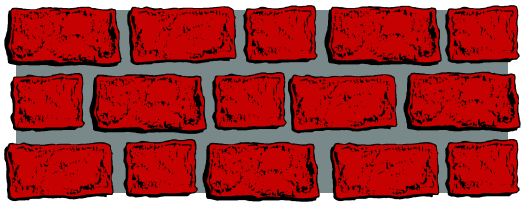
- Describe how to measure **human body temperature** with a **clinical liquid in glass thermometer**:

- Describe any **differences** in your measuring technique if you used a **digital clinical thermometer**:



Sound Travelling Through Materials

Can **sound** travel through:



- **solids** like **brick**?

☐yes ☐no

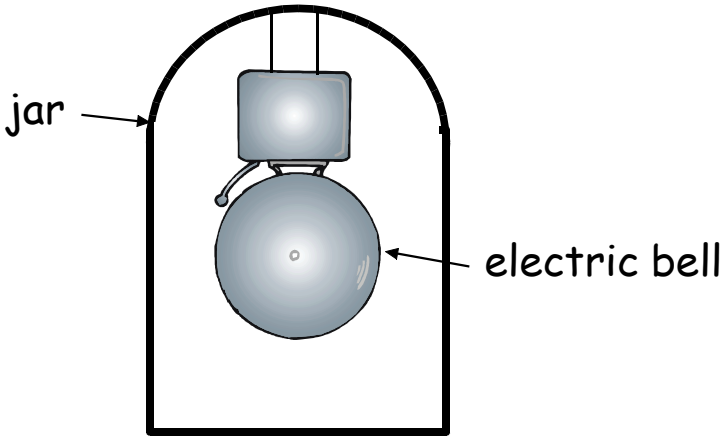
- **liquids** like **water**?

☐yes ☐no

- **gases** like **air**?

☐yes ☐no

Sound cannot travel through a **v** _ _ _ _ _ where there are no **s** _ _ _ _, **l** _ _ _ _ _ or **g** _ _ **particles**.



When the jar has **air** in it, we can hear the bell **r** _ _ _.

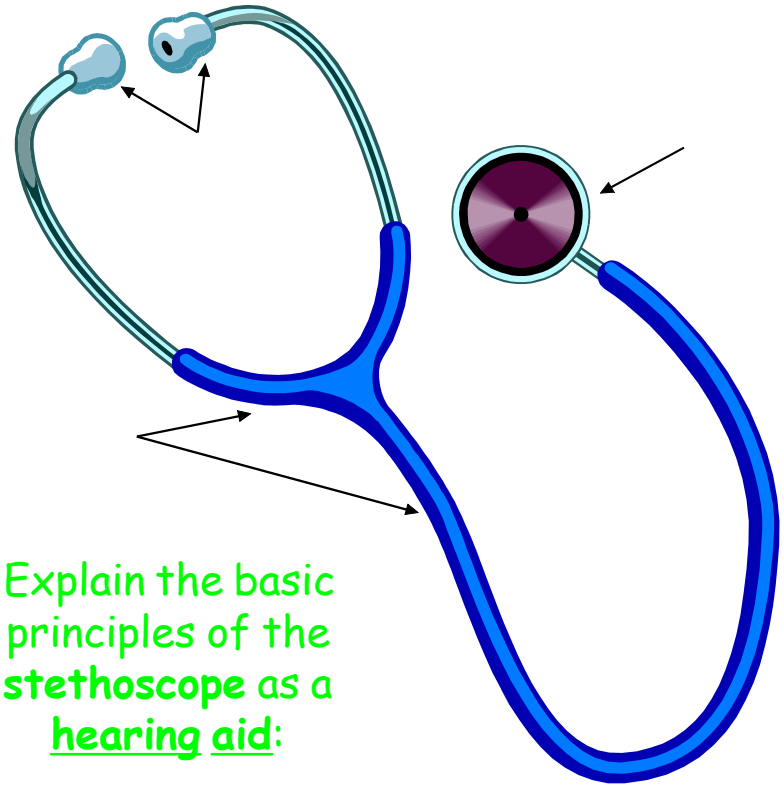
Describe and explain what happens when **air** is pumped out of the jar:

The Stethoscope

- Label the diagram of a **stethoscope**:

word bank

bells, ear pieces, rubber tubes



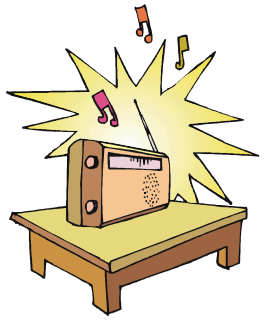
- Explain the basic principles of the **stethoscope** as a **hearing aid**:

Noise Pollution

Noise is any **s** _ _ _ _ which is unpleasant to **h** _ _ _.

- What can happen to people who are exposed to **too** **much** **noise** for a **long** **time**:

Some examples of **noise** **pollution** are:



- _____

- _____

- _____

- _____

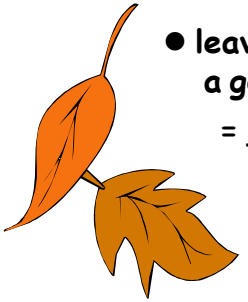
Sound Levels

Some **sounds** are **louder** than others.

We measure the **loudness** of **sound** in units called **d _ _ _ _ _ _ _ (_ _)**.

- Match the **sound levels** given in the box below to the appropriate situations:

0 dB	20 dB	30 dB	50 dB	70 dB	100 dB	110 dB	115 dB	120 dB	130 dB	140 dB



- leaves rustling in a gentle breeze

= _____

- low flying aircraft

= _____

- motor cycle at 1 metre

= _____

- normal conversation

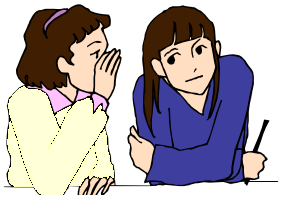
= _____

- pain threshold

= _____

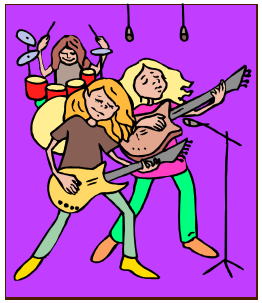
- loud television

= _____



- whisper

= _____



- pop group at 1 metre

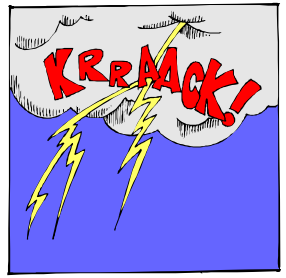
= _____

- minimum sound level that can be heard

= _____

- danger level to hearing

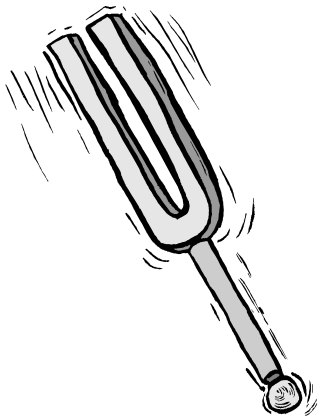
= _____



- thunder

= _____

Frequency of Sound



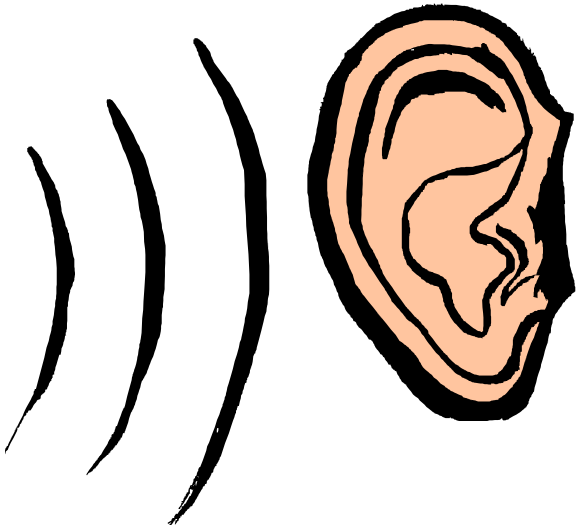
Sound is made by objects which **v** _ _ _ _ _ _.

The number of **vibrations every second** is called the **f** _ _ _ _ _ _ _ _.

Unit: **h** _ _ _ _ (_ _).

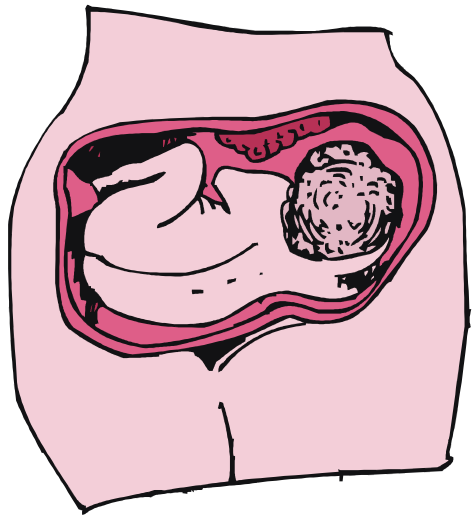
The **lowest frequency** of **sound** that **humans** can hear is ____ **Hz**.

The **highest frequency** of **sound** that **humans** can hear is _____ **Hz**.



High frequency vibrations beyond the range of human hearing (above _____ Hz) are called u _ _ _ _ _ _ _ _ _.

U _ _ _ _ _ _ _ _ _ _ is used as a medical technique to obtain images of a **b** _ _ _ in its mother's **w** _ _ _.



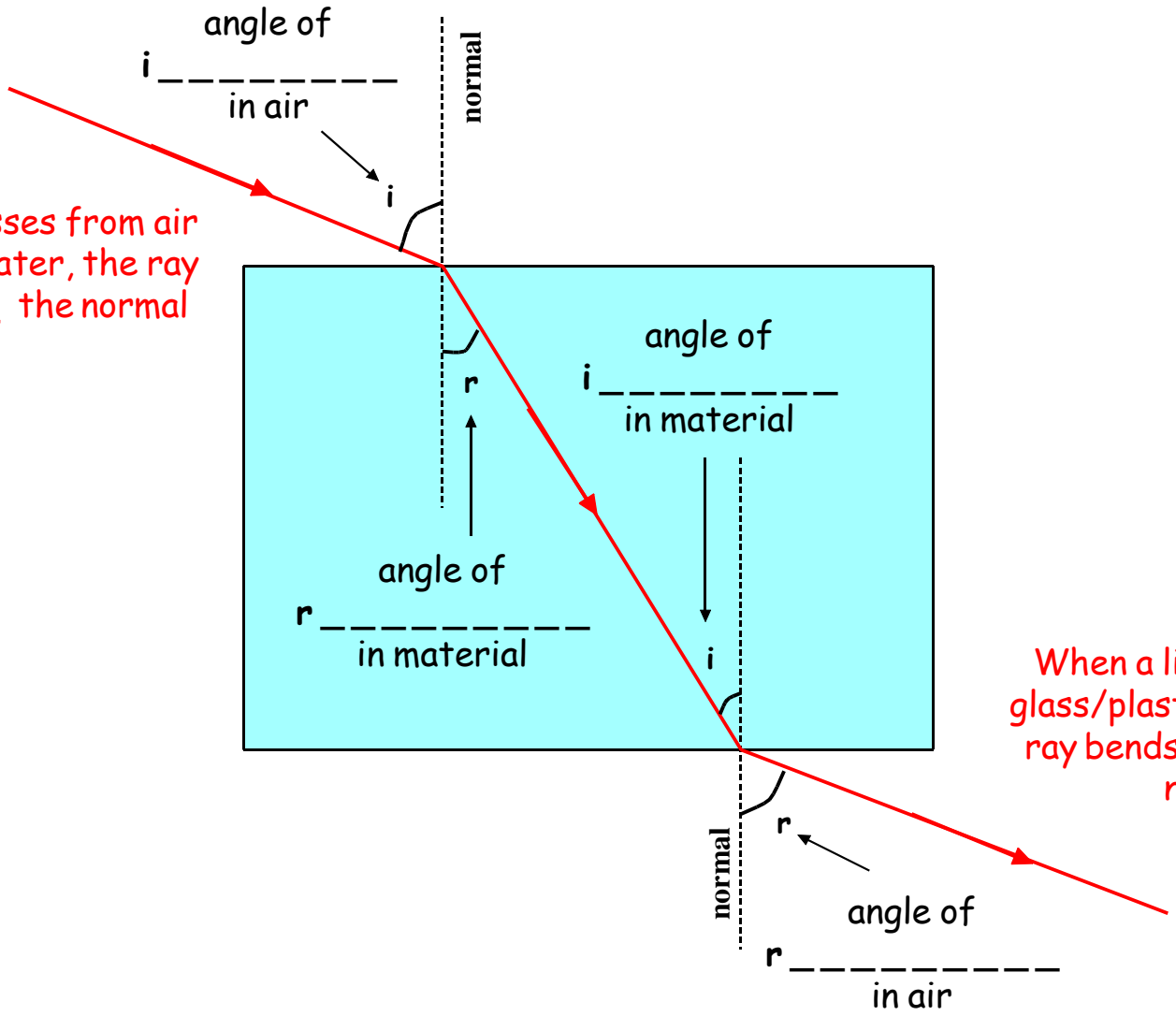
- Explain this **medical technique**:

Refraction of Light

Light travels in **straight lines** called **light r _ _ _**.

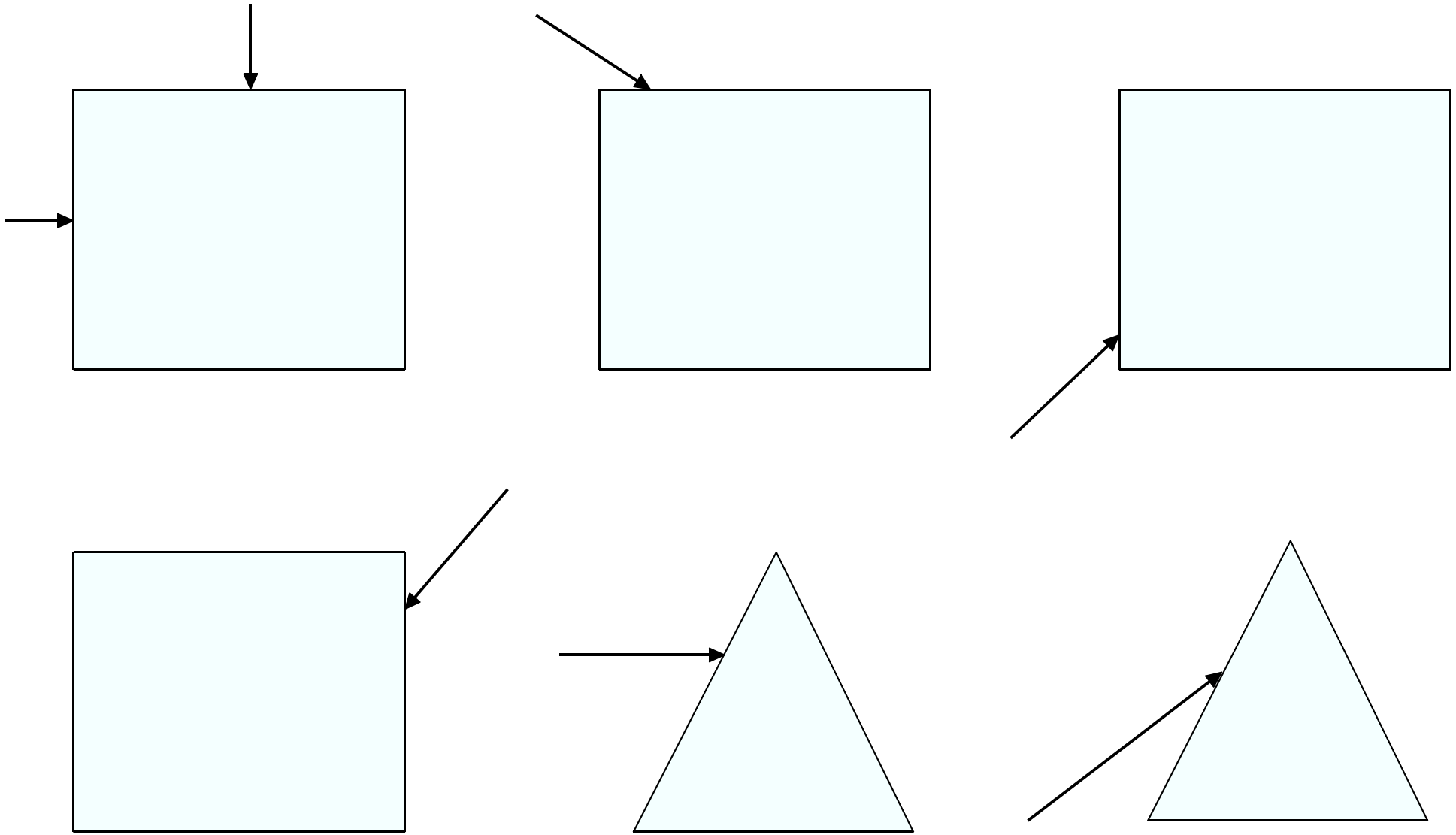
When **light** passes from one material into another of different **density**, its **s _ _ _ _** changes and so its **d _ _ _ _ _ _ _ _** changes (unless the light hits the material at 90° to its surface) - This is known as **r _ _ _ _ _ _ _ _ _**.

A <u>normal</u> is a dashed line drawn at 90° to the surface of a material where a light ray hits the material.



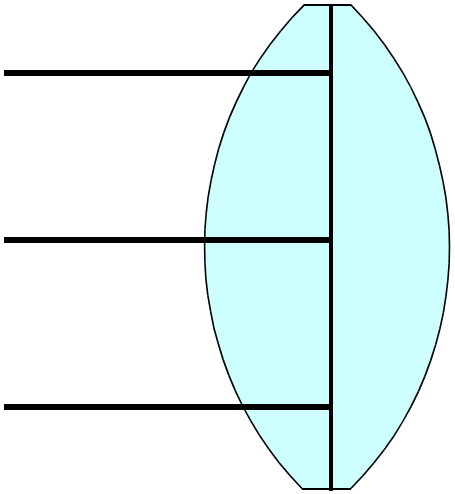
- Using a **ruler** and **protractor**, complete each diagram below to show what happens to the **rays of light** as they pass through the glass blocks. (Remember to draw **normal lines**).

TAKE YOUR TIME AND WORK VERY CAREFULLY.

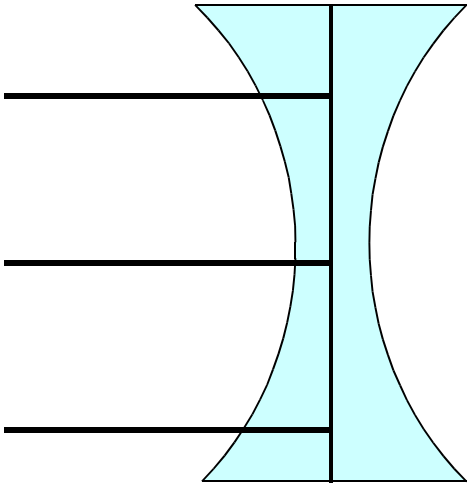


Lenses

- Name each shape of **lens** shown below.
- Using a **ruler**, complete both diagrams to show what happens to the **light rays**.



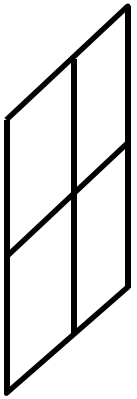
_____ lens



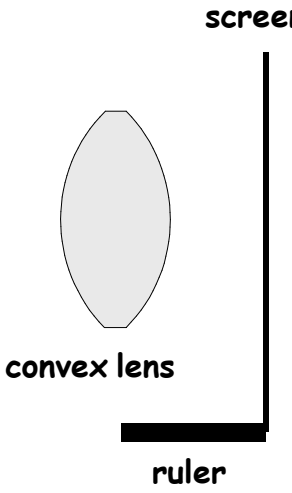
_____ lens

- On each diagram, show the **focal length** of the lens.

- Describe a simple experiment you could perform to find the **focal length** of a **convex lens**.



far away window



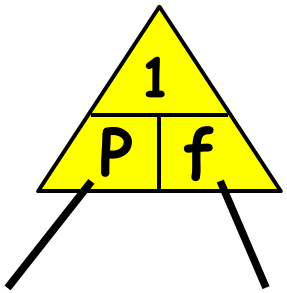
Focal Length and Power of Lenses

T _ _ _ _ lenses refract (**b** _ _ _) light more than **t** _ _ _ lenses - so **t** _ _ _ _ lenses are more **p** _ _ _ _ _ _ _.

A **powerful** lens has a **s** _ _ _ _ _ _ focal length.

Convex lenses have a **p** _ _ _ _ _ _ _ (__) power. Concave lenses have a **n** _ _ _ _ _ _ _ (__) power.

$$\text{power (P)} = \frac{1}{\text{focal length in metres (f)}}$$



$$\text{focal length in metres (f)} = \frac{1}{\text{power (P)}}$$

dioptres (D) **metres (m)**

Convex Lenses

A convex lens has a power of + 5 D. Calculate its focal length in metres.

A convex lens has a focal length of 0.5 m. Calculate its power.

Calculate the focal length of a lens with power + 40 D.

Calculate the power of a convex lens of focal length 0.25 m.

Concave Lenses

A concave lens has a power of -4 D. Calculate its focal length in metres.

A concave lens has a focal length of 1.25 m. Calculate its power.

Calculate the focal length of a lens with power -8 D.

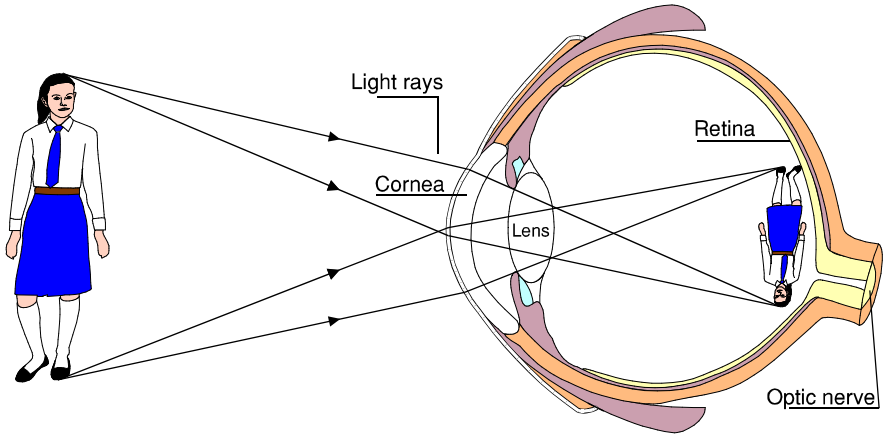
Calculate the power of a concave lens of focal length 0.6 m.

Image Formation on the Retina

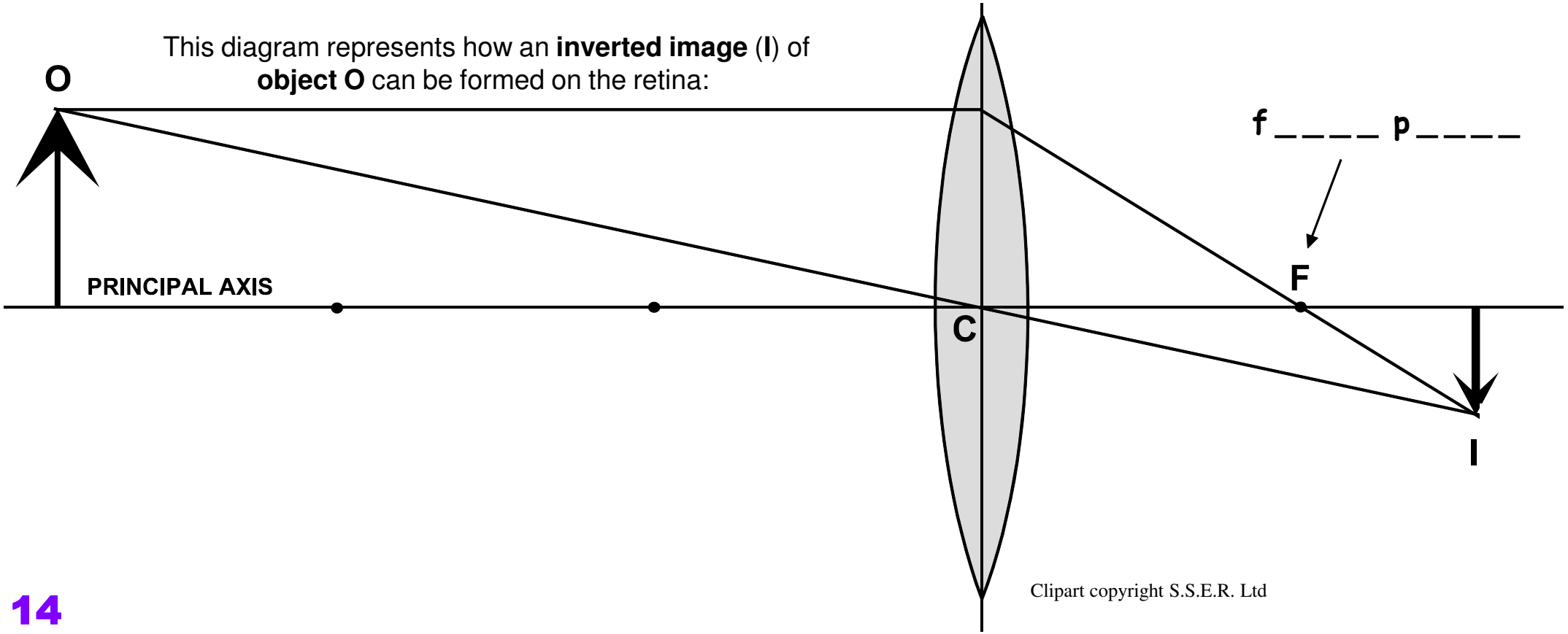
At the back of an eye, there is a layer of light-sensitive cells called the **r** _ _ _ _ _.

When we look at an object, an image (picture) of the object is formed on the **r** _ _ _ _ _.

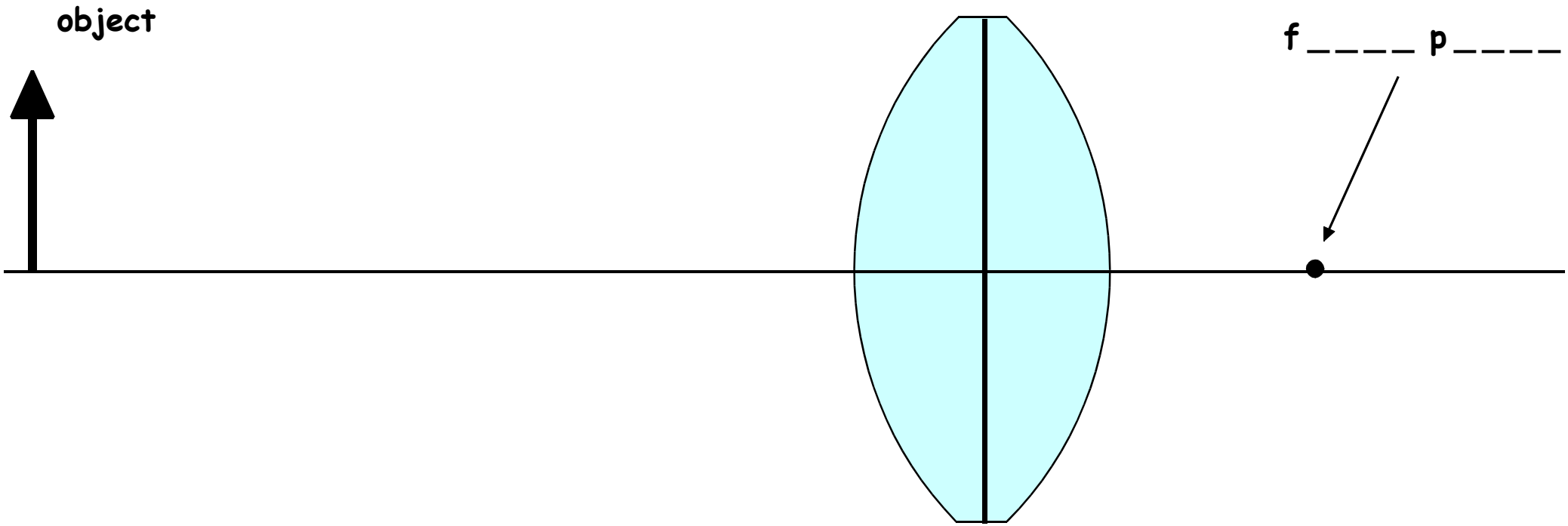
The image is **u** _ _ _ _ _ **d** _ _ _ and **l** _ _ _ _ _ _ _ _ **i** _ _ _ _ _ _ _ (**b** _ _ _ **to f** _ _ _ _).



This diagram represents how an **inverted image** (**I**) of **object O** can be formed on the retina:



To help you understand how the **inverted image** is formed, complete the diagram below.
USE A PENCIL AND RULER !!! TAKE YOUR TIME !!! BE CAREFUL !!!

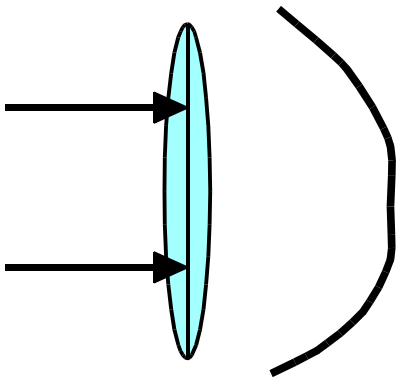


Looking at Distant Objects

When we look at an object some distance from the eye, the light rays from the object which enter our eye are **p** _ _ _ _ _ _ _ to one another.

The muscles around our eye lens are **r** _ _ _ _ _ _, so the eye lens is **t** _ _ _.

Complete the diagram:

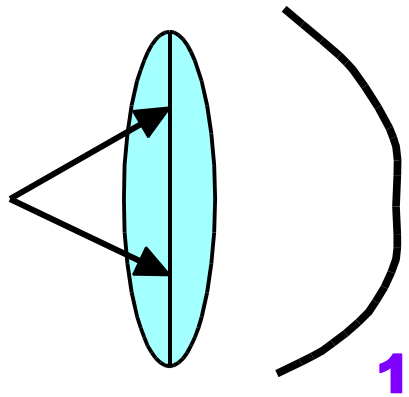


Looking at Close Objects

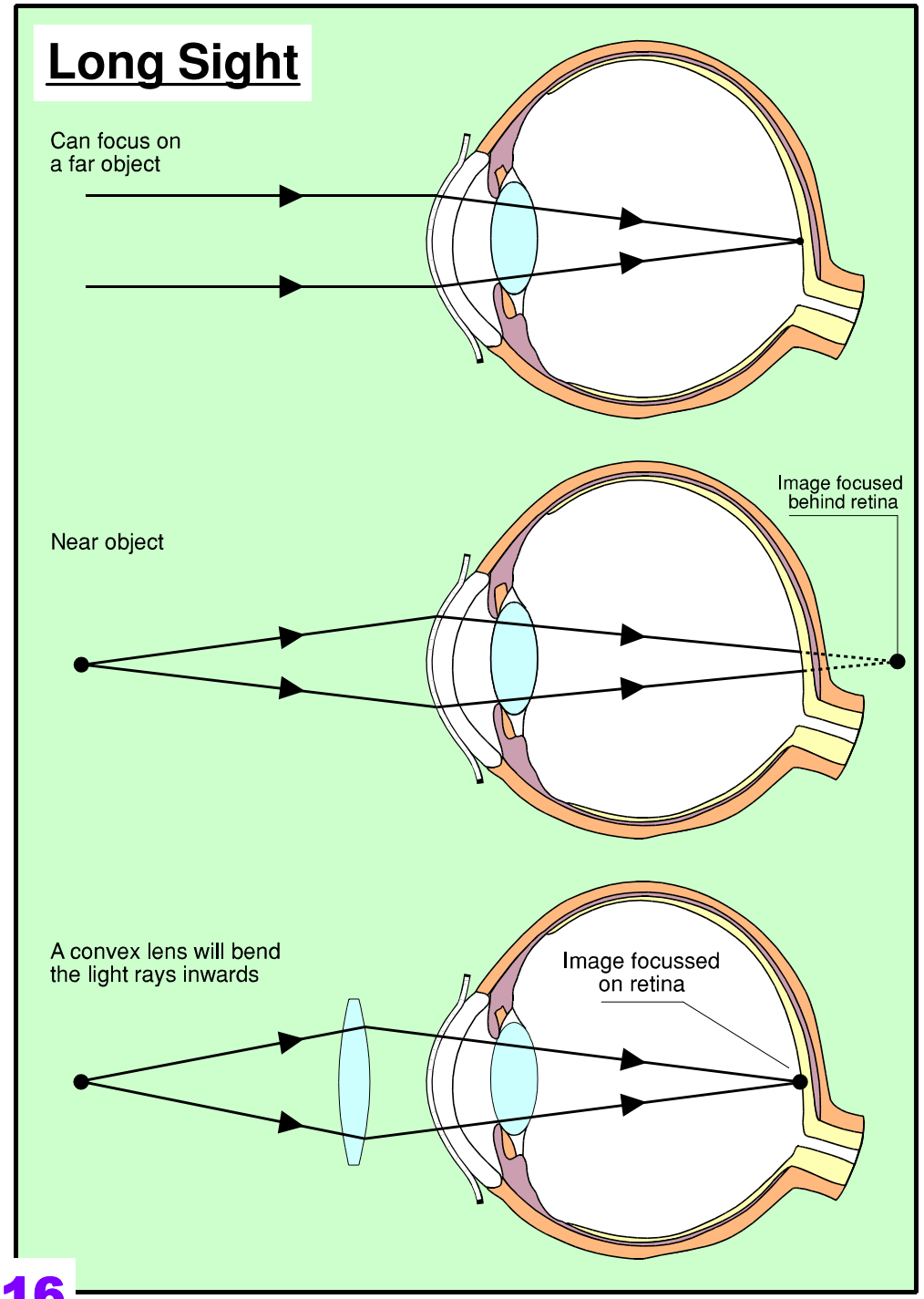
When we look at an object close to the eye, the light rays from the object which enter our eye are **n** _ _ **p** _ _ _ _ _ _ _ to one another.

The muscles around our eye lens squash it, making the lens **t** _ _ _ _ so it can focus the light rays on the retina.

Complete the diagram:



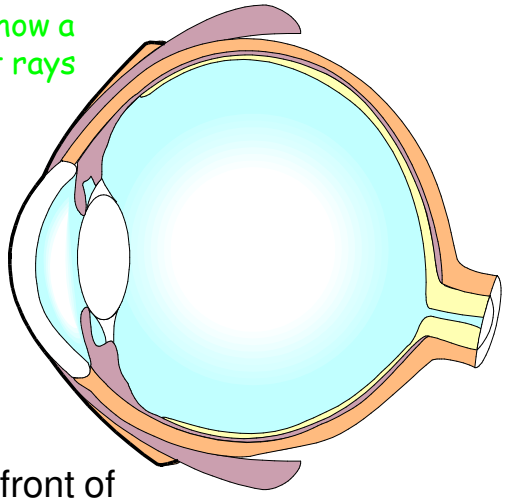
Long Sight



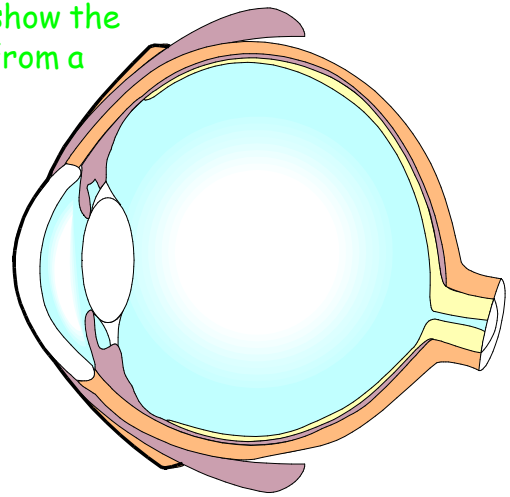
A person who is **l** _ _ _ **s** _ _ _ _ _ _ can see **c** _ _ _ _ _ _ objects which are **f** _ _ **a** _ _ _ - This is because the eye **c** _ _ focus the **p** _ _ _ _ _ _ _ light rays coming from the object on the **r** _ _ _ _ _.

However, the person cannot see **c** _ _ _ _ _ _ objects which are **c** _ _ _ _ to them - This is because the eye **c** _ _ _ _ _ focus the **n** _ _ **- p** _ _ _ _ _ _ _ light rays coming from the object on the **r** _ _ _ _ _.

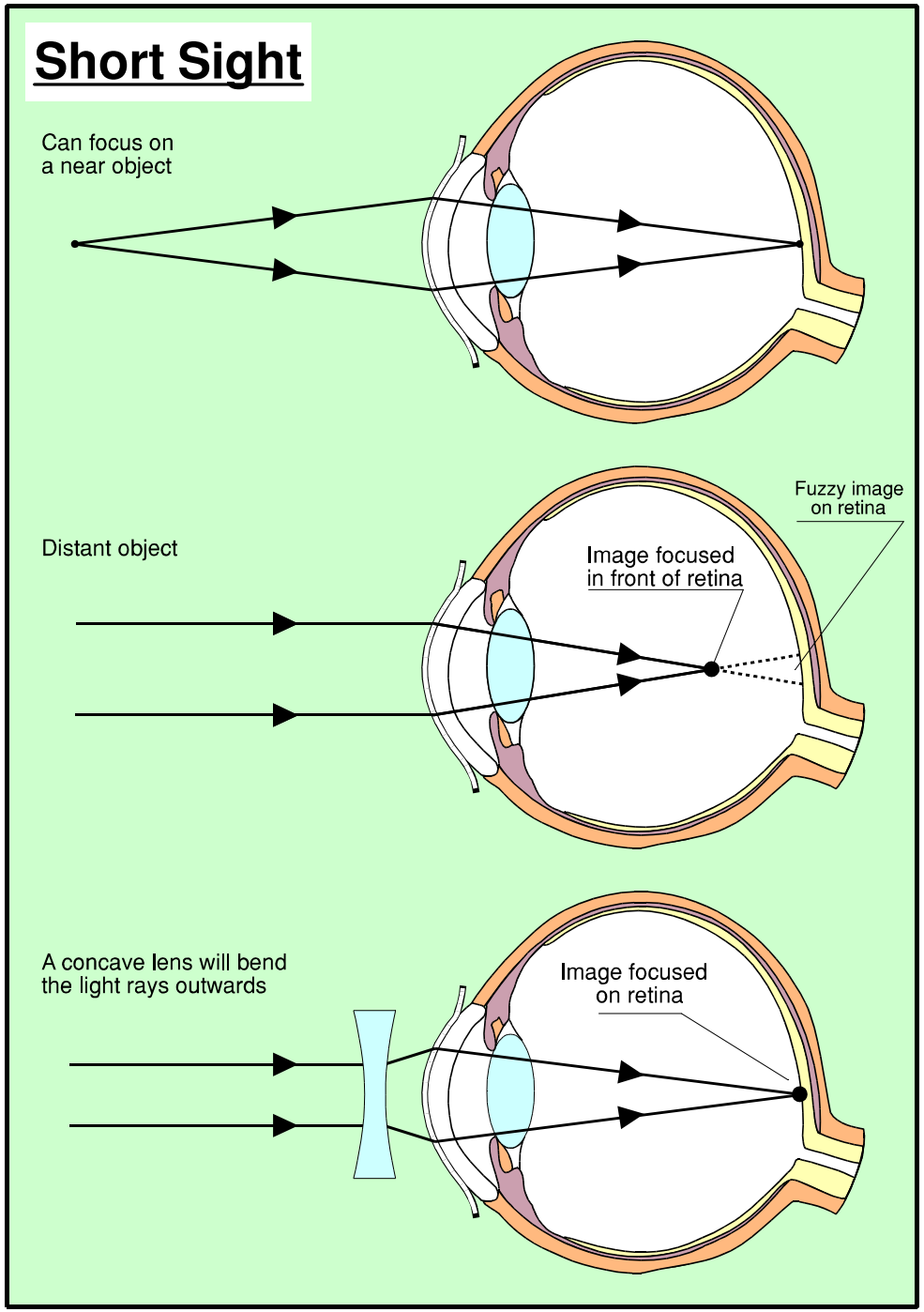
Complete this diagram to show how a "long-sighted eye" focuses light rays from a **close** object.



To correct long sight, a **c** _ _ _ _ _ **l** _ _ _ is placed in front of the eye. Complete this diagram to show the affect the lens has on light rays from a **close** object.



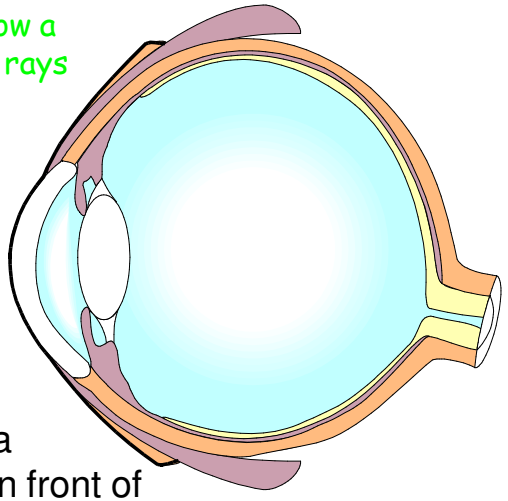
Short Sight



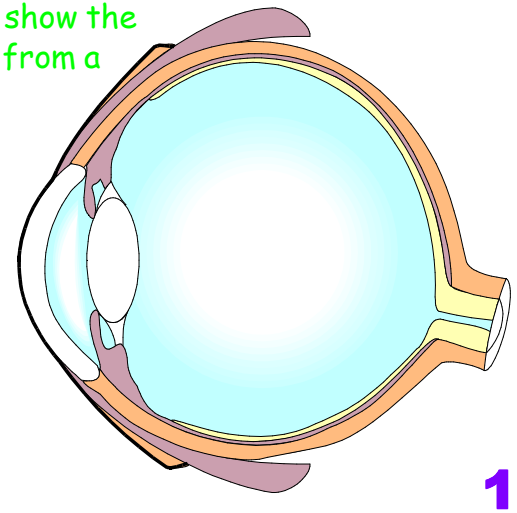
A person who is **s** _ _ _ _ **s** _ _ _ _ _ _ can see **c** _ _ _ _ _ _ objects which are **c** _ _ _ _ - This is because the eye **c** _ _ focus the **n** _ _ **- p** _ _ _ _ _ _ _ light rays coming from the object on the **r** _ _ _ _ _.

However, the person cannot see **c** _ _ _ _ _ _ objects which are **d** _ _ _ _ _ _ (**f** _ _ **a** _ _ _) - This is because the eye **c** _ _ _ _ _ focus the **p** _ _ _ _ _ _ _ light rays coming from the object on the **r** _ _ _ _ _.

Complete this diagram to show how a "short-sighted eye" focuses light rays from a **distant** object.



To correct short sight, a **c** _ _ _ _ _ _ **l** _ _ _ is placed in front of the eye. Complete this diagram to show the affect the lens has on light rays from a **distant** object.



Fibre Optics and the Fibrescope (Endoscope)

Fibre optics can be used as a transmission system for **c** _ _ _ **light** - No **h** _ _ _ **energy** passes through the system.

L _ _ _ _ passes along an **o** _ _ _ _ **f** _ _ _ _ by **t** _ _ _ _ **i** _ _ _ _ _ _ _ **r** _ _ _ _ _ _ _ _ _.

- What do the words "**total**" and "**internal**" tell you about the **reflection**? _____

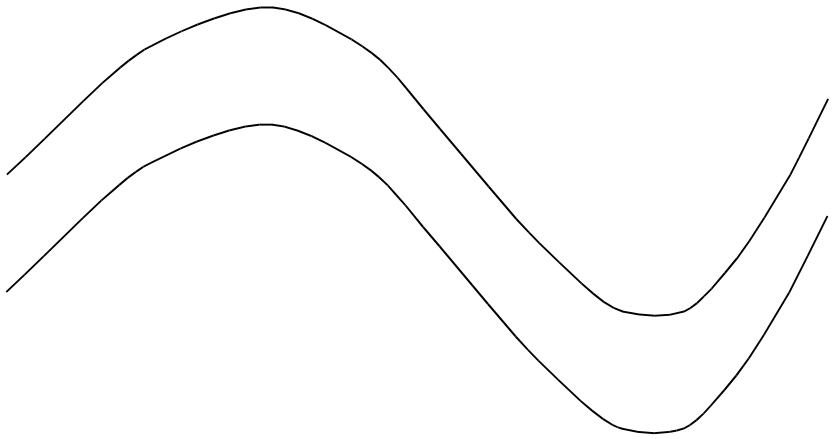
_____

_____

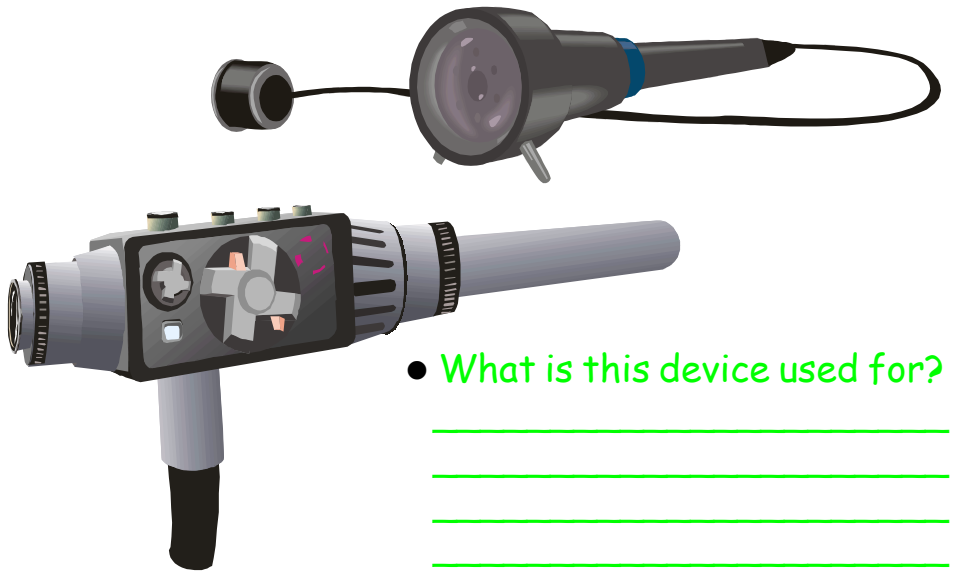
_____

_____

- Complete this diagram to show **light** passing along an **optic fibre**:



This diagram shows parts of a
f _ _ _ _ _ _ _ _ _ **(e** _ _ _ _ _ _ _ _ **)**



- What is this device used for?

_____

_____

_____

_____

- Describe and explain how it works: _____

_____

_____

_____

_____

_____

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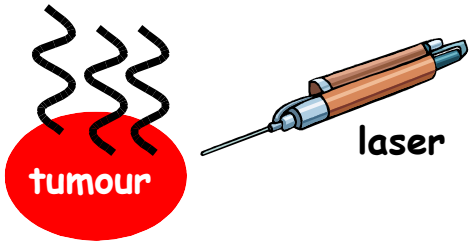
Lasers

A **laser** produces an **intense** beam of light in **one direction**.

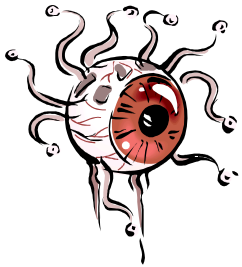
Lasers have various uses in **medicine**. For example:

Vaporising Cancer Tumours

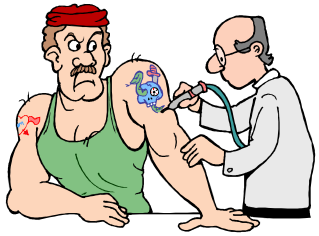


Laser Scalpel

Eye Surgery



Removing Tattoos/Birth Marks



Infra-Red (I.R.)

Infra-red rays are **i** _ _ _ _ _ _ _ _ **h** _ _ _ **rays** given out by all **w** _ _ _ **objects**.

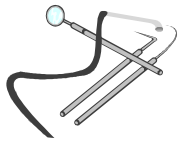
Cancer tumours are **w** _ _ _ _ _ _ than **healthy tissue**, so can be detected by the **i** _ _ _ _ - _ _ _ **rays** they give off.

Physiotherapists also use **infra-red rays** to heat up injured **m** _ _ _ _ _ _ - This speeds up the healing process.

infra-red heat lamp

Ultra-Violet (U.V.)

Ultraviolet rays can be used to kill microbes. Hospitals use UV lamps to **s** _ _ _ _ _ _ _ _ _ surgical equipment and the air in operating theatres. Food and drug companies also use UV lamps to **s** _ _ _ _ _ _ _ _ _ their products.



Large doses of **ultraviolet** cause **s** _ _ _ _ _ _ and even **s** _ _ _ **c** _ _ _ _ _. Fortunately, the ozone layer in the Earth's atmosphere screens us from most of the **ultraviolet** given off by the Sun. Think of a sun tan as a radiation burn!

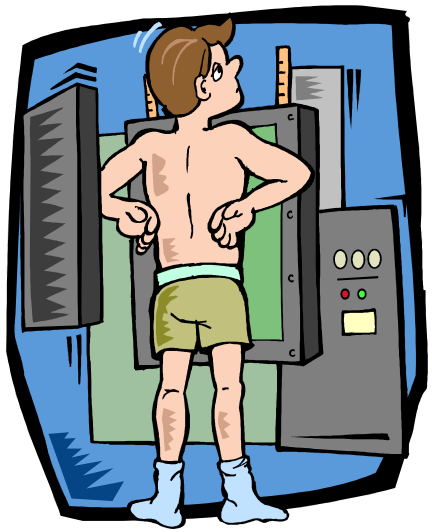
X - Rays

X-rays are very high frequency **w** _ _ _ _, and carry a lot of **e** _ _ _ _ _. They pass through most substances, and this makes them useful in medicine and industry to see inside things.

- **X-rays** are used by doctors to see inside people. They pass easily through **s** _ _ _ **t** _ _ _ _ _, but not so easily through **b** _ _ _ _.

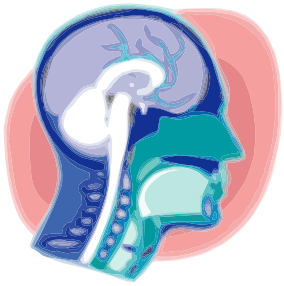
We use **p** _ _ _ _ _ _ _ _ _ _ _ **f** _ _ _ to detect **X-rays**.

We send a beam of **X-Rays** through the patient and onto a piece of **p** _ _ _ _ _ _ _ _ _ _ _ **f** _ _ _, which goes **d** _ _ _ where **X-Rays** hit it. This leaves **w** _ _ _ _ patches on the film where the **b** _ _ _ _ were in the way.



An X-ray machine

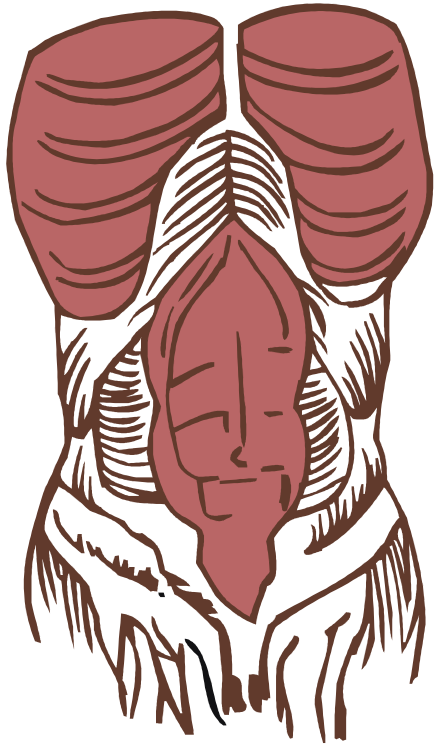
An X-ray photograph



- Low energy **X-Rays** don't pass through tissues as easily as normal **X-Rays**. They can be used to scan soft areas such as the **b** _ _ _ _.

X-Rays can also be used in **high doses** to kill **c** _ _ _ _ _ **t** _ _ _ _ _ _.

X-Rays and Computerised Tomography



Using a special **X-Ray** machine which **r** _ _ _ _ _ _ around the body, **X-Rays images** of the body are taken in **t** _ _ _ **s** _ _ _ _ _.
A computer combines all these **images** to provide a **t** _ _ _ _ **- d** _ _ _ _ _ _ _ _ _ _ picture of the body.

A **3-D image** provides far more detail than a normal **2-D X-Ray image**.

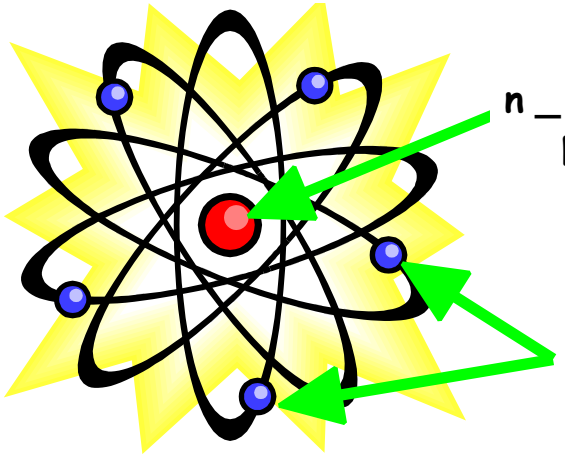
NUCLEAR RADIATION

The Atom

Everything is made up of tiny particles called **a** _ _ _ _.

Each atom contains **p** _ _ _ _ _ _ and **n** _ _ _ _ _ _ _ which are tightly packed together in a tiny centre called the **n** _ _ _ _ _ _.

Circling around the **n** _ _ _ _ _ _ are **e** _ _ _ _ _ _ _ _.



n _ _ _ _ _ _ containing **p** _ _ _ _ _ _ and **n** _ _ _ _ _ _ _

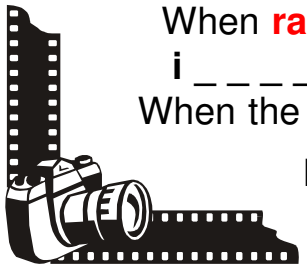
e _ _ _ _ _ _ _ _

Ionisation of Atoms

Radioactivity can knock **e** _ _ _ _ _ _ _ out of **atoms**. This is known as **i** _ _ _ _ _ _ _ _.

Radioactivity can **i** _ _ _ _ _ **atoms** in the **cells** of the **human body** - This can **k** _ _ _ the **cells** or **change their n** _ _ _ _ _ - The **cells** might grow in a different way to what they should or might change into **c** _ _ _ _ _ **cells**.

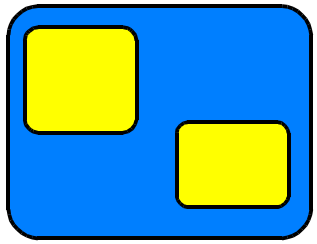
Because **radioactivity** kills living cells, it is used to **s** _ _ _ _ _ _ _ surgical instruments - The **b** _ _ _ _ _ _ **c** _ _ _ _ are **k** _ _ _ _ _.



When **radioactivity** hits **photographic film**, it **i** _ _ _ _ _ _ the **atoms** on the **film** surface. When the **film** is developed, it looks **f** _ _ _ _ _.

People who work with **radioactivity** often wear a **badge** containing **photographic film** - a **f** _ _ _ **b** _ _ _ _.

When they finish work, they hand in their **f** _ _ _ **b** _ _ _ _. The **photographic film** inside is developed.



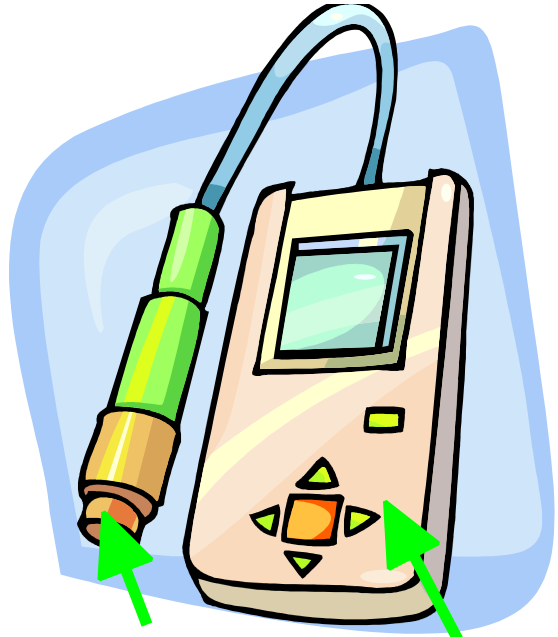
A film badge

We can tell how much **radioactivity** they have received at work by observing how **f** _ _ _ _ _ the **film** is.

We can detect **radioactivity** with a **G** _ _ _ _ _ **- M** _ _ _ _ _ **tube.**

Inside the tube there is a **gas**. When **radioactivity** enters the tube through a thin window in the front or through its walls, **atoms** in the **gas** are **i** _ _ _ _ _ _.

The **e** _ _ _ _ _ _ _ _ knocked out of the **a** _ _ _ _ form an **e** _ _ _ _ _ _ _ **c** _ _ _ _ _ _ _ - This produces a reading on a **m** _ _ _ _. This shows us that **radioactivity** is present.



Geiger - Muller tube

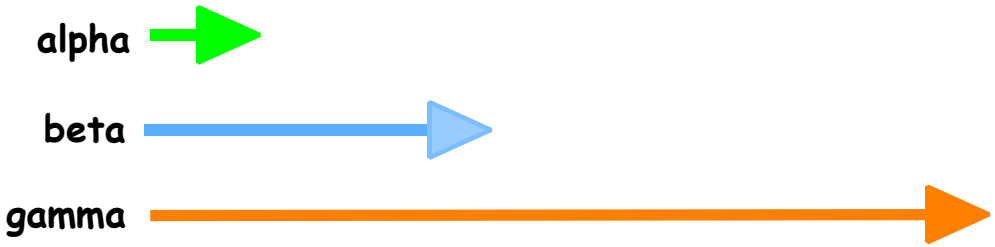
meter

Types of Radioactivity

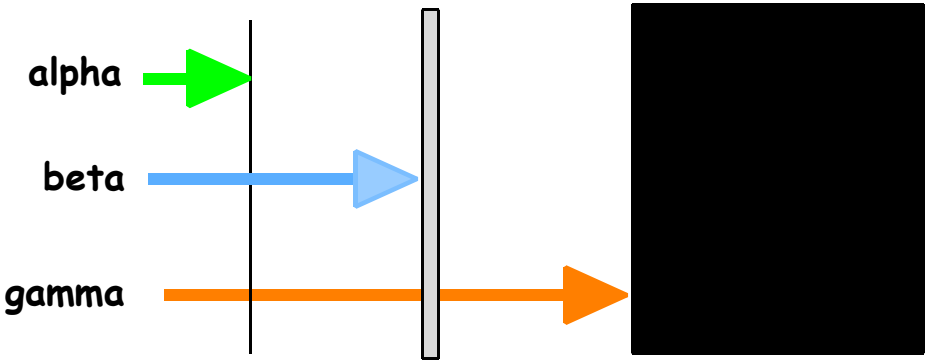
There are **3** types of **radioactivity**:

- **a** _ _ _ _ **p** _ _ _ _ _ _ _ _ _ (symbol ___)
- **b** _ _ _ **p** _ _ _ _ _ _ _ _ _ (symbol ___)
- **g** _ _ _ _ **r** _ _ _ (symbol ___)

These can travel different distances through the air:



They are **a** _ _ _ _ _ _ _ by different **types** and **thicknesses** of material:



A _ _ _ _ **p** _ _ _ _ _ _ _ _ are the most dangerous type of **radioactivity** for humans because they cause the most **i** _ _ _ _ _ _ _ _ _ and so the most **d** _ _ _ _ _ to **body cells**.

Radioactivity Safety Precautions

When dealing with **radioactive** substances, it is necessary to adopt **safety procedures**.

For example:

_____
_____
_____
_____
_____
_____
_____

radioactivity hazard symbol

Affect of Radioactivity on the Body

For **living materials**, the **biological effect** of radioactivity depends on the type of **absorbing** **t** _ _ _ _ _ and the type of **r** _ _ _ _ _ _ _ _ _ _ _ _ _.

A quantity called the **d** _ _ _ **e** _ _ _ _ _ _ _ _ _ takes account of the **t** _ _ _ and **e** _ _ _ _ _ of the **r** _ _ _ _ _ _ _ _ _ _ _ _ _.

D _ _ _ **e** _ _ _ _ _ _ _ _ _ is measured in **s** _ _ _ _ _ _ _ (_ _).

Activity of a Radioactive Source

The **a** _ _ _ _ _ _ _ of a **radioactive source** is the number of **a** _ _ _ _ **p** _ _ _ _ _ _ _ _ _ , **b** _ _ _ **p** _ _ _ _ _ _ _ _ and **g** _ _ _ _ **r** _ _ _ it gives out every **s** _ _ _ _ _.

A _ _ _ _ _ _ _ is measured in **b** _ _ _ _ _ _ _ _ _ (_ _).

The **a** _ _ _ _ _ _ _ of a **radioactive source** **d** _ _ _ _ _ _ _ _ with **time**.

Background Radiation

The air around us is slightly **radioactive** - We are exposed to this **b** _ _ _ _ _ _ _ _ _ **r** _ _ _ _ _ _ _ _ 24 hours a day.

Sources of **b** _ _ _ _ _ _ _ _ _ **r** _ _ _ _ _ _ _ _ include:

- **C** _ _ _ _ _ **r** _ _ _ **from outer space.**
- **Rocks such as g** _ _ _ _ _ _ _.
- **Hospital waste from c** _ _ _ _ _ **treatment.**
- **Nuclear w** _ _ _ _ _ **tests and leaks from nuclear p** _ _ _ _ **s** _ _ _ _ _ _ _ _.

Half-Life of a Radioactive Source

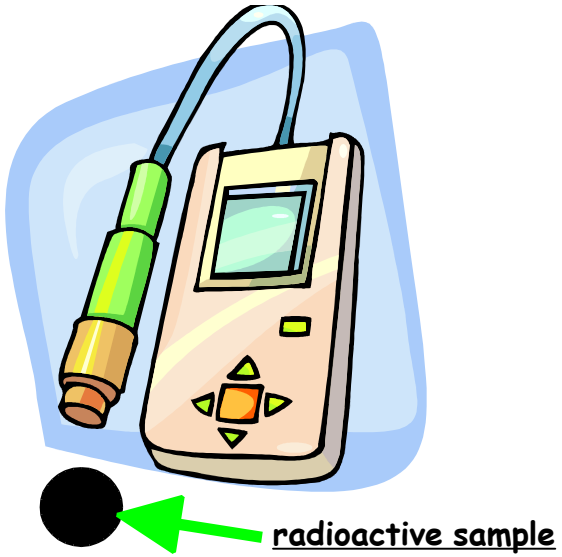
The **h** _ _ _ **- l** _ _ _ of a **radioactive source** is the **t** _ _ _ it takes for the **a** _ _ _ _ _ _ _ of the **source** to **h** _ _ _.

Different substances have **d** _ _ _ _ _ _ _ _ **h** _ _ _ **- l** _ _ _ _.

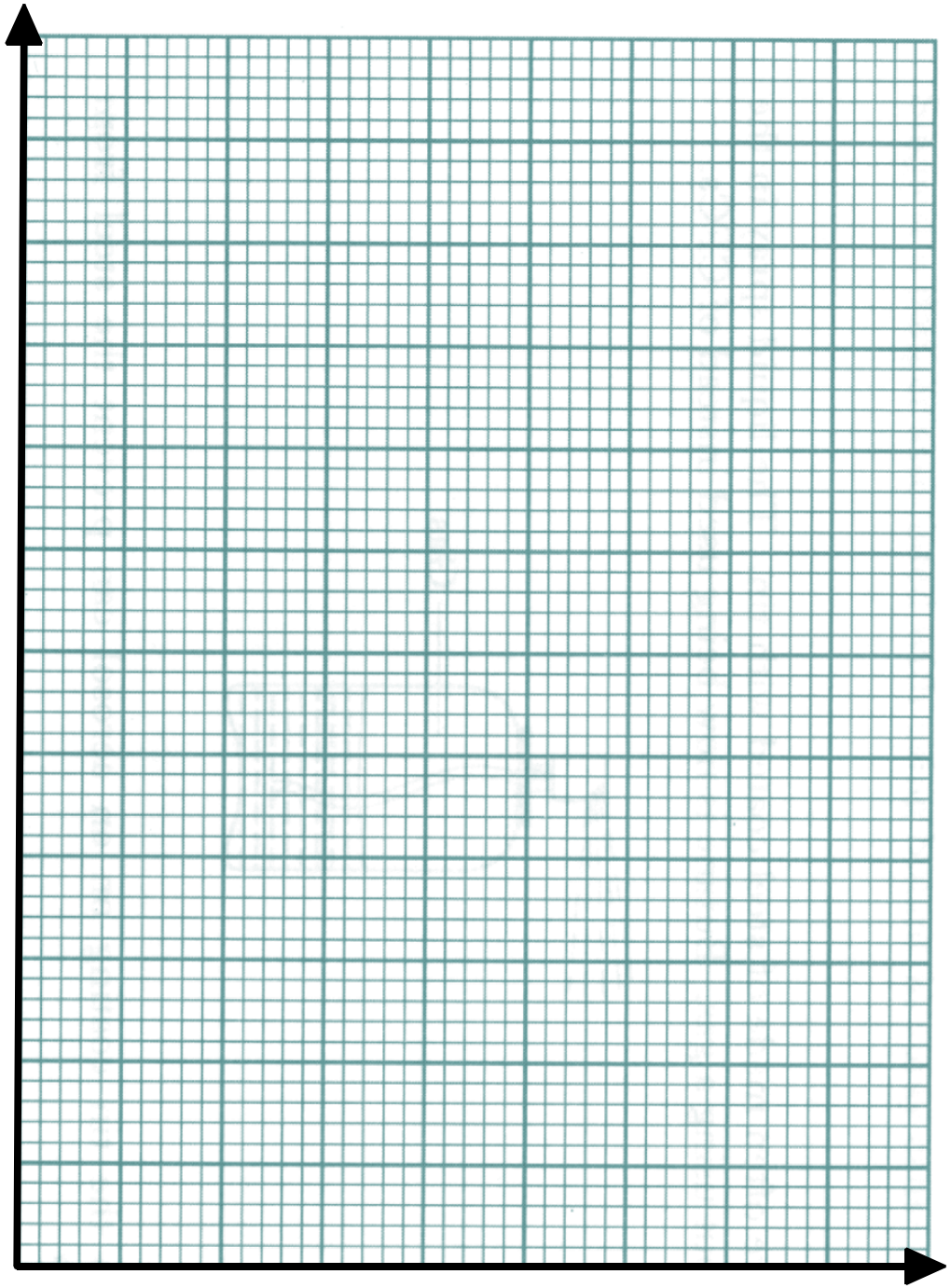
For example: _____

_____

Label this **apparatus** and describe how you would use it to measure the **half-life** of the **radioactive sample**. Include how you would allow for **background radiation**. Assume you have obtained the results provided on the next page and that you will use these results to plot a **half-life graph**:



Time / minutes	Activity (corrected for background radiation) / Bq
0	**480**
10	**240**
20	**120**
30	**60**
40	**30**



The half-life of a radioactive substance is 15 minutes. How long will it take for the activity of the substance to fall from 160 Bq to 20 Bq?

How long will it take for the activity of a radioactive source to fall from 3 200 Bq to 100 Bq if the source has a half-life of 25 days?

Determine the half-life of a radioactive source if its activity falls from 200 Bq to 25 Bq in 120 minutes.

The activity of a radioactive sample decreases from 640 Bq to 20 Bq in 100 seconds. Calculate the half-life of the sample.