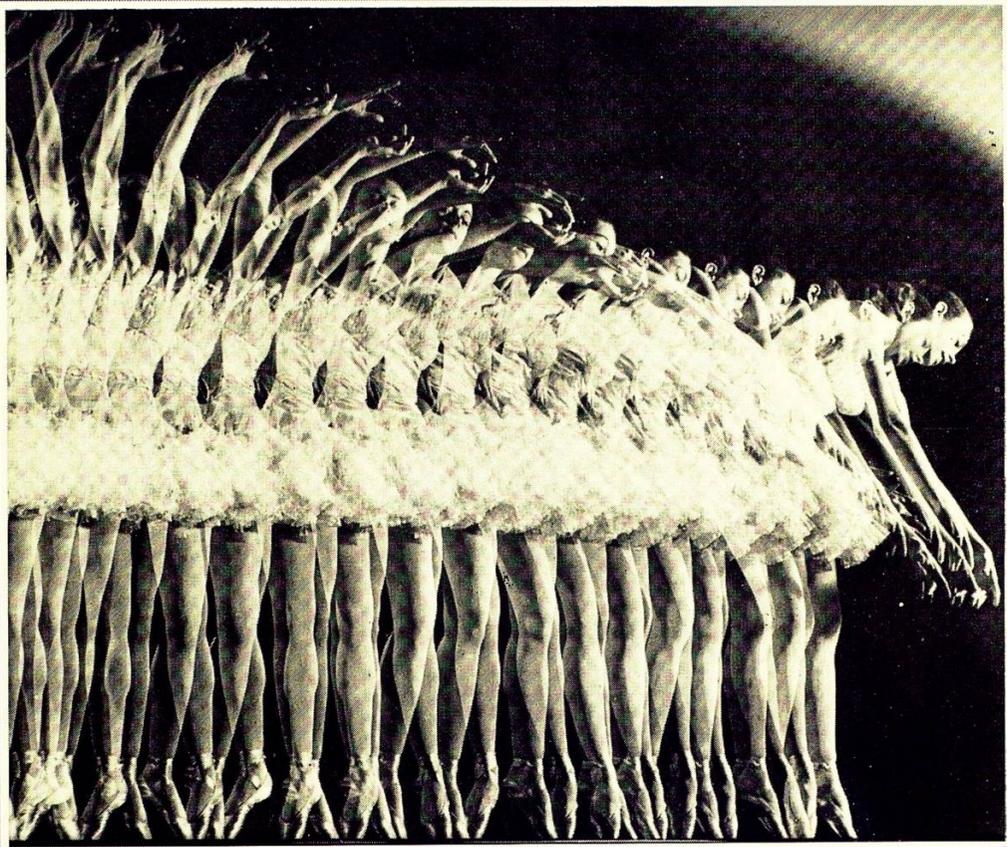


# SCIENCE AT WORK



## Photography

# SCIENCE AT WORK

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# 1 How film takes a picture

## Looking at the chemicals used on film

Apparatus

- ★ 3 test tubes      ★ 3 test tube racks      ★ 3 droppers      ★ 3 stoppers      ★ marker
- ★ bench lamp      ★ stop clock      ★ silver nitrate solution      ★ rubber gloves
- ★ sodium bromide solution      ★ developing solution

You are going to make silver bromide and find out how it is affected by light.

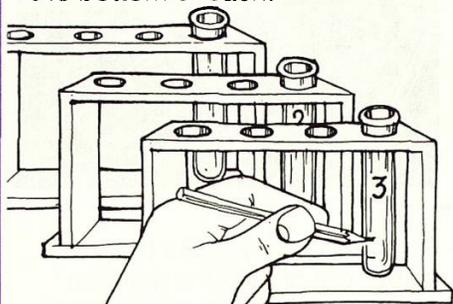


Rubber gloves must be worn when using the chemicals.

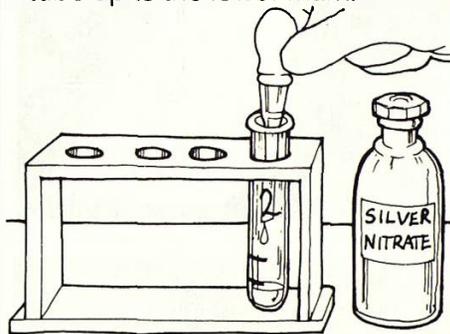
Q1 Copy this table.

| Test tube number | Place where test tube was put. | Brightness of light:<br>v. bright, bright, dim,<br>v. dim completely dark | Colour <sup>x</sup> before developing | Colour <sup>y</sup> after developing |
|------------------|--------------------------------|---|---------------------------------------|--------------------------------------|
|                  |                                |   |                                       |                                      |

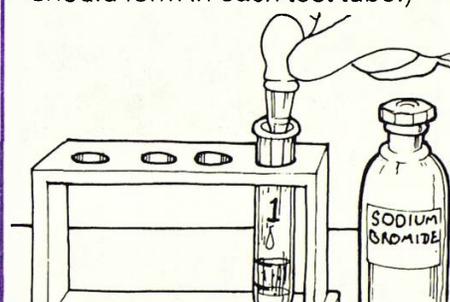
**A** Label the test tubes 1, 2 and 3. Draw a mark 2 cm from the bottom of each test tube. Draw another mark 4 cm from the bottom of each.



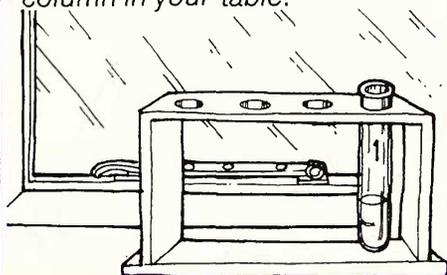
**B** Put on rubber gloves. Using a dropper, put silver nitrate solution into each test tube up to the lower mark.



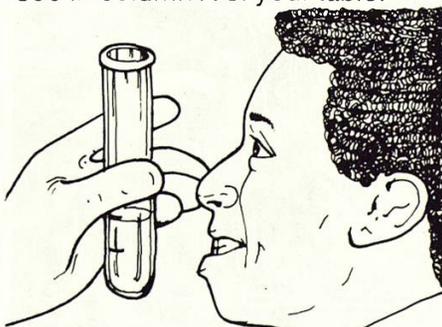
**C** Using a clean dropper, add sodium bromide solution to each test tube up to the 2nd mark. (A milky substance should form in each test tube.)



**D** Put test tube 1 near a window. Put test tube 2 in a dark cupboard. Put test tube 3 under a lamp. Switch on the lamp. Fill in the **brightness** column in your table.



**E** After 20 minutes, look closely at each test tube. Record the colours you can see in column X of your table.



**F** Using a clean dropper, add a few drops of developing solution to each test tube. Put on stoppers and shake the test tubes. Look closely at each test tube. Record the colours you can see in column Y of your table.

Q2 What effect did the developing solution have?

Q3 Which mixture was darkest?

Science Learning Centres



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# How film takes a picture

## Making shadow prints

Apparatus.

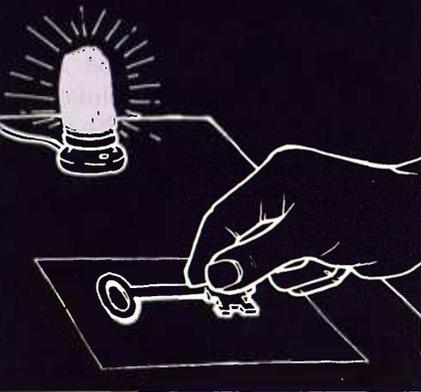
- ★ photographic paper
- ★ object to photograph
- ★ plastic tongs
- ★ dishes of developing, stop-bath and fixer solutions
- ★ bench lamp
- ★ stop clock
- ★ paper towels
- ★ safe light
- ★ rubber gloves

You are going to make a shadow print of an object. This work must be done in the dark using a 'safe' light.

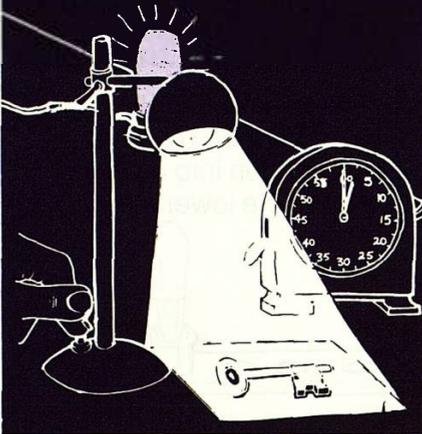


Rubber gloves must be worn when using the chemicals.

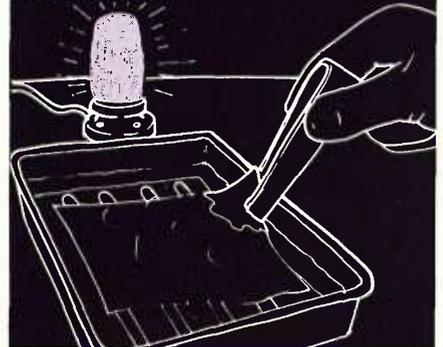
**A** Put a sheet of photographic paper, shiny side up, onto the bench. Put the object you want to photograph onto the paper.



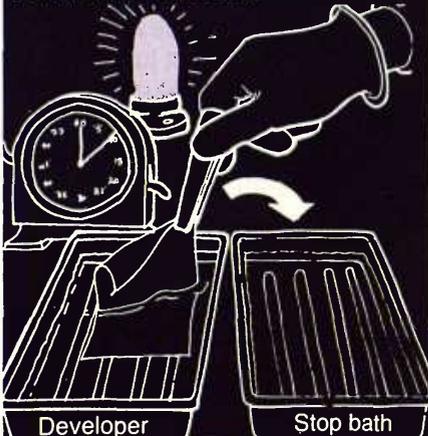
**B** Stand a bench lamp over the photographic paper. Switch on the lamp for 10 seconds. Then switch it off.



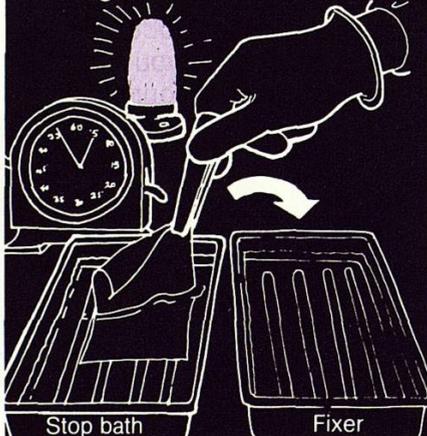
**C** Put on rubber gloves. Using tongs, slide the photographic paper, shiny side up, into the developing solution. Leave it in the solution until a clear picture can be seen.



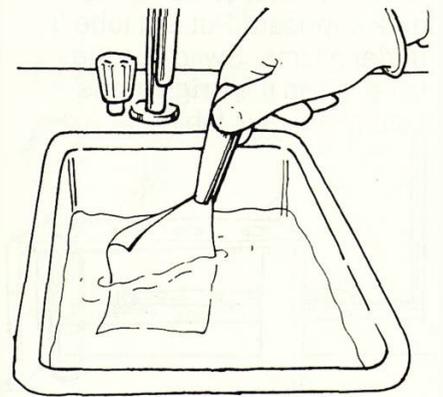
**D** Using tongs, take the paper out of the developing solution. Rinse it in stop-bath solution for about 15 seconds.



**E** Using tongs, put the paper into fixer solution and leave for 5 minutes. Now switch on the room lights.



**F** Using tongs, take the paper out of the fixer solution. Wash the paper thoroughly in a bowl or sink of water. Then dry it between paper towels.



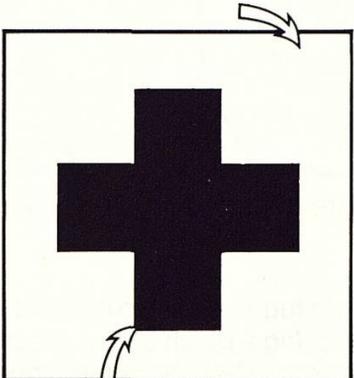
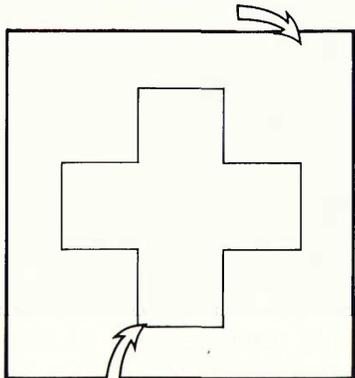
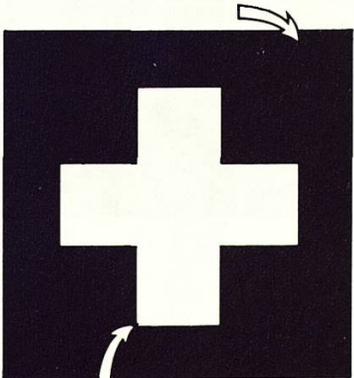
**Q4** Did you get a good photograph of the object?

**Q5** Why is this method of photography not very useful?

## Information: How film takes a picture

Photographic paper is coated with a thin layer of **emulsion**. This emulsion is a mixture of **gelatin** and light sensitive **silver halide crystals**. When light falls on the paper, the crystals are changed to black particles (bits) of metallic silver.

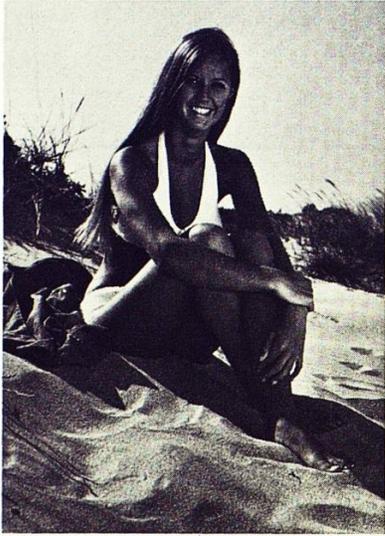
The **developing solution** speeds up this change. The silver shows up as dark grey or black patches. The patches where most light has fallen are darkest.

|  |  |
|--|--|
| <p>white (reflects a lot of light to the film)</p>  <p>black (reflects no light to the film)</p> <p>Suppose we photograph this design . . . . .</p>  | <p>some silver halide crystals changed here</p>  <p>silver halide crystals unchanged here</p> <p>. . . if the film could be seen before it is developed, it would look like this.</p>   |
| <p>dark area of silver metal particles</p>  <p>silver halide crystals not affected</p> <p>After developing, it would look like this. This is called a <b>negative</b>. The white area of the design appears black and the black area appears white.</p> | <p>A photograph is made <b>permanent</b> (that is, stopped going too dark) by putting it into <b>fixer solution</b>. This takes away the unaffected silver halide crystals. The film is no longer sensitive to light. It can then be kept for a long time.</p> <p><b>Q6</b> What is a negative?</p> <p><b>Q7</b> What does fixer solution do?</p> <p><b>Q8</b> Why are silver halide crystals useful in photography?</p> |

# How film takes a picture

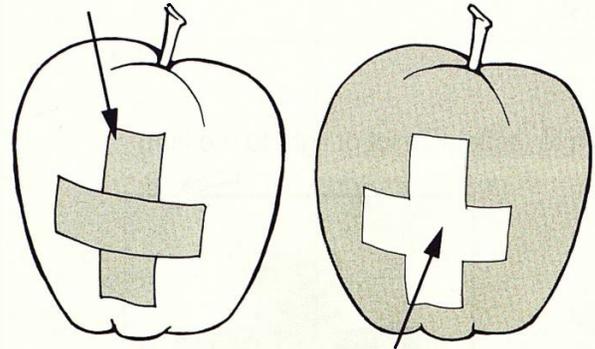
## Information: Shadow prints

A shadow print (or **photogram**) is a photograph taken without using a camera. Many substances are changed when **exposed** to sunlight.



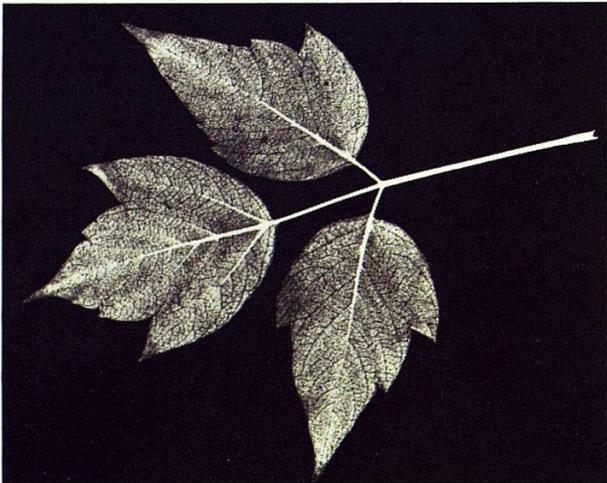
The skin turns brown in strong sunlight. The straps on the bathing costume act as a **screen** between the sun and the skin. They stop the skin underneath going brown.

sticky tape on green apple

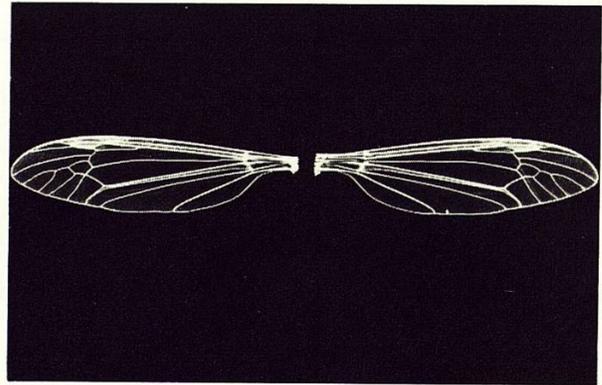


green patch left when tape removed

A green apple turns red when it ripens. This can be tested by sticking a patch onto a green apple. The patch is removed when the apple is ripe. The apple is green underneath.



Many interesting designs can be made this way. The photographic paper you used in your experiment contains tiny crystals of silver halide.



The crystals are far more sensitive to light than human skin, or fruit.

**Q9** What is a photogram?

**Q10** In what way is photographic paper similar to human skin?

# 2 The pinhole camera

## Looking at things through a pinhole camera

### Apparatus

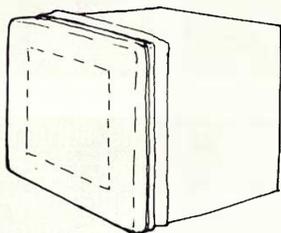
- ★ pinhole camera
- ★ tracing paper
- ★ sugar paper
- ★ pin
- ★ 2 rubber bands
- ★ lamp or candle

You are going to investigate a pinhole camera.

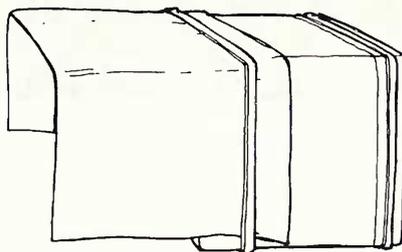
**Q1** Copy this table.

| Size of pinhole. | Image-clear or blurred. | Image-coloured or black and white. | Image-bright or dull. | Image-upright or upside-down. |
|------------------|-------------------------|------------------------------------|-----------------------|-------------------------------|
| Small.           |                         |                                    |                       |                               |
| Large.           |                         |                                    |                       |                               |

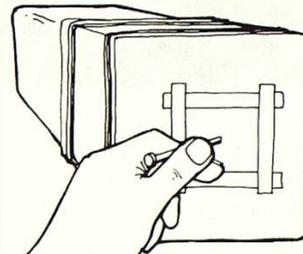
**A** Using a rubber band, fix some tracing paper to the open back of a pinhole camera. This will act as a **screen**.



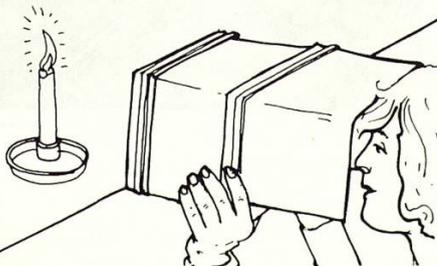
**B** Using a rubber band, fix a piece of sugar paper around the screen end of the camera. This acts as a shade for the screen.



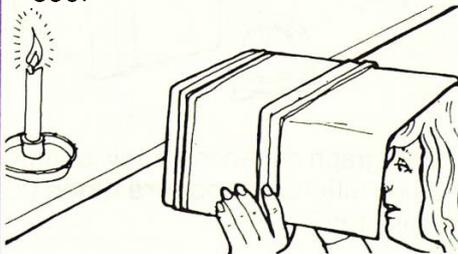
**C** Using a pin, make a small, neat hole in the centre of the foil at the front of the camera. The camera is now ready to use.



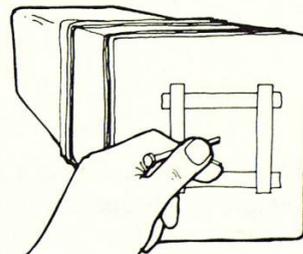
**D** Work in a darkened area. Point the pinhole end of the camera at a bright object (a lamp or candle). Look at the screen.



**E** Move the camera nearer to, then further away from the bright object. Look at the **image** (picture) on the screen. Record in your table what you see.



**F** Using the pin, make the pinhole bigger. Look at the image of the bright object on the screen. Record in your table what you see.



**Q2** Draw a labelled diagram of a pinhole camera.

**Q3** Is the image clearer with a small or large pinhole? Why do you think this is so?

# The pinhole camera

## Taking photographs with a pinhole camera

### Apparatus

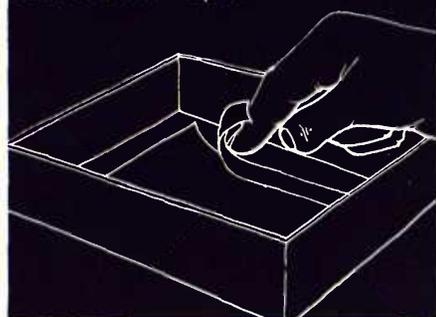
- ★ pinhole camera
- ★ photographic paper
- ★ sugar paper
- ★ black tape
- ★ scissors
- ★ stop clock
- ★ plastic tongs
- ★ dishes of developing, stop-bath and fixer solutions
- ★ paper towels
- ★ rubber gloves
- ★ safe light

You are going to use a pinhole camera to take a photograph. Steps A, B, C and F must be done in the dark using a 'safe' light.

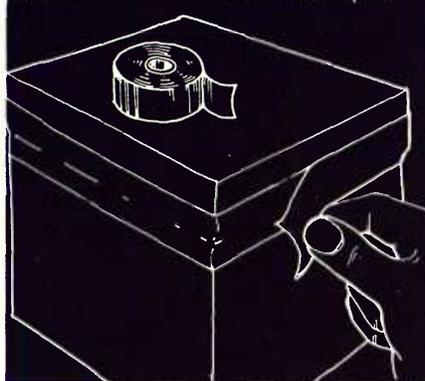


Rubber gloves must be worn when using the chemicals.

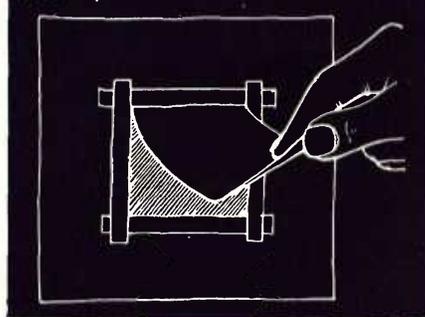
**A** With the shiny side facing up, fix a piece of photographic paper inside the lid of a pinhole camera with tape.



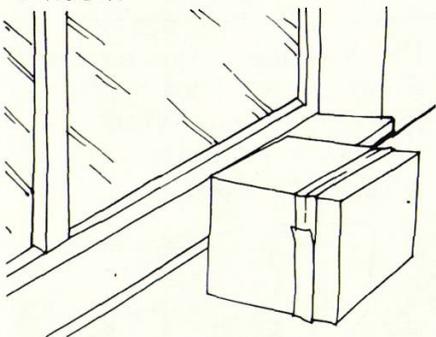
**B** Fix the lid on to the camera. Seal it with black tape.



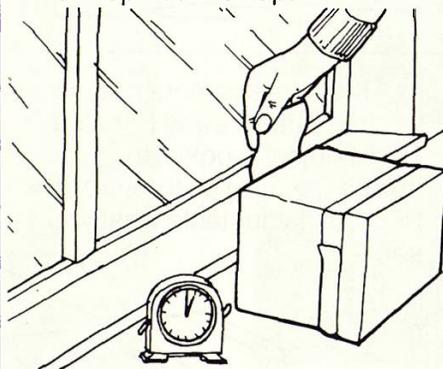
**C** Using tape and a piece of sugar paper, make a hinged flap to cover the pinhole. Close the flap.



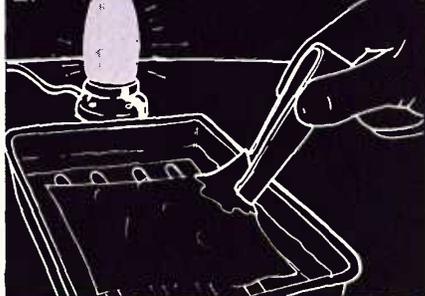
**D** Put the camera on a firm surface next to a window. Point the pinhole end towards the window.



**E** Carefully, lift the flap. Leave the camera for 1 minute. Then replace the flap.



**F** Using the safe light, take out the photographic paper. Develop the photograph by following steps C to E on page 2.



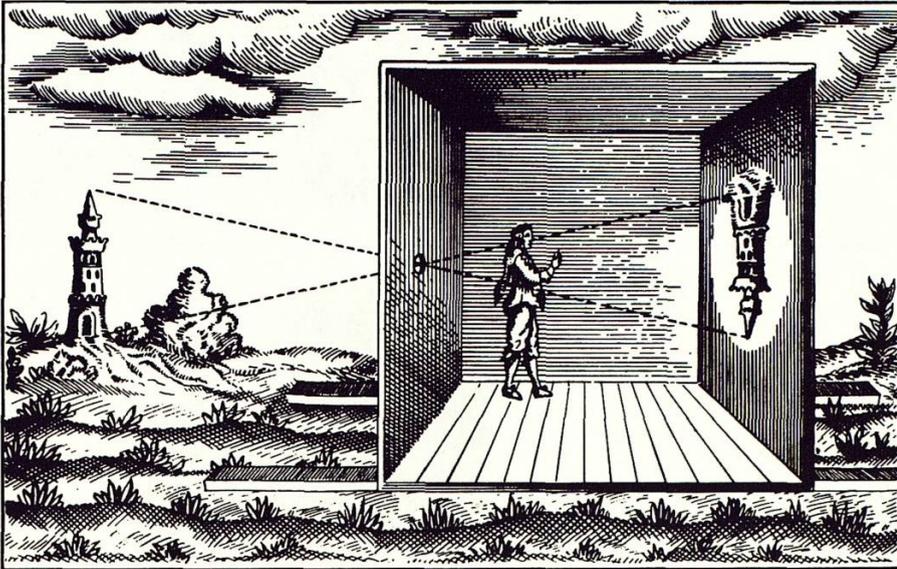
**G** The time needed to get a good photograph depends on how bright or dull the daylight is. Repeat steps A to E, trying different **exposure times** (leaving the camera open for more or less time in step E).

**Q4** What was the best exposure time?

**Q5** Imagine the day had been sunnier. Would you have needed a longer or shorter exposure time?

## Information: The pinhole camera

In the 10th century, Arabian scholars found that light coming through a small hole into a darkened room made a picture of the scene outside. The picture was on the opposite wall, and was upside-down.



In the 16th century, the same idea was used in the **camera obscura**.

In effect, the people were inside a huge camera. Using a lens instead of a pinhole gave a much brighter image.

A Frenchman, Nicéphore Niépce, was the first person to record a picture with a camera in 1826. It took 8 hours to make the picture because the chemicals he used were less sensitive to light than those used today.

Soon afterwards an Englishman, Fox Talbot, started recording pictures using a method very similar to that used today. First, he made a **negative**. From that he made a **positive print** which was an accurate copy of the original scene. A disadvantage of this method was that the paper used for negatives was easily torn or creased. This is one of Fox Talbot's earliest photographs.



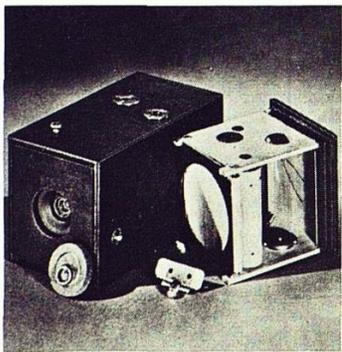
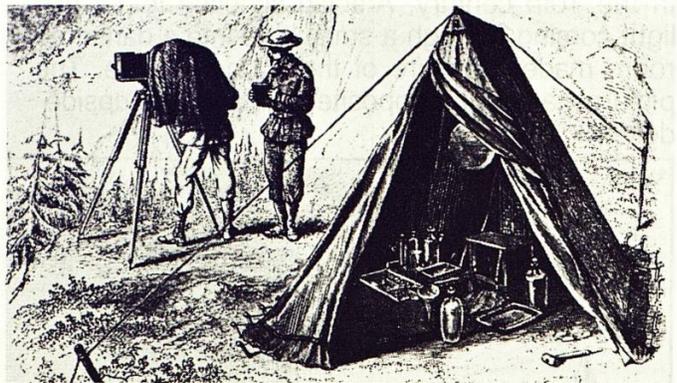
**Q6** What is a camera obscura?

**Q7** How can a pinhole camera be improved?

# The pinhole camera

## Information: Camera development

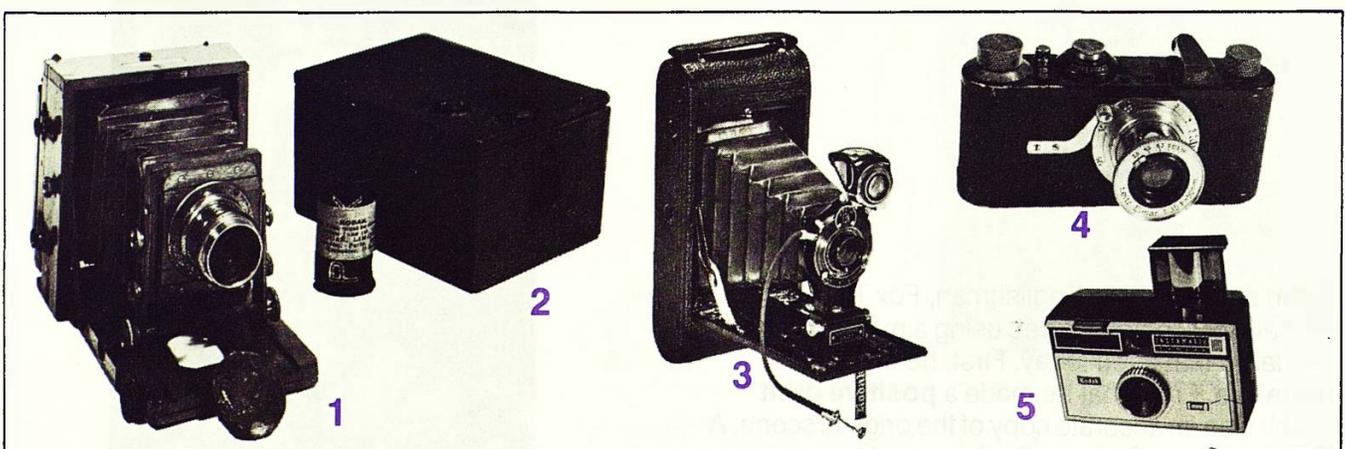
Early photographers had to carry around with them a lot of heavy equipment. The cameras they used were very big and used heavy, glass slides. They also needed a tripod and a tent to use as a darkroom.



The **flexible** film that we use today was invented by George Eastman. He also developed a simple camera in 1888 which could be used by people with little skill in photography.



The camera, called the No 1 Kodak, was loaded for 100 exposures. The whole camera was sent back to the factory for developing, printing and reloading. The photographs were round like this one.



Since the No 1 Kodak was introduced, many changes and improvements have been made to cameras and film. Here is a range of cameras from 1894 to 1963.

1. An early plate camera
2. An early roll film camera
3. A folding roll film camera
4. The first 35 mm camera (Leica)
5. The first easy-load **cartridge** camera

# 3 A simple camera

## Using a lens in a pinhole camera

### Apparatus

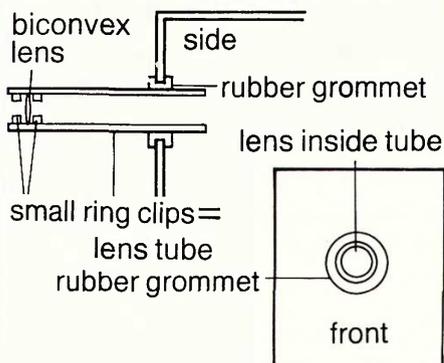
- ★ pinhole camera
- ★ lens holding tube
- ★ small biconvex lens
- ★ rubber grommet
- ★ small ring clips
- ★ tracing paper
- ★ rubber band
- ★ plasticine
- ★ photographic paper
- ★ black tape
- ★ safe light
- ★ dishes of developing, stop-bath and fixer solutions
- ★ plastic tongs
- ★ rubber gloves

You are going to take a picture with a simple lens camera. Steps C, D and F must be done in the dark using a 'safe' light.

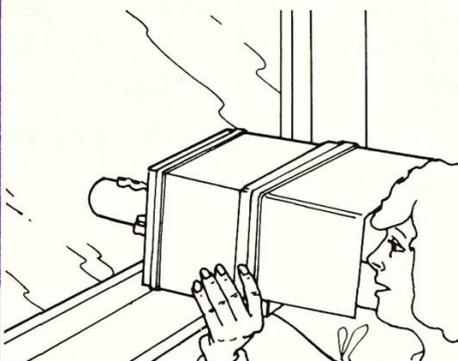


Rubber gloves must be worn when using the chemicals.

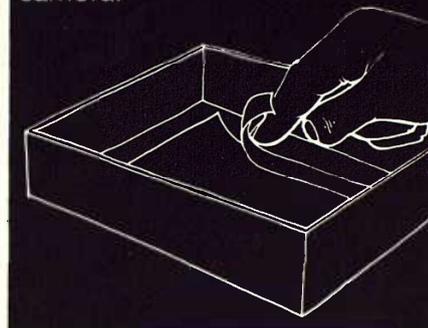
**A** Fix the lens holder into the camera, as shown. Fix the tracing paper to the back of the camera with a rubber band.



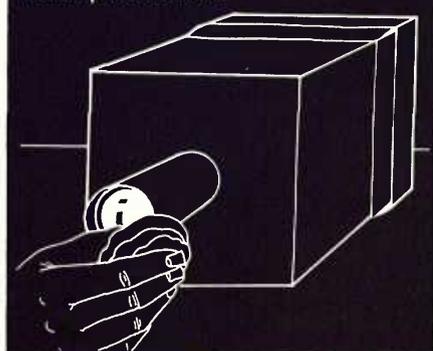
**B** Point the camera at a window. Slide the lens tube in and out until you get a clear image on the screen.



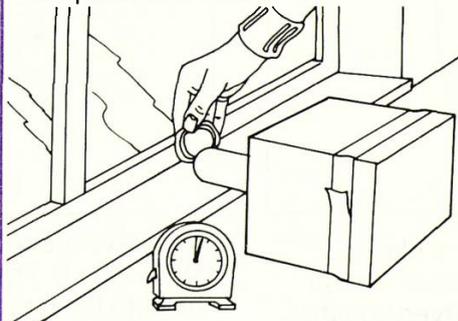
**C** Remove the screen carefully. **In the dark**, tape a piece of photographic paper, shiny side up, into the lid of the camera.



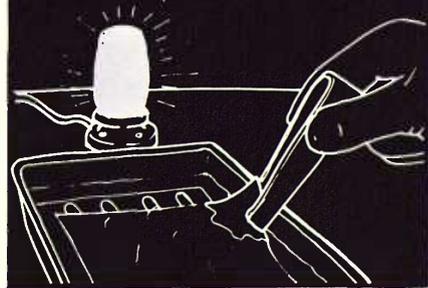
**D** Fix the lid on the camera. Seal it with black tape. Carefully, cover the lens-tube with plasticine.



**E** Put the camera on a firm surface, pointing through a window. **Carefully**, take off the plasticine. After 2 seconds, put the plasticine back.



**F** Using the safe light, take out the photographic paper. Develop the photograph by following steps C to E on page 2. Repeat the experiment with different exposure times.



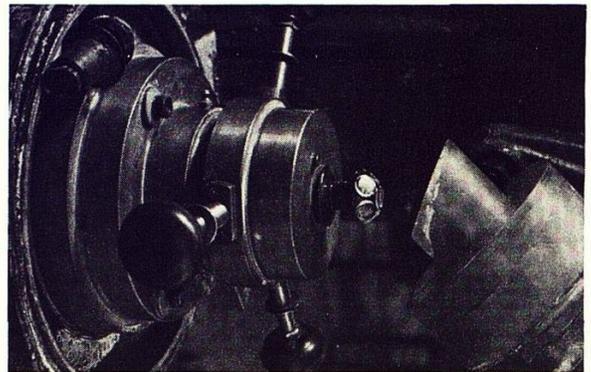
**Q1** What was the best exposure time?

**Q2** Did you get a better picture than the one from the pinhole camera (page 6)?

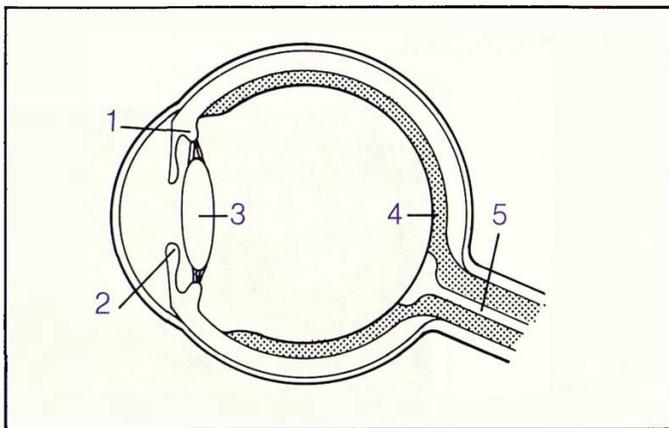
# A simple camera

## Information: Lenses

The photograph shows lenses being made.



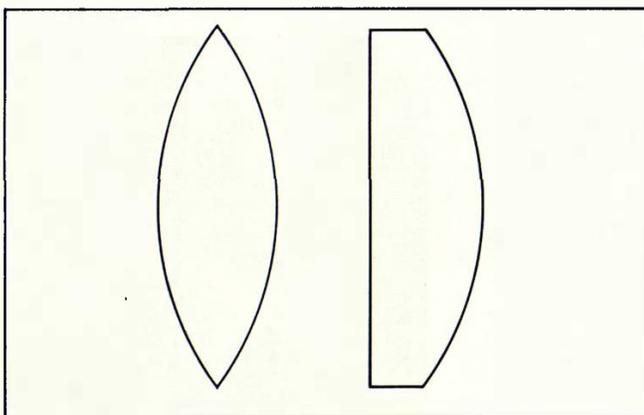
The camera works in much the same way as the human eye. Both have a lens which collects light from an object and **focuses** it to form a sharp image. The **iris** of the eye opens up in dim light and closes in bright light. The lens opening of an automatic camera works in this way too.



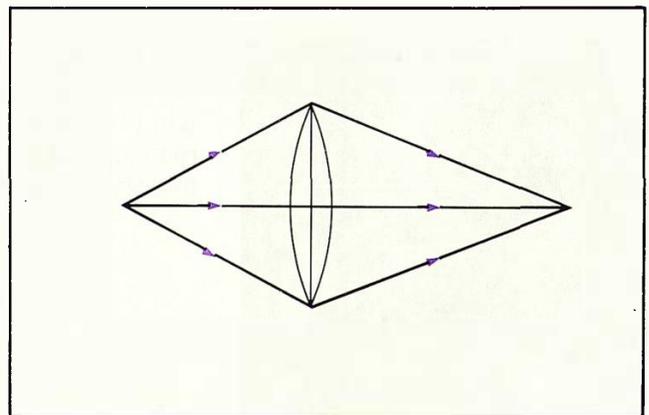
### Basic features of the human eye.

1. **Ciliary muscles** — let the eye focus on objects at different distances.
2. **Iris** — opens and closes to control the amount of light reaching the retina.
3. **Lens** — **gelatinous** (jelly-like) **transparent** (see-through) substance.
4. **Retina** — the image from the lens forms on this.
5. **Optic nerve** — connects the eye with the brain.

## A simple camera lens



A camera lens is made from a piece of plastic or glass. It has 2 opposite, regular surfaces. These can either both be curved, or one curved and the other flat.



Light rays are reflected from an object onto the camera lens. The rays are bent as they pass through the lens. The rays are bent more at the edges of the lens.

**Q3** Which part of a camera does a similar job to the retina in the eye?

**Q4** Would the iris be open or almost closed in bright sunlight?

# 4 Using a commercial camera

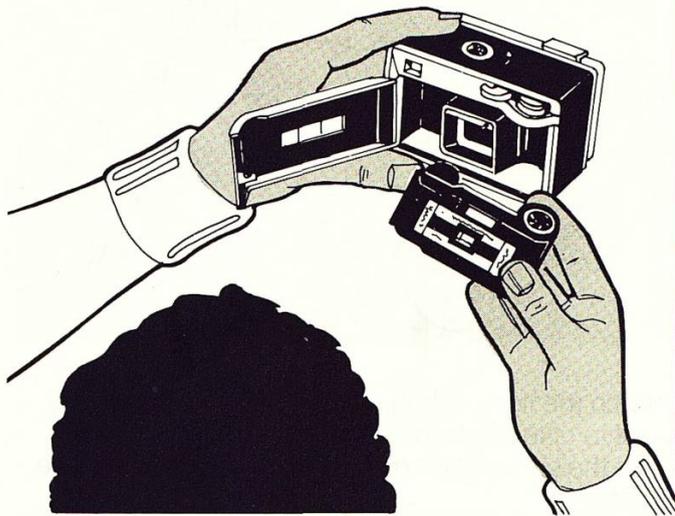
## Loading the camera and taking photographs

Apparatus

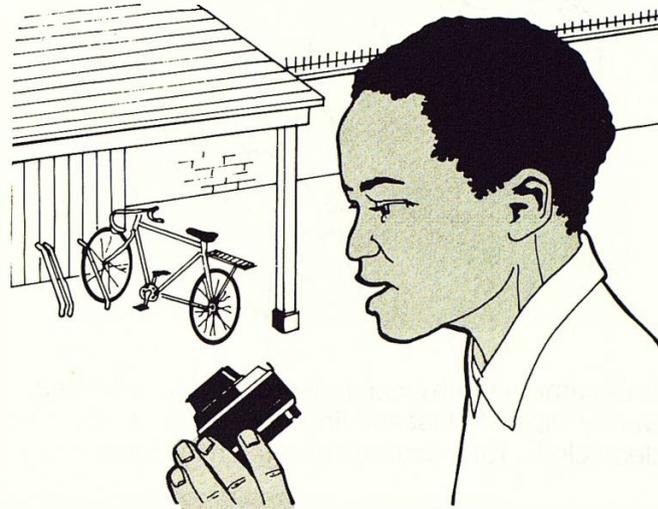
★ camera      ★ roll film or cartridge

You are going to load a camera and take some photographs.

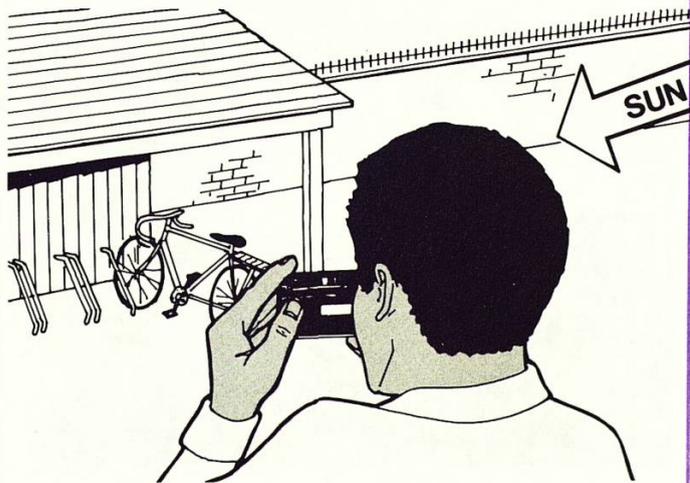
**A** Load a film into the camera. Close the back of the camera. Wind on the film to the first picture.



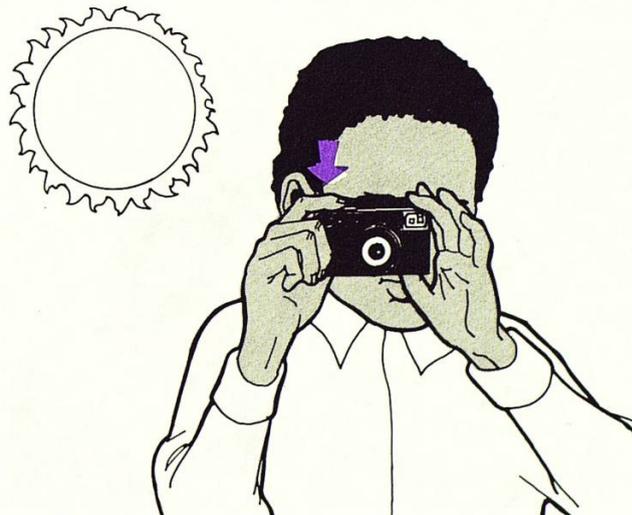
**B** Choose a scene to photograph. Set the **focusing distance** and the **aperture** if your camera is adjustable.



**C** Look through the **viewfinder** and make sure the scene is in the middle. Make sure the sun is behind you.



**D** Hold the camera steady against your face. Squeeze the shutter **gently**. Then wind on the film.



**E** When you have finished the film, take it out of the camera. Keep the film for developing and printing (chapters 5 and 6).

**Q1** Why is it important to make sure the scene is in the middle of the view finder?

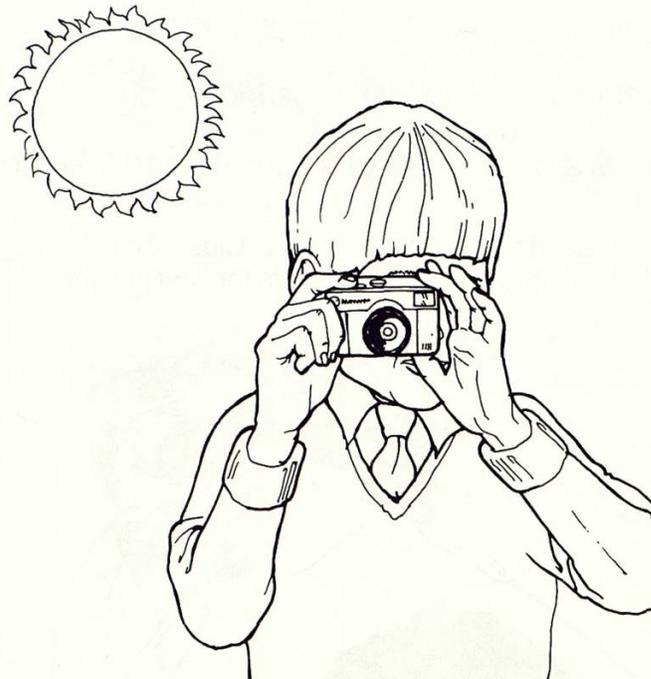
**Q2** Why should you squeeze the shutter **gently**?

# Using a commercial camera

## Information: Taking pictures



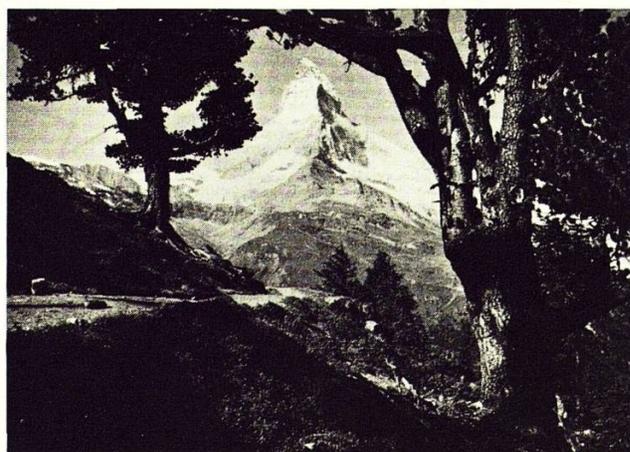
Only cameras with clean lenses take good pictures. Gently wipe off dust and fingerprints with a soft, clean cloth. Take care not to scratch the lens.



Watch the light. When using a simple camera, it is best to take photos outdoors in **sunlight**. Make sure the sun is behind you. For indoor pictures, use a flash.



Keep your camera steady to get a clear picture. Stand still and hold the camera firmly in both hands. Squeeze the shutter release **gently**.



Keep your picture level. Use the horizon, or vertical (upright) buildings as a guide. If you can, use a frame of branches or rocks in the foreground when taking photos of views.

## Using a commercial camera

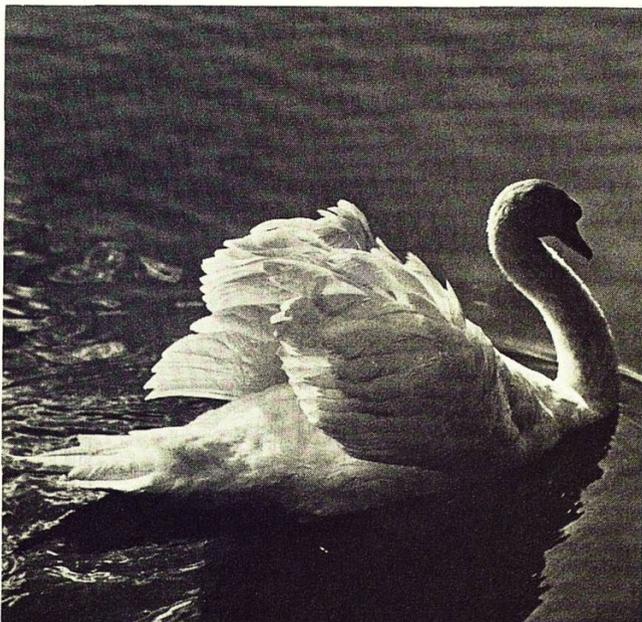
Here are some good photographs and tips on how you can take them.



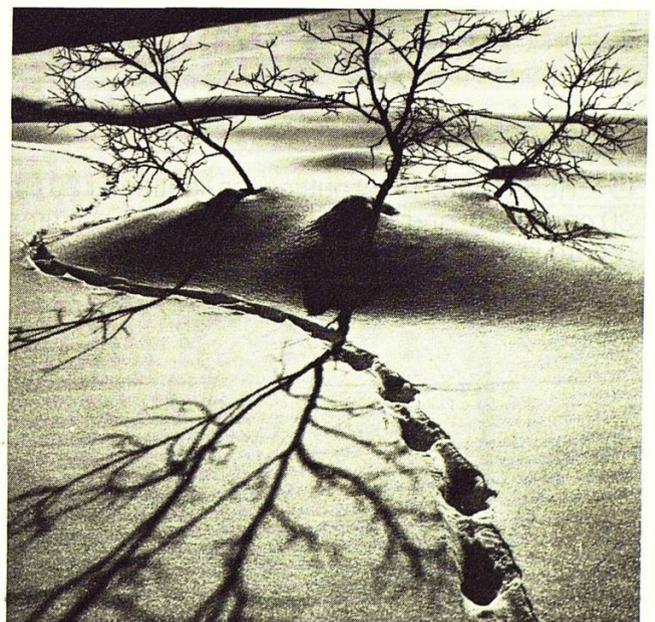
People do not look natural staring stiffly at a camera. Take photos of people doing things.



For best results, when using flash, keep within the distance range of your camera. This is usually 1–3 metres.



It is often more interesting to take **close-ups**. With most cameras you can get as close as 1–1.5 metres.



Keep your scenes simple. Have **one** centre of interest. Look at the background as well as the foreground. Avoid cluttered backgrounds.

**Q3** Why should you take photographs with the sun behind you?

**Q4** What should you do to get a good picture with flash?

# Using a commercial camera

## Measuring light intensities

Apparatus

★ lightmeter    ★ bench lamp    ★ ruler

You are going to find out how to use a lightmeter.

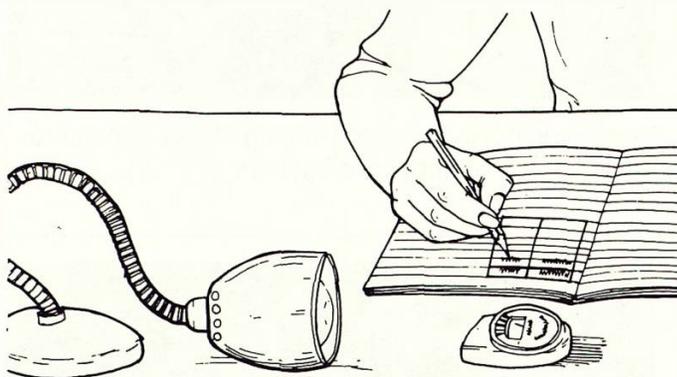
**Q5** Copy this table.

| Distance from Lamp | Reading on meter. |
|--------------------|-------------------|
|--------------------|-------------------|

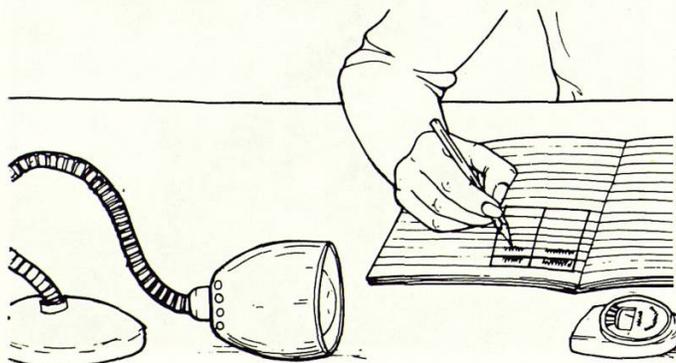
**A** Put your finger over the lightmeter. Adjust it so the reading is zero.



**B** Switch on the bench lamp. Put the lightmeter 10 cm from the lamp. Record in your table the reading on the meter.



**C** Repeat step B but putting the lightmeter 20 cm, 30 cm, 40 cm and 50 cm from the lamp. Each time record in your table the reading on the meter.



**D** Take the lightmeter to different parts of the room. See what happens to the readings on the meter.

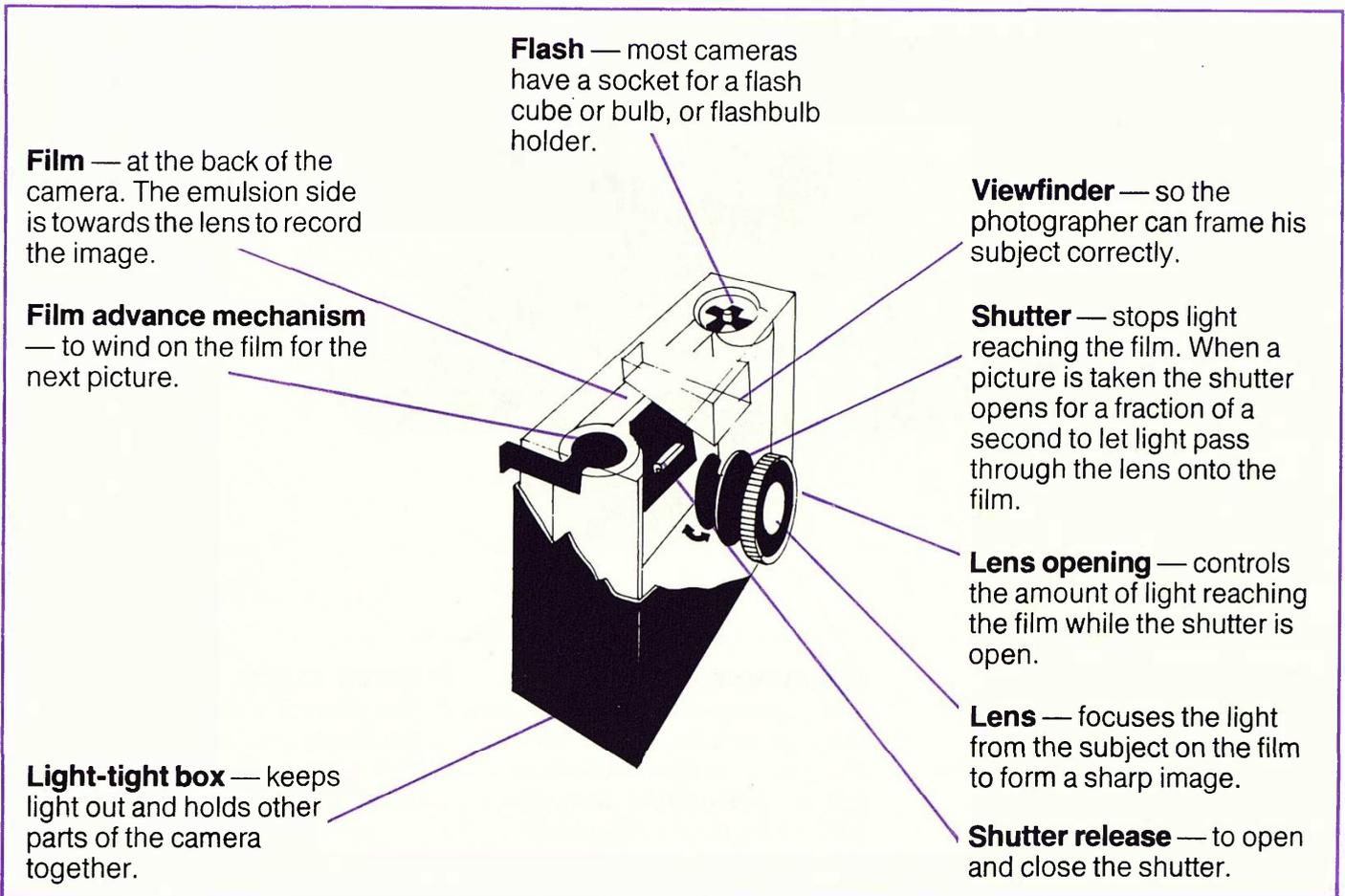


**Q6** Explain how you 'set' the lightmeter (in step A).

**Q8** What did you notice about the readings on the lightmeter in different parts of the room?

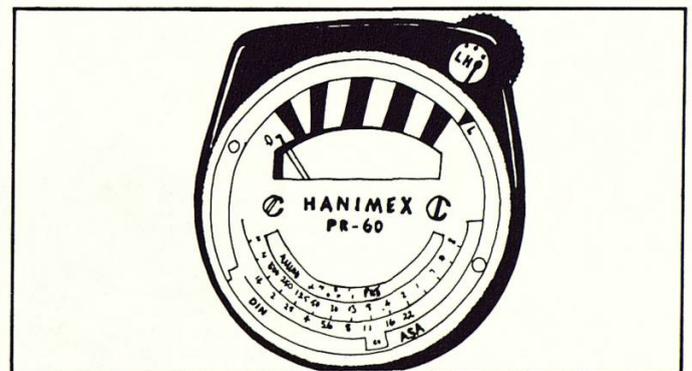
**Q7** What was the reading on the lightmeter 50 cm from the lamp?

## Information: Basic features of a modern camera



## Information: The lightmeter

A lightmeter is an instrument that changes light energy into electrical energy. This moves the pointer round the scale. A lightmeter is used by a photographer to set the correct aperture and **shutter speed** on his camera (see page 16). This makes sure that the right amount of light enters the camera. Many modern cameras have a lightmeter built into them.



**Q9** What does the shutter of a camera do when a picture is taken?

**Q10** What is the job of a camera lens?

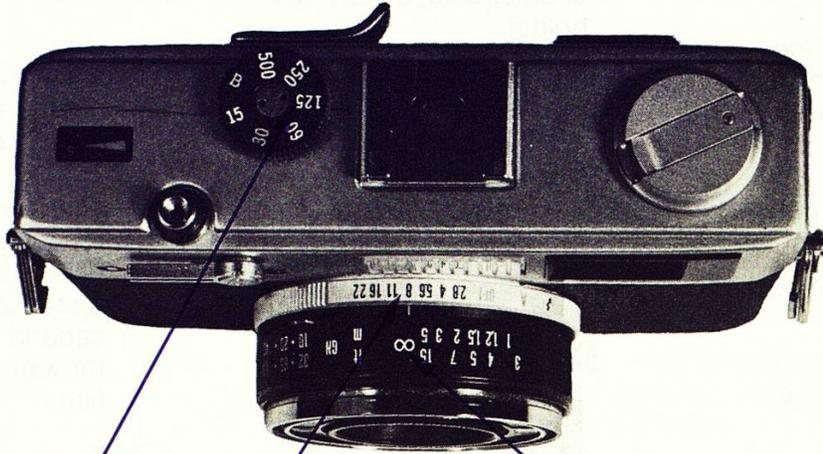
**Q11** What kind of energy is light energy changed into by a lightmeter?

**Q12** What does a photographer use a lightmeter for?

# Using a commercial camera

## Information: Adjustable cameras

An adjustable camera has controls that allow you to take pictures under a wide range of conditions.



### Shutter speed control

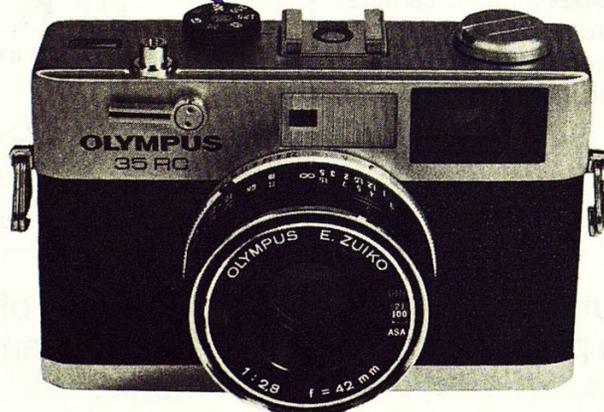
Choose fast speeds (eg 1/500 second) for fast moving objects. Choose slow speeds (eg 1/30 second) for objects photographed in dim light. 'B' means the shutter is open for as long as the shutter release is held down. The speed here has been set at 1/125 second.

### Aperture setting

The aperture is the hole that lets light into the camera when the shutter is open. Aperture size is measured in **f-numbers**. Small f-numbers mean large lens openings. In general, a fast shutter speed needs a large lens opening. This lets in enough light to expose the film. The aperture here has been set at f8.

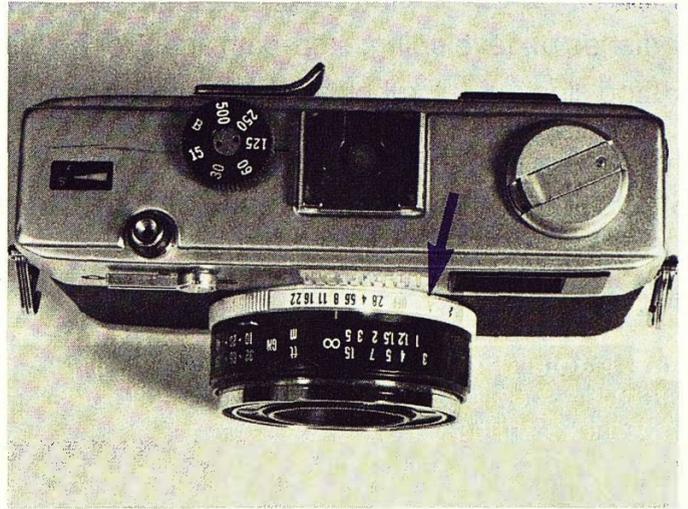
### Focus setting

This gives the distance from the camera lens to the object. The distance here has been set at **infinity** (far away).



## Automatic cameras

Some cameras have an 'A' on the aperture setting control. This means they are automatic. The focus setting and shutter speed controls are set. 'A' is chosen on the aperture setting. The camera automatically chooses the right aperture for the light conditions.

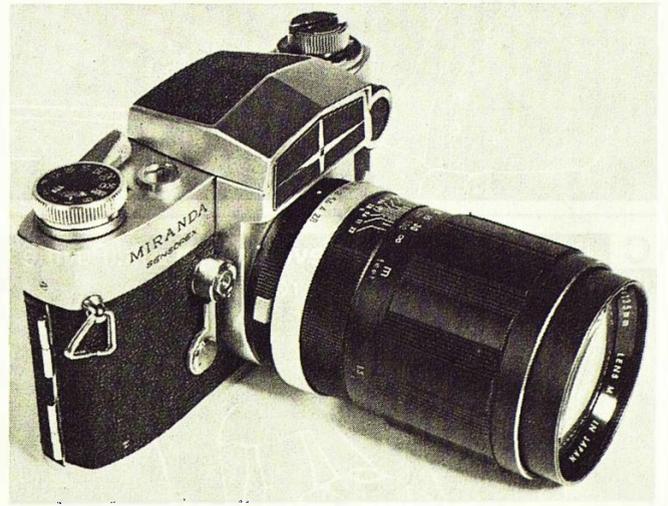


## Interchangeable lenses

On some cameras the lens can be changed. A **telephoto** lens is used for taking pictures of distant objects. A **wide-angle** lens is used when the object is very broad — a mountain range, for example.



This camera has three lenses.



The camera with the telephoto lens attached.

**Q13** What does the aperture setting control?

**Q14** Why should you use a fast shutter speed for taking pictures of fast-moving objects?

**Q15** What is an f-number?

**Q16** Would you need a large or small f-number setting in dim light?

# 5 Developing the film

## Apparatus

- ★ film
- ★ developing tank
- ★ thermometer
- ★ measuring cylinder
- ★ dishes of developing, stop-bath and fixer solutions
- ★ dish of wetting agent
- ★ stop clock
- ★ rubber gloves
- ★ pegs

You are going to develop the film you have taken.

Steps A to C must be done in **total darkness**. It is a good idea to practise the steps first with an old film.

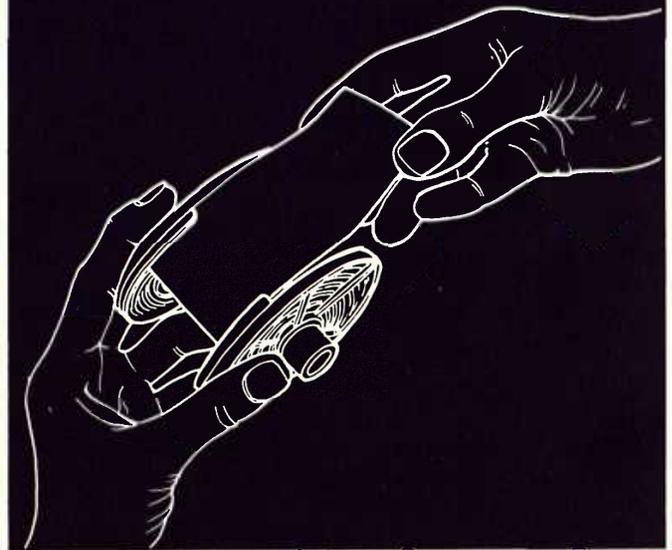


Rubber gloves must be worn when using the chemicals.

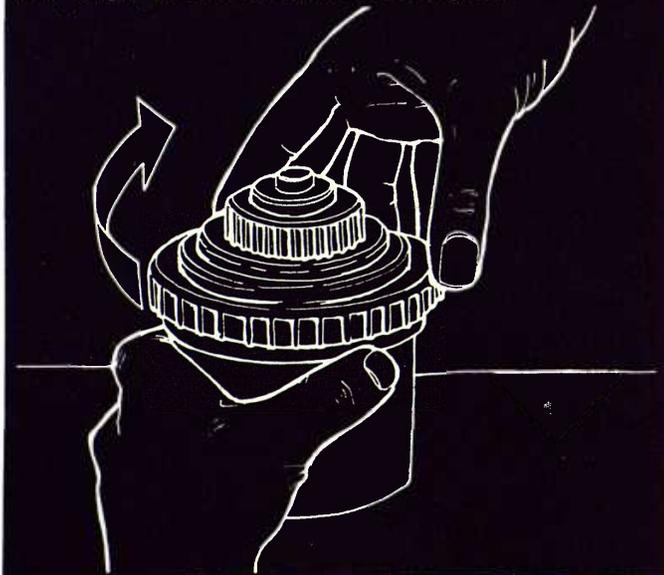
**A** In **total darkness**, carefully remove the film from the spool or cartridge. (You will need to break open the cartridge.)



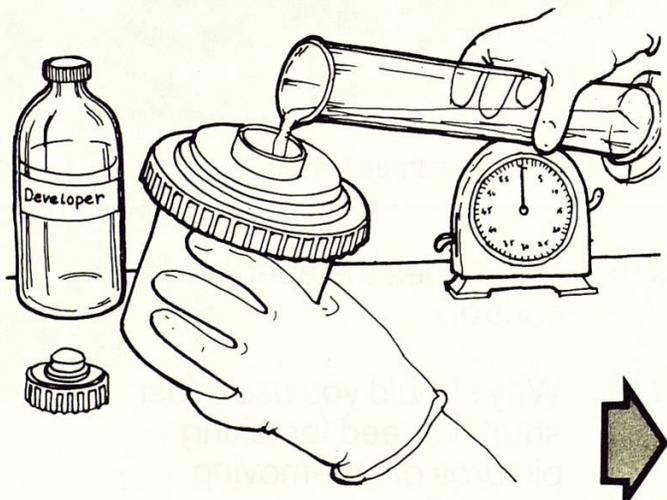
**B** Peel off the backing paper. Hold the film by its edges only. Feed it slowly into a **spiral**. Don't force it.



**C** Put the spiral into a **developing tank**. Put the lid on tightly. Switch on the room lights.

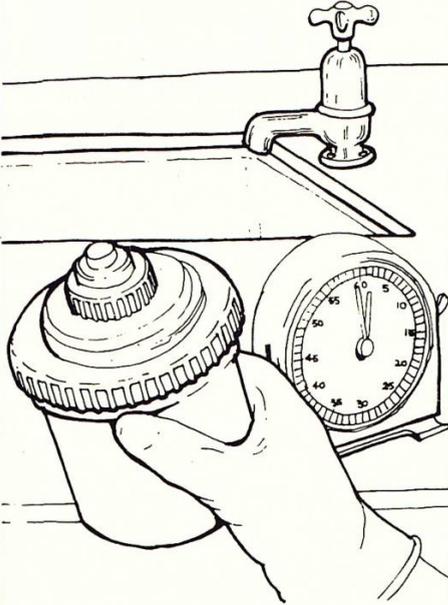


**D** Put on gloves. Take the temperature of the developing solution. Check the developing time needed. Carefully, pour the right amount of developing solution into the tank. Start timing.



## Developing the film

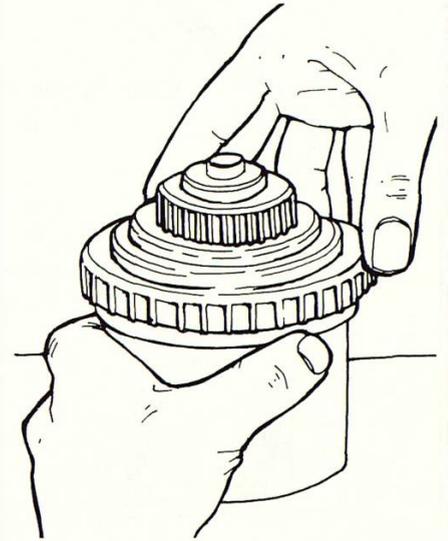
**E** Every 30 seconds, shake the tank for 5 seconds. When the developing time is up, pour out the solution.



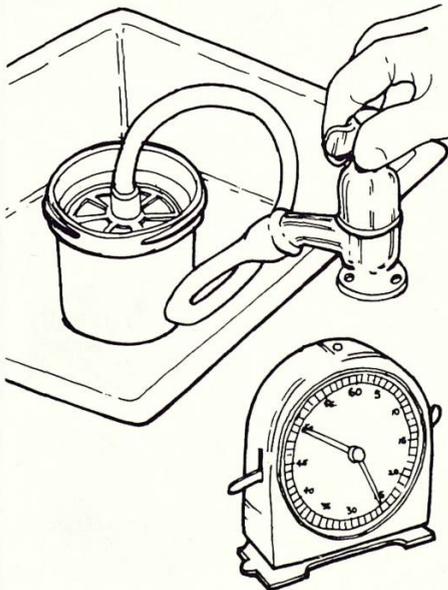
**F** Pour some stop-bath into the tank. Shake the tank for 30 seconds. Pour out the solution.



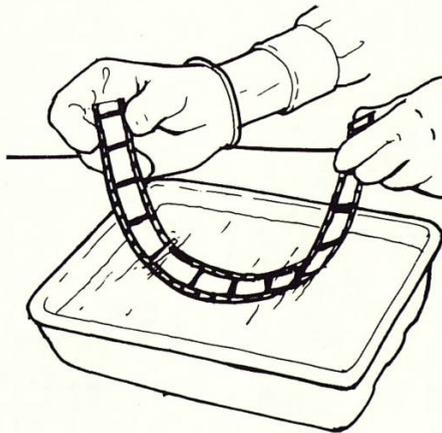
**G** Pour some fixer into the tank. Fix for about 5 minutes. Every 30 seconds, shake the tank for 5 seconds. Pour out the solution.



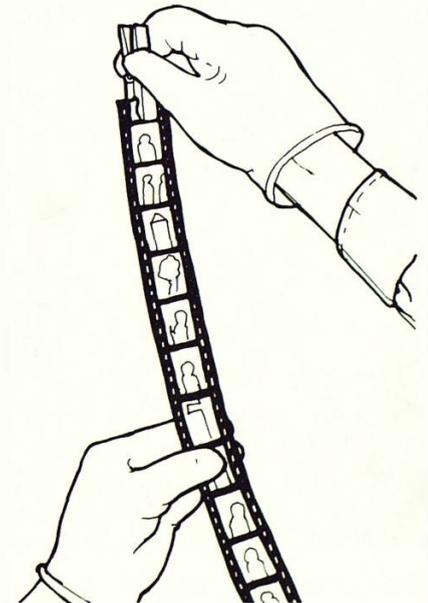
**H** Take off the tank lid. Wash the film in **gently** running water for about 30 minutes.



**I** Take the film off the spiral and pass it through a dish of diluted wetting agent.



**J** Using pegs, hang up the film in a dust-free place. The film should hang freely and not touch anything.

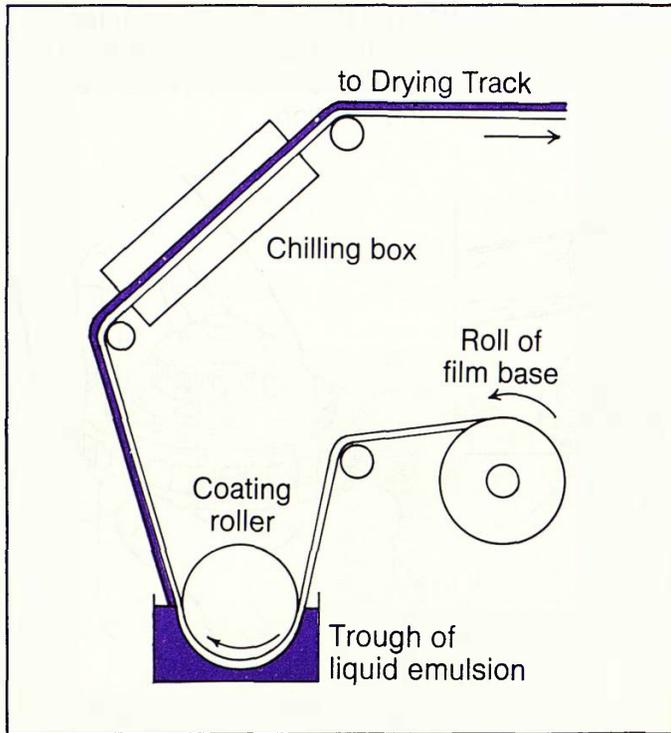


**Q1** What was the developing time needed?

**Q2** If the temperature of the developing solution had been higher, would the developing time have been longer or shorter?

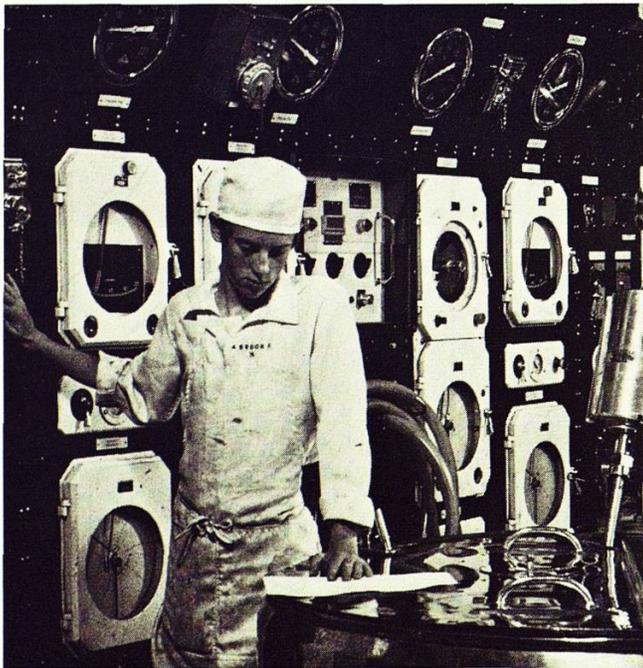
# Developing the film

## Information: How film is made

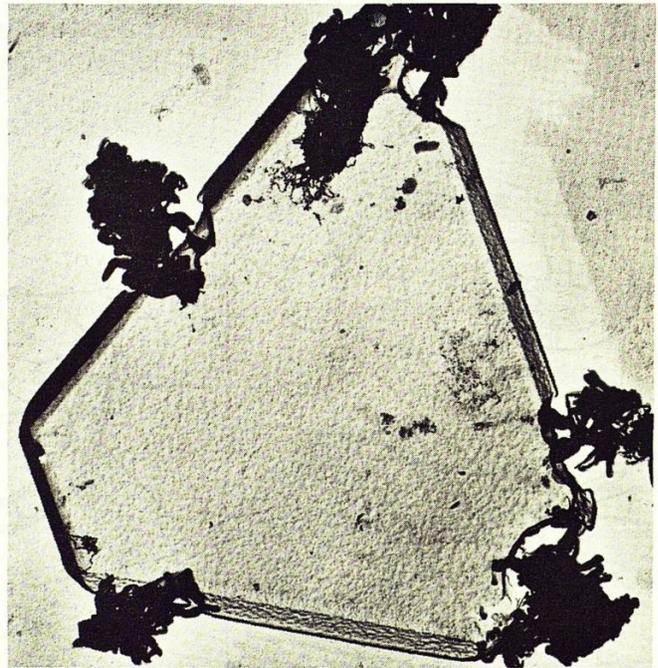


A roll of transparent plastic film is unwound onto rollers. It is coated on one side with a very thin layer of liquid emulsion. The film is then passed through a **chilling box** to set and harden the emulsion.

After drying and cutting, the film is wound onto **spools** with backing paper to protect it from light. The film spools are wrapped in sealed foil and packed in cartons.



The chemicals that make up the emulsion are very carefully controlled. Emulsion is mixed in darkness.



The emulsion is made up of very small crystals of silver halide. This crystal is being developed — it is beginning to turn black. (Magnification 12 000 times.)

**Q3** What happens to the film in the chilling box?

**Q4** Why do you think emulsion is mixed in darkness?

## Information: Developing a film

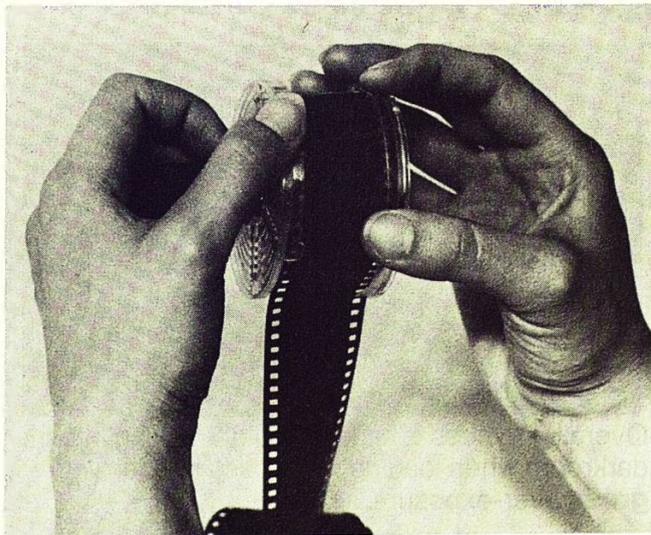
When a photograph is taken, an image is formed on the film. The image is invisible. Developing solution changes the invisible image into one we can see.

Film is full of tiny **silver halide** particles which are sensitive to light. The particles on which light has fallen turn black when put in developing solution. After development, all the light parts of the image are dark. All the dark parts are light. This is called a negative.

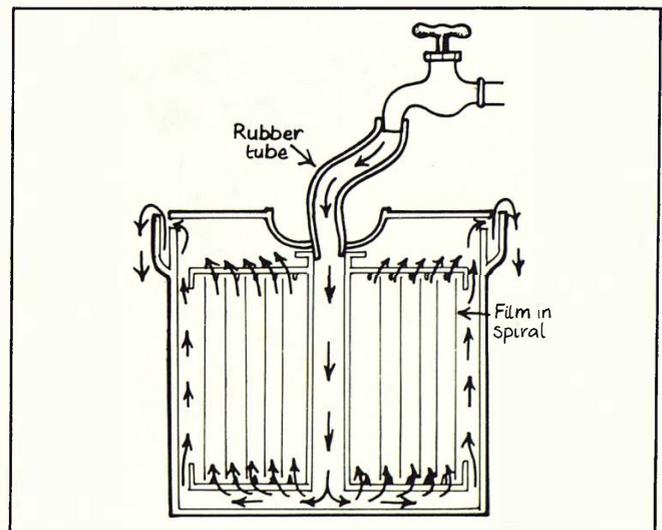
Developing solution must be used as shown on the instruction sheet supplied with the film. Some films need the developing solution at a higher temperature than others. The higher the temperature of the developing solution, the shorter the developing time needed.

| Film | 18 °C        | 20 °C       | 22 °C       | 24 °C       |
|------|--------------|-------------|-------------|-------------|
| A    | 105–240 secs | 90–180 secs | 70–135 secs | 60–110 secs |
| B    | 105–150 secs | 90–120 secs | 70–90 secs  | 60–75 secs  |
| C    | 105–150 secs | 90–120 secs | 70–90 secs  | 60–75 secs  |
| D    | 150 secs     | 120 secs    | 90 secs     | 75 secs     |

The table shows a range of time/temperatures to be used with different films. If necessary, the containers of developing, stop-bath and fixer solutions can be heated in a bowl of warm water. Cold water is used if the solutions need cooling.



The film is wound onto a spiral so the developing and other solutions can reach every part of the film. The tank is designed to let liquids in but not light.

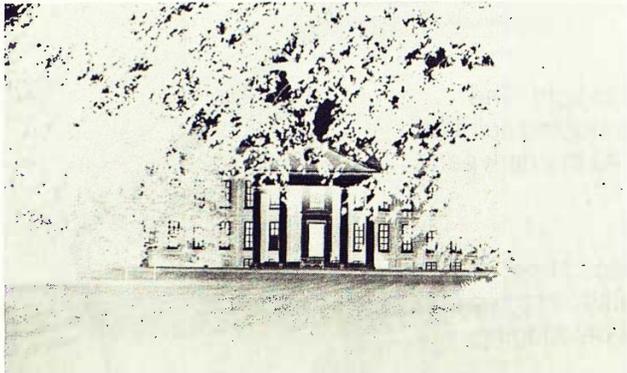


For the final rinse, a **wetting agent** is added to the water so it wets the film evenly. This stops 'water stains' forming on the film as it dries.

# Developing the film

## Information: Some problems in developing

To get good prints from your negatives you must handle them **carefully** and develop them properly. Here are some things that can go wrong.



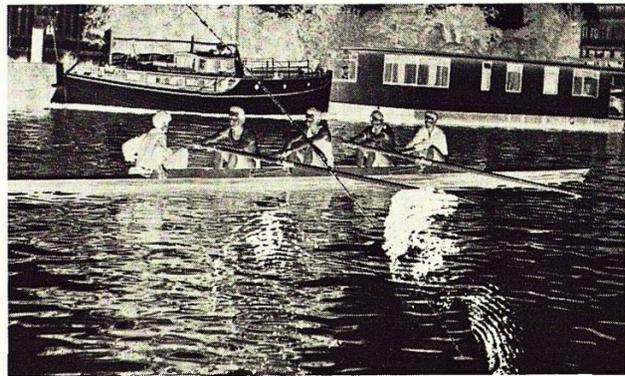
A thin, transparent negative means that it was under-exposed. (Not enough light reached the film when the picture was taken.)



A **dense**, heavy negative means the film was over-developed, or the negative was over-exposed, or both.



A streaky negative is a result of uneven development. This happens when the developing solution is poured into the tank too slowly.



Scratches or fingermarks on a negative are caused by careless handling of the film during loading or processing.



Half-moon shaped markings are caused by forcing the film into a damp spiral. It also happens if you try to load the film too quickly into the spiral.



Overall greyness is caused by light getting into the darkroom when loading. It can also happen with **gross** over-exposure.

**Q5** What does under-exposed mean?

**Q6** What does over-exposed mean?

# 6 Making positive prints

## Making a contact print

Apparatus

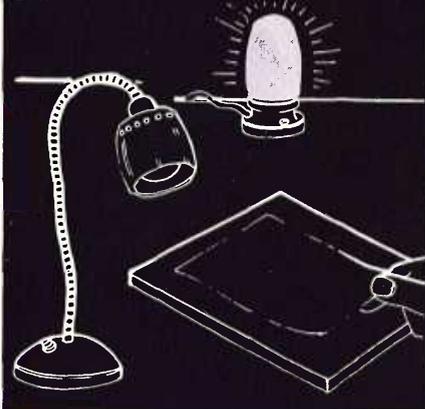
- ★ a negative
- ★ photographic paper
- ★ sheet of glass
- ★ bench lamp
- ★ board
- ★ plastic tongs
- ★ dishes of developing, stop-bath and fixer solutions
- ★ stop clock
- ★ paper towels
- ★ rubber gloves
- ★ ruler
- ★ safe light

You are going to make a **contact print** from a negative. This work must be done in the dark using a 'safe' light.

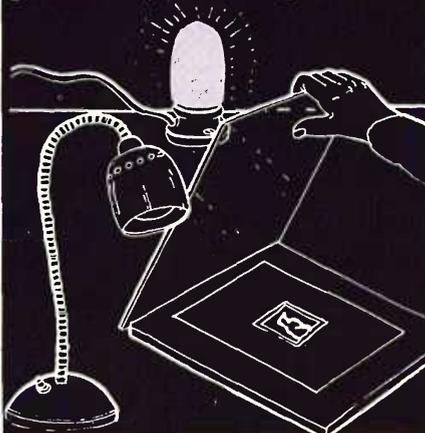


Rubber gloves must be worn when using the chemicals.

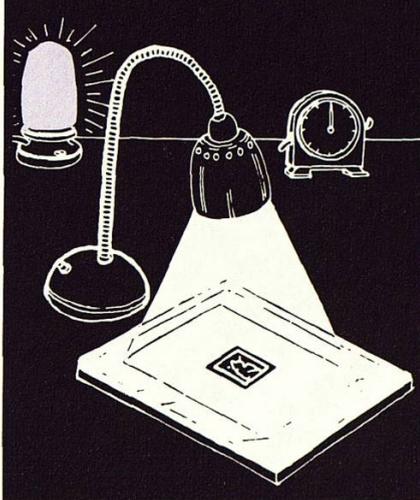
**A** Put a sheet of photographic paper, shiny side up, onto a board. Stand a bench lamp over the paper. Do not switch it on.



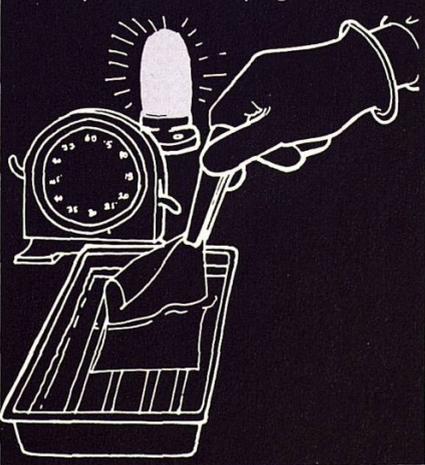
**B** Put a negative, shiny side up, onto the photographic paper. Carefully, put a sheet of glass on top of the negative.



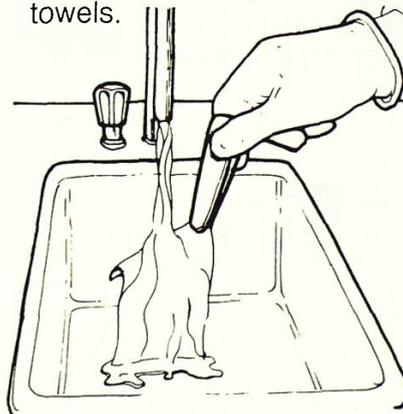
**C** Switch on the lamp for 3 or 4 seconds. Then switch off.



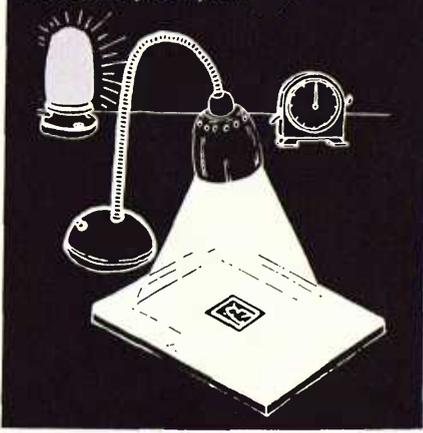
**D** Remove the photographic paper and develop it as you did in steps C to E on page 2.



**E** Hold the print with tongs and wash it under gently running water for 5 minutes. Then dry it between paper towels.



**F** Repeat the experiment using different exposure times until you get a good print. Measure your print.



**Q1** What was the best exposure time?

**Q2** What size was your print?

# Making positive prints

## Making a proof sheet

### Apparatus

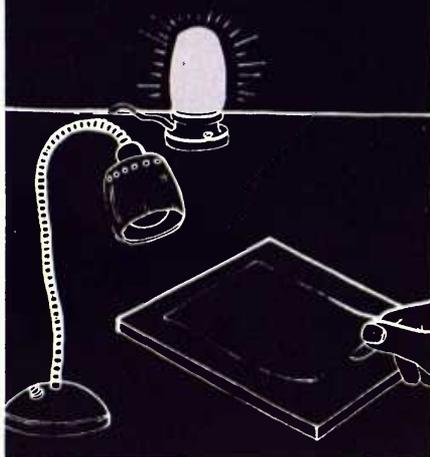
- ★ set of negatives
- ★ photographic paper
- ★ sheet of glass
- ★ board
- ★ plastic tongs
- ★ dishes of developing, stop-bath and fixer solutions
- ★ stop clock
- ★ rubber gloves
- ★ safe light
- ★ bench lamp
- ★ paper towels

You are going to make a **proof sheet** from a set of negatives. This work must be done in the dark using a 'safe' light.

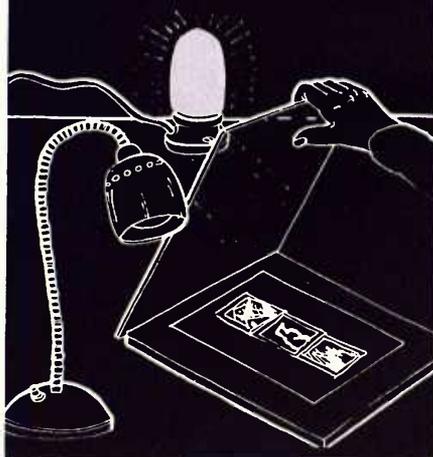


Rubber gloves must be worn when using the chemicals.

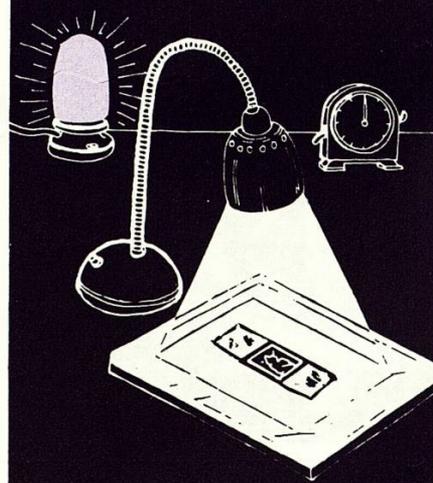
**A** Put a sheet of photographic paper, shiny side up, onto a board. Stand a lamp over the paper. Do not switch it on.



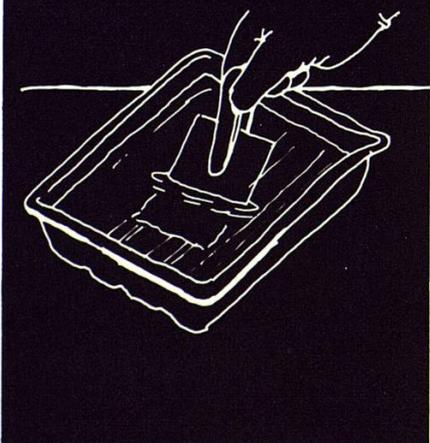
**B** Put a set of negatives, shiny side up, onto the photographic paper. Put a sheet of glass on top of the negatives.



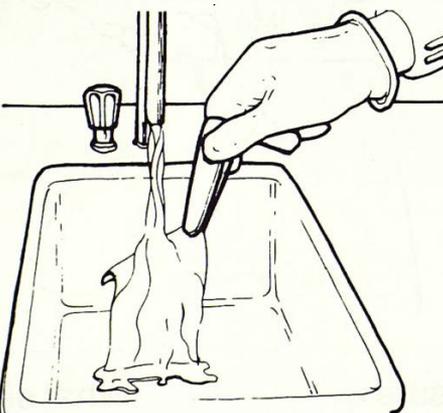
**C** Switch on the lamp for 10 seconds. Then switch off.



**D** Remove the photographic paper and develop it as you did in steps C to E on page 2.



**E** Switch on the room lights. Hold the proof sheet with tongs and wash it in gently running water for 5 minutes. Then dry it between paper towels.



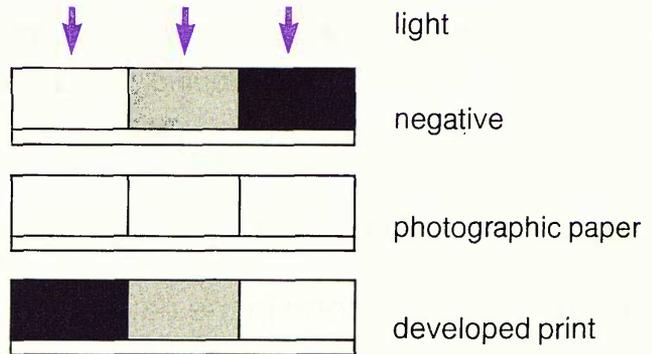
**Q3** What is a proof sheet?

**Q4** What is a contact print?

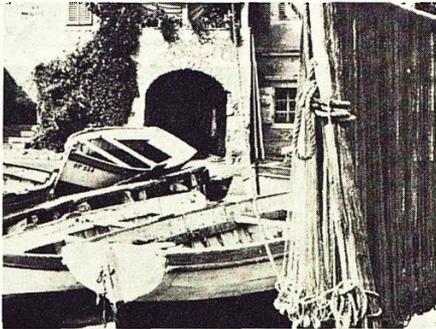
## Information: Making positive prints

During printing, the light and dark shades on the negative are **reversed**. This means that the positive print will show an accurate copy of the subject that was photographed.

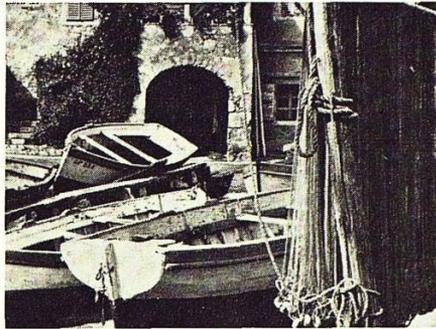
Photographic papers are made in a similar way to films. The emulsion on photographic papers is less sensitive to light than the emulsion on film.



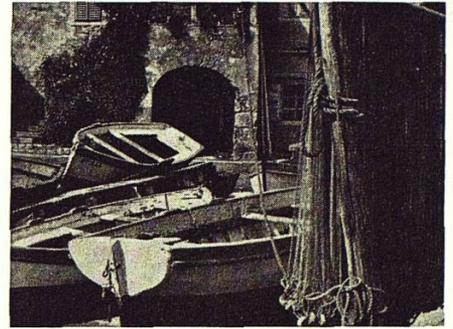
It takes practice to get a correctly exposed print.



This print is under-exposed and needs to be kept longer under the lamp.



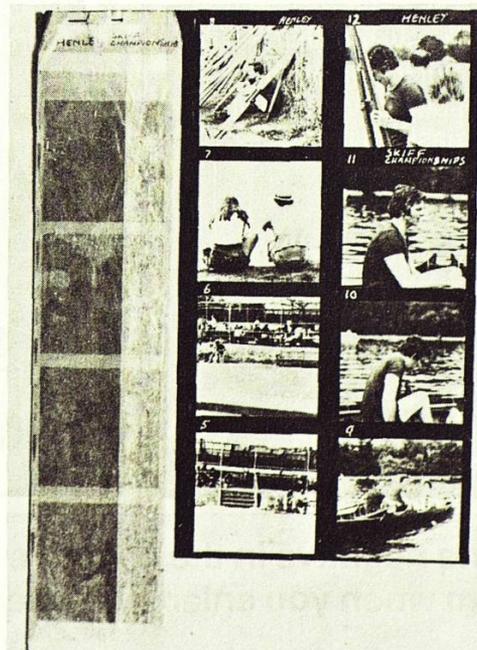
This print is correctly exposed.



This print is over-exposed and needs less time under the lamp.

## Information: Proof sheets

Proof sheets are useful if you take a lot of photographs and want to file them. Professional photographers use them, for example for weddings. Their clients can choose the pictures they want from the proof sheets.



# 7 Enlarging

## Making a test strip

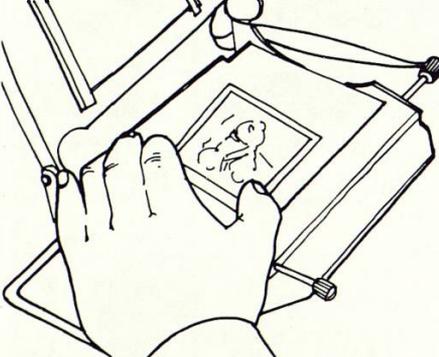
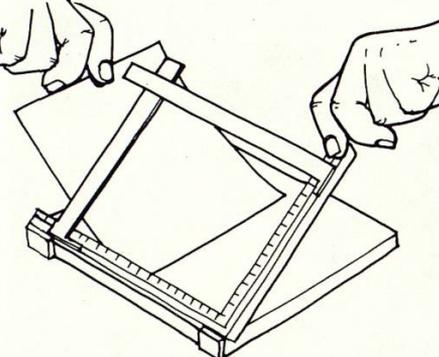
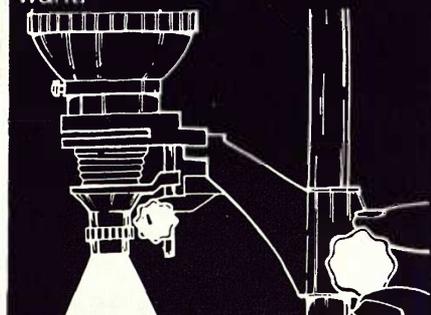
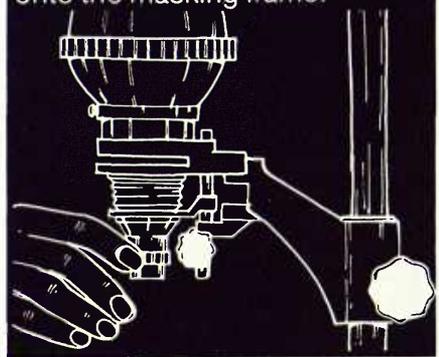
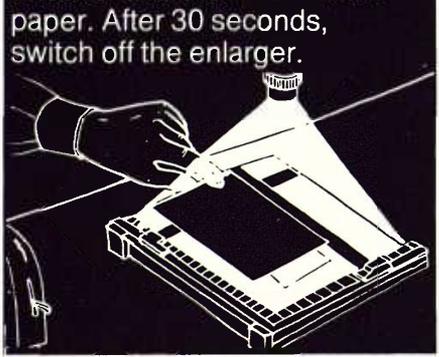
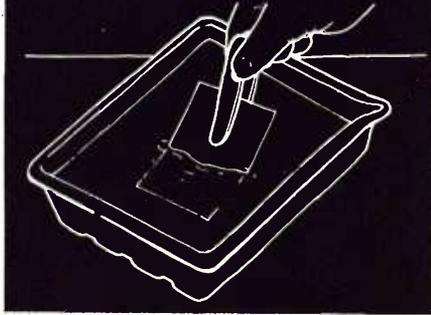
Apparatus

- ★ photographic paper
- ★ negative(s)
- ★ enlarger
- ★ plastic tongs
- ★ cardboard
- ★ dishes of developing, stop-bath and fixer solutions
- ★ stop clock
- ★ rubber gloves
- ★ safe light
- ★ white paper
- ★ masking frame

You are going to make a **test strip**. This will help you when you enlarge a negative (page 27).

Steps C to F must be done in the dark using a 'safe' light.

 Rubber gloves must be worn when using the chemicals.

|  |  |  |
|--|--|--|
| <p><b>A</b> Put a negative, shiny side up, into the negative carrier of an enlarger. Replace them in the enlarger.</p>                                        | <p><b>B</b> Put a sheet of plain, white paper into a masking frame. Switch on the safe light. Switch off the room lights.</p>    | <p><b>C</b> Set the enlarger at its widest opening (smallest f-number). Switch on the enlarger. Adjust the height to get the size of picture you want.</p>   |
| <p><b>D</b> Focus the picture. Set the lens to f/11. Switch off the enlarger. Put a strip of photographic paper, shiny side up, onto the masking frame.</p>  | <p><b>E</b> Cover 5/6th of the photographic paper with a piece of cardboard. Switch on the enlarger. Every 5 seconds, uncover a further 1/6th of the paper. After 30 seconds, switch off the enlarger.</p>  | <p><b>F</b> Put on rubber gloves. Put the test strip into developing solution for 90 seconds. Then put it in stop-bath solution for 5 seconds. Then put it in fixer solution for 30 seconds.</p>  |

Leave the negative in the negative carrier. Do not adjust the enlarger. You will use them when you enlarge the negative (page 27).

**Q1** What does a test strip look like?

**Q2** Did the darkest part of the strip have the most or least light shone on it?

## Making an enlarged print

### Apparatus

- ★ photographic paper    ★ negative(s)    ★ enlarger    ★ plastic tongs
- ★ dishes of developing, stop-bath and fixer solutions    ★ print drier    ★ sponge
- ★ stop clock    ★ rubber gloves    ★ safe light    ★ masking frame

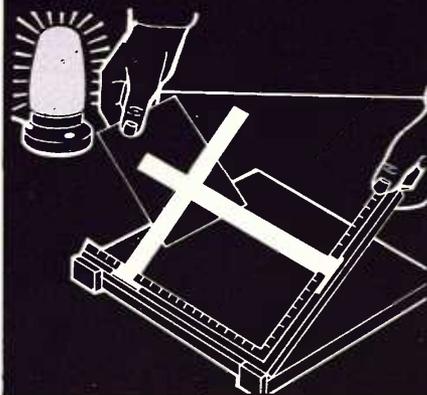
You are going to make an enlarged print from a negative. Steps B to D must be done in the dark using a safe light.

 Rubber gloves must be worn when using the chemicals.

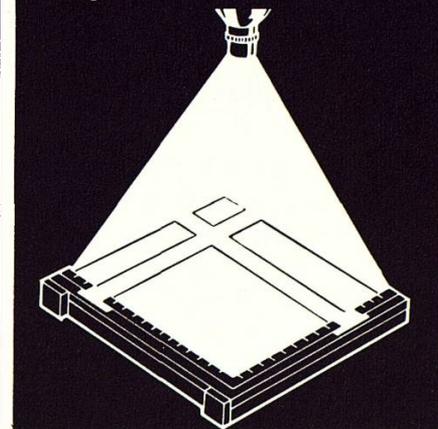
**A** Look at your test strip from the last experiment. Choose the exposure time that gave the best result.



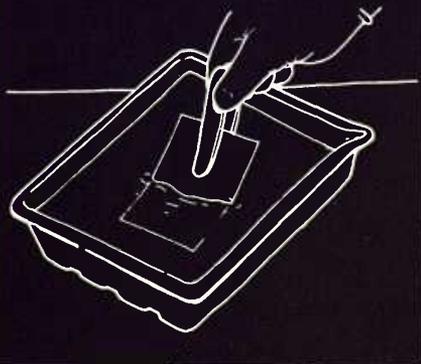
**B** Switch on the 'safe' light. Switch off the room lights. Put a sheet of photographic paper, shiny side up, into the masking frame.



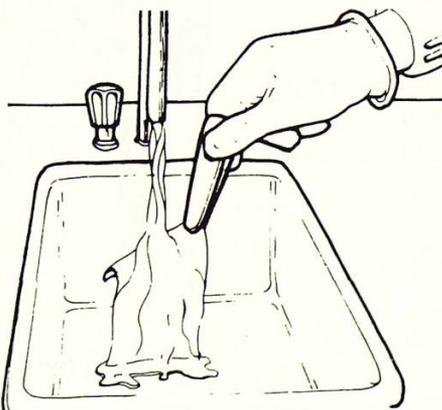
**C** Switch on the enlarger. Expose the paper for the chosen time. Switch off the enlarger.



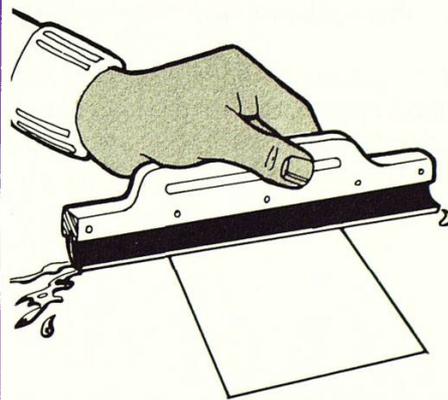
**D** Put on rubber gloves. Develop the print as you did in step F, page 26. This time, leave it in fixer solution for about 5 minutes.



**E** Switch on the room lights. Wash the enlargement in gently running water for a few minutes.



**F** Sponge the water from both sides of the print. Put it in a print drier or leave it on a flat surface to dry.

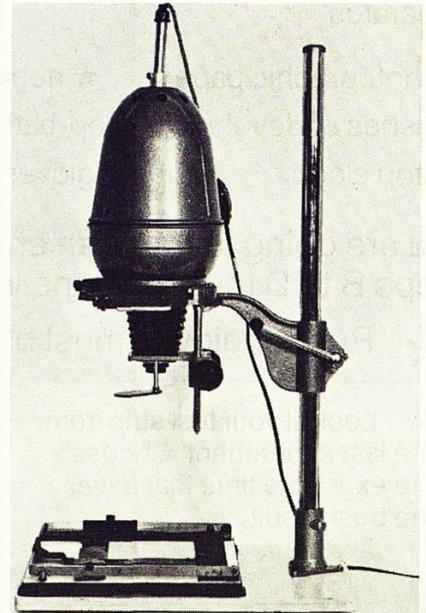
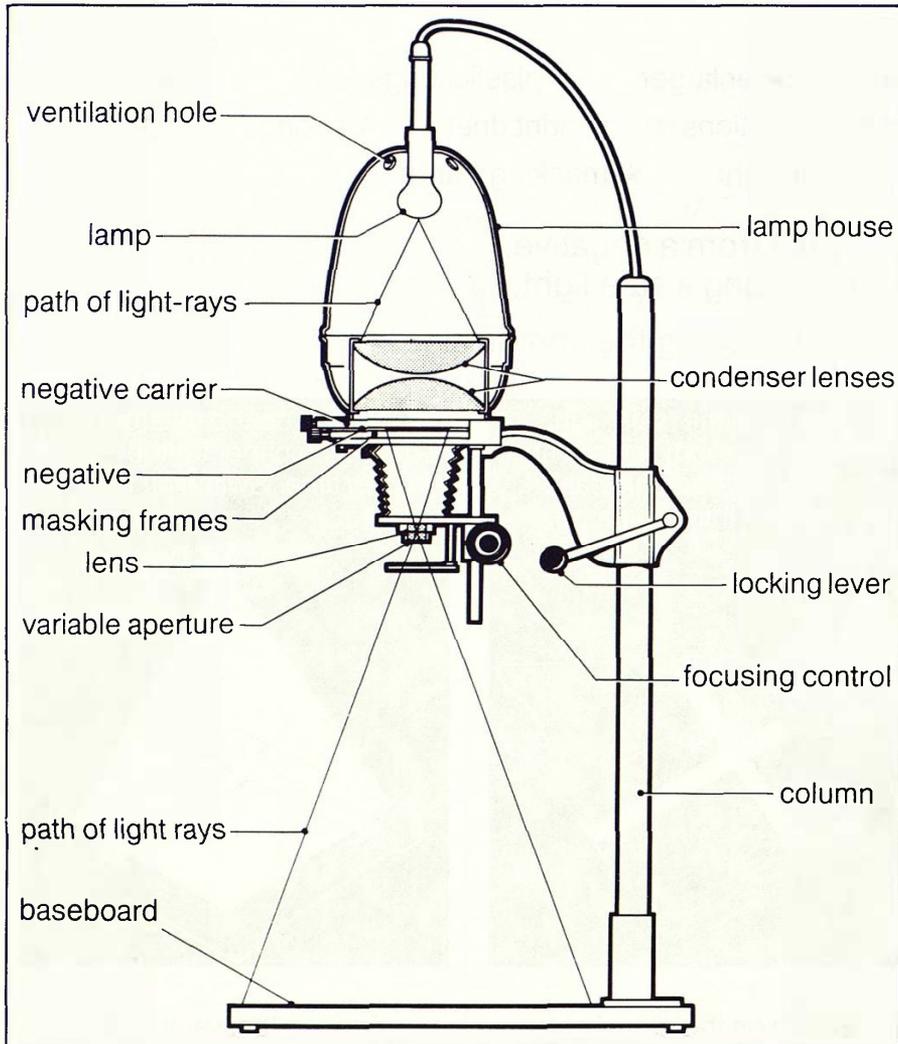


**Q3** What was the exposure time you chose in step A?

**Q4** Did you get a clear print?

# Enlarging

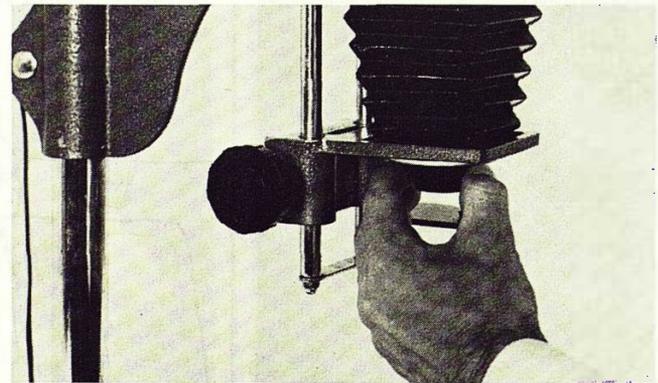
## Information: Enlarging



Light from the **lamp house** passes through the **negative** in the **negative carrier**. An image of the negative is formed on the baseboard by the **enlarger lens**. The **condenser lenses** make sure that the same amount of light is spread over the whole negative.

The enlarger lens is usually marked with f-numbers. The brightness of the image on the board is controlled by the f-number setting.

A negative carrier is used to keep the negative flat and in place. Some negative carriers have adjustable masks. These are used when only part of the negative is to be enlarged.



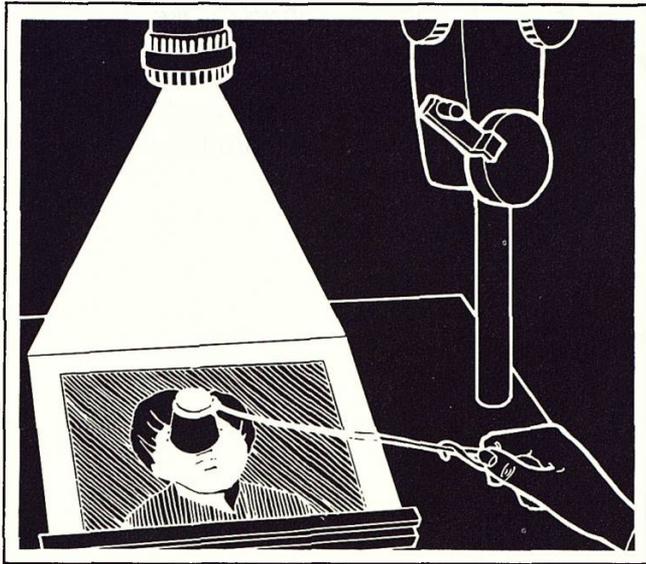
Adjusting the f-number setting

**Q5** What would happen to the print if there were no condenser lenses?

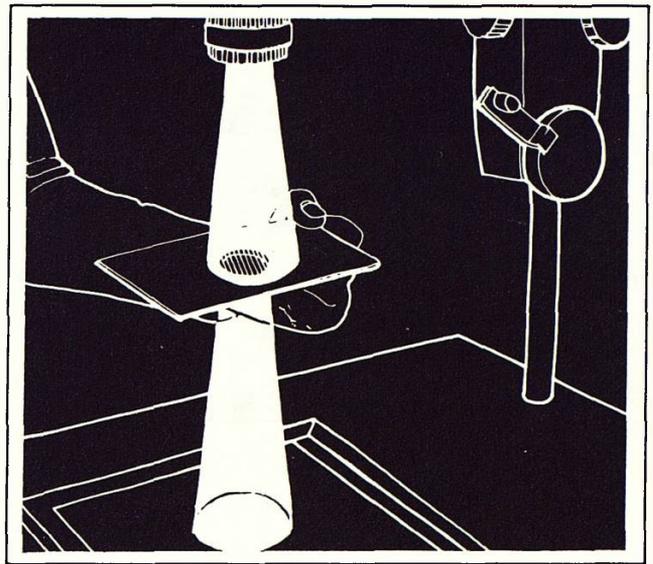
**Q6** What is the effect of sliding the enlarger up the column?

## Information: Beautiful prints from poor negatives

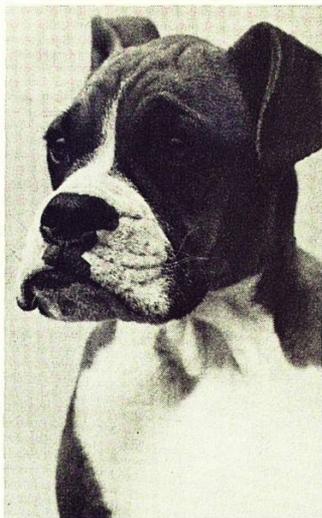
An enlarger can be very useful to get a good print from a poor negative. Here are some useful "tricks" you could try to improve your prints.



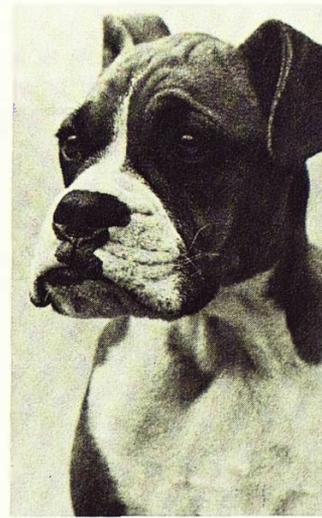
**Shading** is used to hold back light from the photographic paper. This means that you can have less exposure to light on areas that were too dark on your original print. You can cut the shape you need from card and attach it to wire to hold over the right place.



**Printing-in** gives the opposite result to shading. You can do this by cutting a hole in a piece of card. Hold the card under the enlarger lens over the part of the photo that needs more exposure. This makes the area darker.



This photograph of a dog has been improved in the next photo by both shading and printing-in.



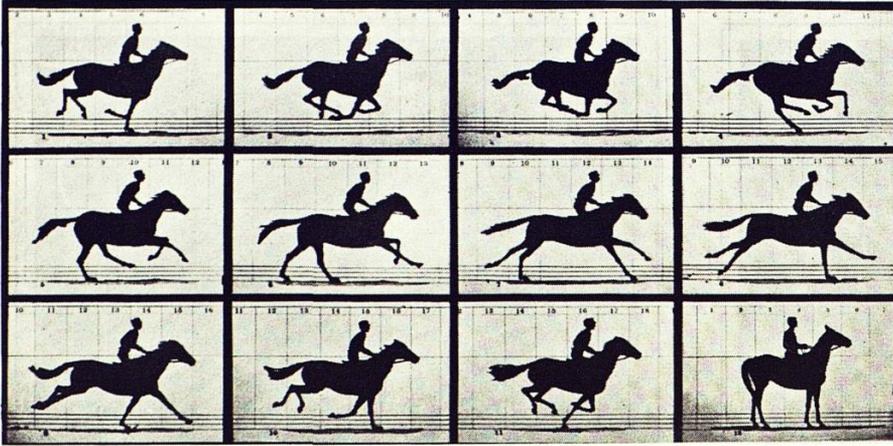
You can see that the eyes have been shaded to make them lighter. Printing-in has been used to make the shadows on the dog's chest darker.

**Q7** How would you use printing-in to improve a poor negative?

**Q8** What does shading mean?

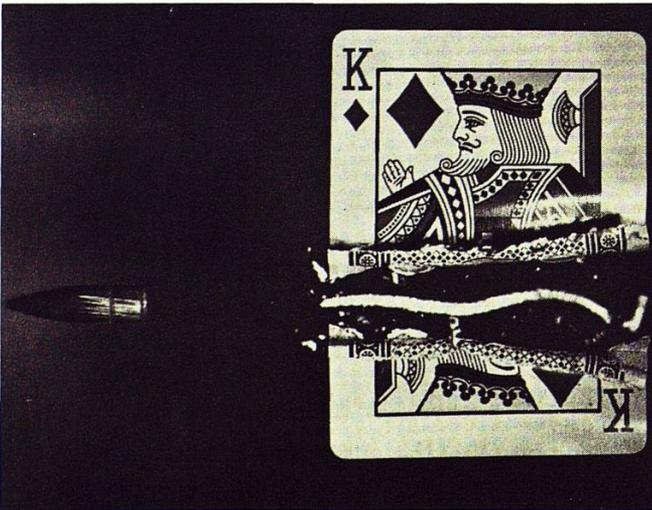
# 8 Uses of photography

Photography has many uses — at home, in science and in industry.

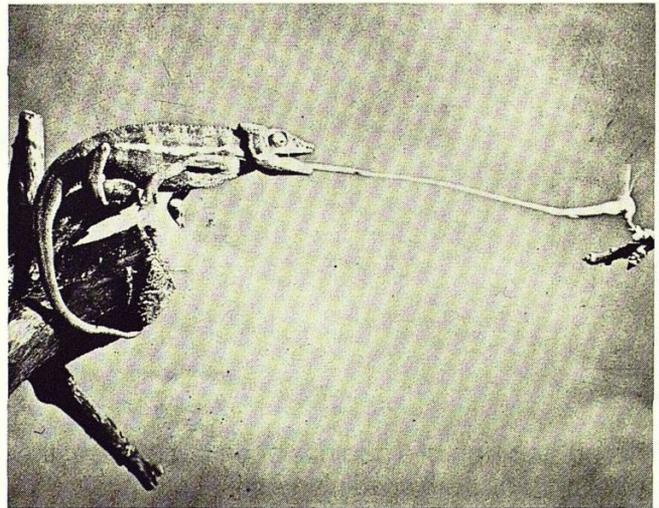


The first true scientific photographs were taken by Muybridge in 1878. These were taken to show that a galloping horse has all 4 hooves off the ground at the same time.

Science has advanced greatly since Muybridge's time and so has scientific photography. These 2 photos show how effective high-speed photography is.



This .22 calibre rifle bullet was travelling at 350 metres per second.

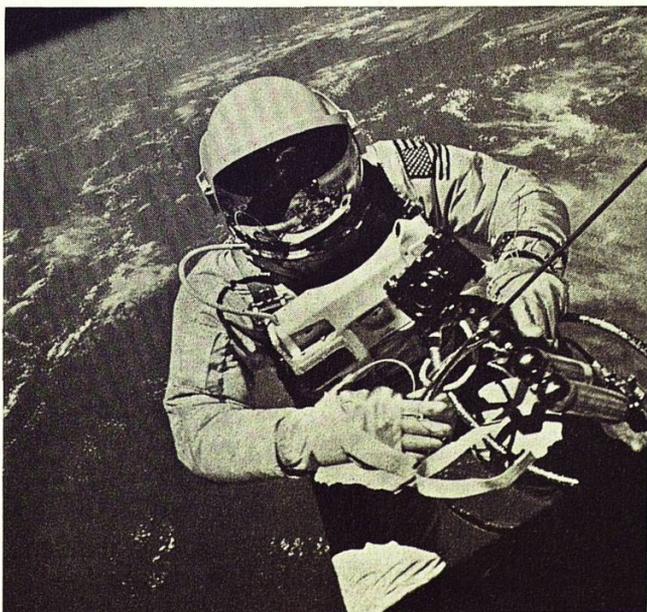


This chameleon was caught in the act of seizing its prey.

**Aerial photography** gives pictures that are interesting and attractive. Pictures taken from a plane are used to help in map-making.



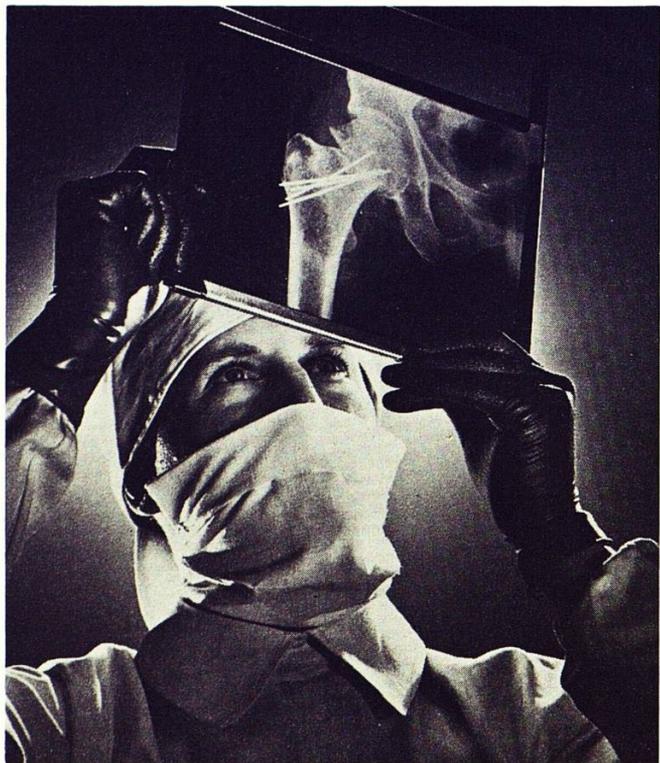
Photographic equipment is used at greater heights than an aeroplane can reach.



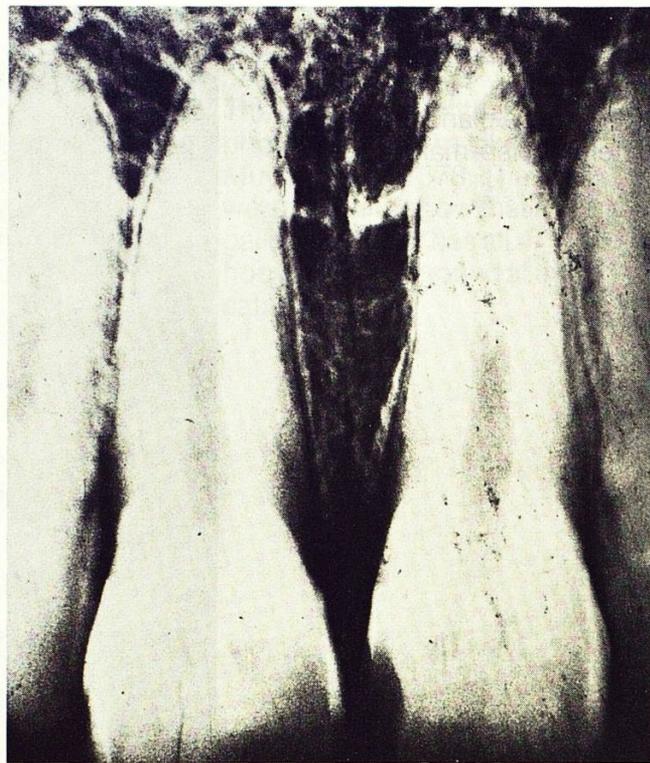
These 2 photos were taken in space. The one on the right shows the Red Sea.



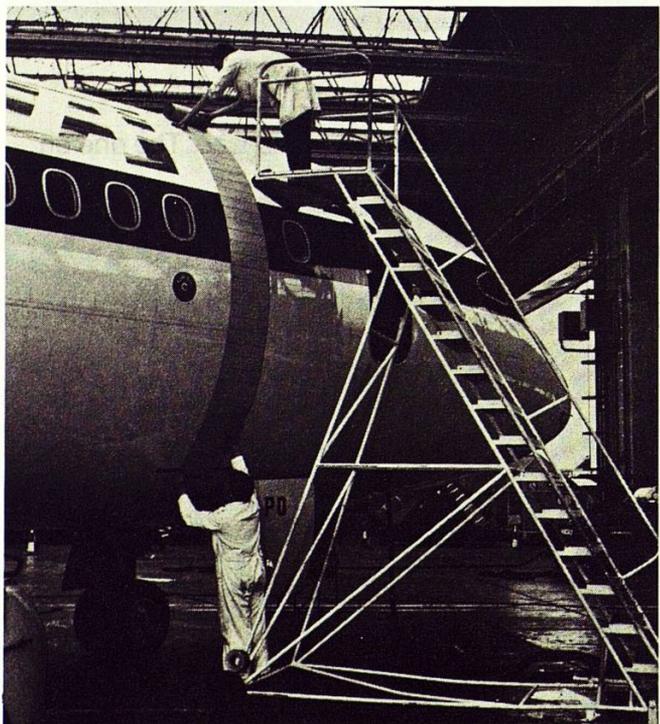
## Uses of photography



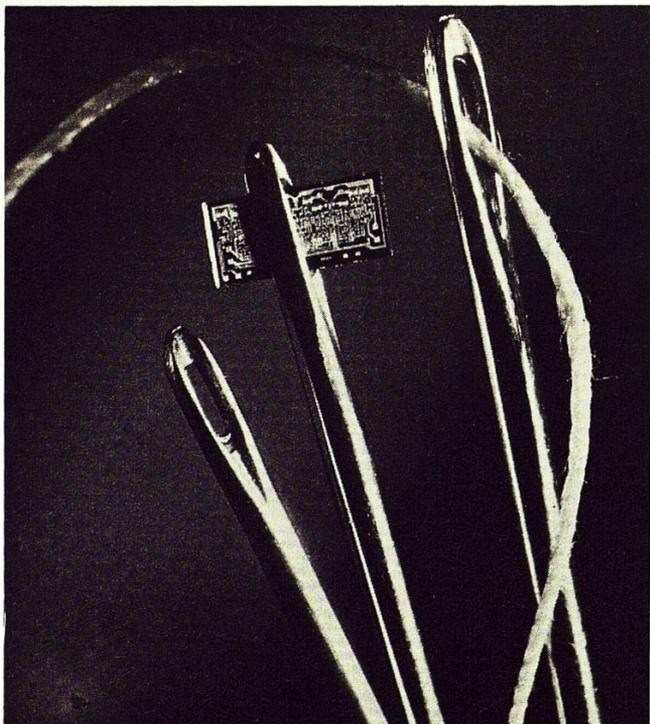
Photography is also widely used in medicine. **Radiography** was discovered in 1895.



X-rays are used in hospitals and in dentistry, as these pictures show.



More powerful X-rays are used in industry. Here a BEA Trident is being inspected by radiography.



**Photofabrication** is a new development. It means that tiny electronic circuits, like this one, can be made photographically.

A 621 367 HAK  
Photography

## Acknowledgements

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Kodak Limited (all photographs).

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