Activity 1

Seeing in The Dark

Book Reference: Vision and Cameras, page 26.

THE CAMERA IS NOT A MODERN INVENTION! It was invented around a thousand years ago by Muslim scientist Abu Ali al-Hasan Ibn al-Haitham. Ibn al-Haitham did a great deal of revolutionary and influential work on optics through meticulous experimentation and evidence collection, creative explaining and thorough recording. He was almost certainly the first to prove that light travels in straight lines, and that we see things when light reflects off an object and enters the eye. Ibn al-Haitham's '*Book of Optics*' had a profound impact on the work of Bacon (13th century) and da Vinci (15th century).

In this activity, students re-create some of Ibn al-Haitham's experiences through constructing pinhole cameras. They reinforce their knowledge of light by examining some of Ibn al-Haitham's work and comparing digital to pinhole cameras.

Curriculum link

11-14	**QCA 8k – light** • Light travels in straight lines • The path of light can be represented by rays **Ideas and evidence** • The interplay between questions, evidence and scientific explanations using historical and contemporary examples • The ways in which scientists work today and how they worked in the past, including the roles of experimentation, evidence and creative thought in the development of scientific ideas
14-16	**How Science Works** • Interpreting data, using creative thought, to provide evidence for testing ideas and developing theories • Many phenomena can be explained by developing and using scientific theories, models and ideas • How scientific ideas change over time

Learning objectives

Students will learn:

- How Ibn al-Haitham changed ideas about important optical phenomena
- How to construct and use a pinhole camera
- About the similarities and differences of pinhole and digital cameras

Running the activity

Starting the activity

A really exciting way to start this lesson would be to set the whole teaching room up as a camera obscura (instructions on how to do this later). Then set the scene by displaying **Activity 1a** (either projected or as an OHT) and getting groups of students to do the two short tasks on this page.

Running the main part of the activity

Display **Activity 1b**, and take students through the work and findings of Ibn al-Haitham. Stress the way he worked – very like modern scientists – through making observations, collecting evidence and creating explanations. Emphasise box 4 – Ibn al-Haitham's room, with its hole in the window shutter – it was his camera obscura.

Then ask students to follow the instructions in **Activity 1c** to construct pinhole cameras.

Each group needs:

- A clean tube with a tight-fitting lid (eg from Pringles crisps)
- Aluminium foil
- Masking tape or black electricians' tape
- Scissors
- A drawing pin
- A ruler

If quantities of Pringles tubes are difficult to come by, any tin-can will work well with both ends removed (safety: make good jagged ends). One end can be covered with aluminium foil, and holes poked into it, the other end with tracing paper or greaseproof paper for a screen – held in place with elastic bands. It works better if a tube of black paper is made around the screen end to view through, or the pupils cover their heads with a dark cloth (or their jumpers) – obviously with the hole end poking out towards the lit object / light source. Note: pupils must not look directly at the Sun! You could make up a store of can 'tubes' which can be re-used many times. They work much better if the inside of the cans is painted in matt black. There are many versions of the pinhole camera – some using photosensitive paper or even film. See the web links for some examples if you feel adventurous!

Running the plenary

Give each group a copy of **Activity 1d**. Ask them to compare their pinhole camera to the digital one on the sheet by completing the table. Finally, display **Activity 1a** again to remind students just how long cameras have been around, and to emphasise the contributions of the work of Ibn al-Haitham to our knowledge and understanding of optics.

How to make your classroom into a camera obscura

This will work best if:

- Your classroom has an interesting view – particularly if there is something moving outside
- The Sun shines on a window
- The students can become part of the picture by standing in the view outside

If you can meet all of these prerequisites then go ahead by:

1. Make the room completely blacked out.
2. Cover all of the windows with something opaque like thick cardboard boxes or aluminium foil. Tape together small sections to make it more manageable using something like masking or parcel tape. Use black electricians' tape to plug any holes.
3. Make an opening in the centre of a window covering in which to trial different apertures. This needs to be a square of about 5 cm across. If you wish, make more than one pilot hole, so that several groups of students can work at the same time.
4. Make apertures out of black paper, or thick aluminium foil. The shapes and sizes of the apertures can vary, but a small, round hole will give the sharpest image. Any jagged edges produced when making the aperture need to be sanded off for safety and to prevent a blurred image. The apertures can be stuck across the hole made in the window blackout. Light must only come through the aperture, so it needs to be sealed carefully when placing it across the hole. It is better to mount the aperture onto some thick card with a hole cut in the centre for placing and fixing across the pilot hole.
5. Images can be projected onto opposite walls, or onto viewing screens. If the screen is made out of translucent material, then the images produced can be seen from both sides.

Web links

http://www.paintcancamera.com/pages/616184/
A very detailed website on how to construct a camera obscura and further pinhole camera designs from empty film containers (only for more deft students)! There is a good downloadable PDF file on this, and video clips of how to construct both items. The video of the camera obscura demonstrates many different effects and how they are caused.

http://www.exploratorium.edu/science explorer/pringles pinhole.html
A good Pringles pinhole camera site with explanations of how the images are formed.

http://www.charlesdisonfund.org/Experiments/HTMLexperiments/Chapter5/5-Expt6/p1.html
Really nice, simple pinhole camera instructions.

http://www.kodak.com/global/en/consumer/education/lessonPlans/pinholeCamera/pinholeCanBox.shtml
A more sophisticated pinhole camera from Kodak that uses real film!

http://www.bbc.co.uk/history/historic figures/alhazen.shtml
Nice, concise pieces about the life of Ibn al-Haitham.

Seeing in the dark

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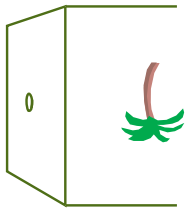
What a shot! Cameras must be one of the greatest modern inventions.

Not that modern – they've been around for years!

- ***How many years ago do you think the first pinhole camera was invented?***

  a 100 b 150 c 500 d 1000

- ***Can you show how this first pinhole camera – camera obscura – made an image of a tree? (draw 2 lines)***



Ibn al-Haitham invented the pinhole camera in Egypt, 1000 years ago.

Here's how...

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1

One day, as the sunlight streamed through a small hole in the shutter of his room.

There's a tiny image of a tree on my wall.

2

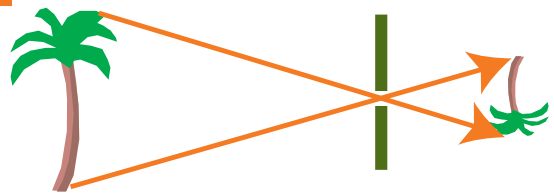
I think I can explain my observations like this.

Light rays from the Sun travel in straight lines

They hit the tree

The tree reflects the light rays

3

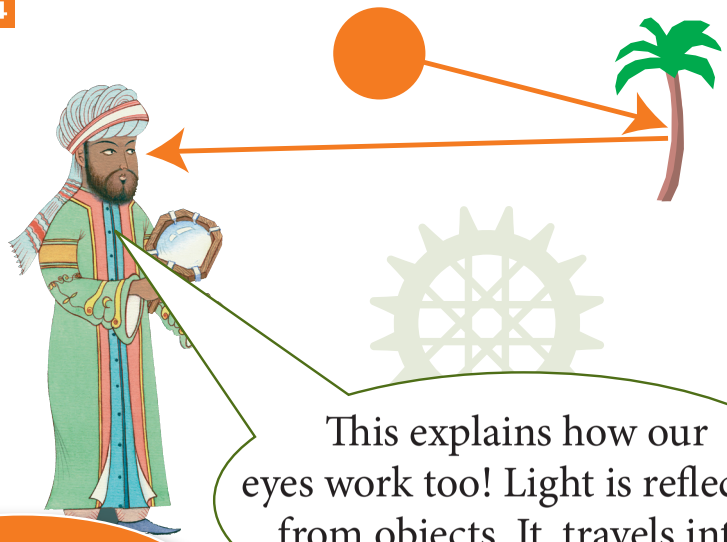


The reflected rays travel in straight lines and go through the small hole.

When they hit the wall they make an image of a tree.

This room is my camera!

4



This explains how our eyes work too! Light is reflected from objects. It travels into our eyes.

Make your own pinhole camera

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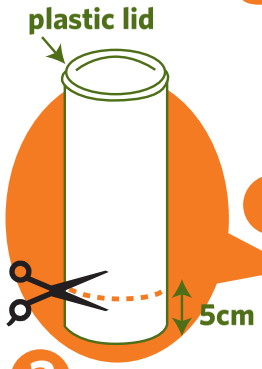
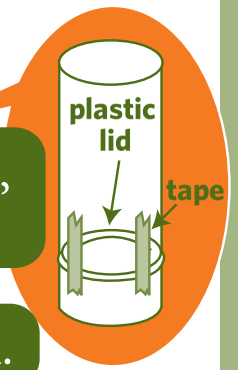
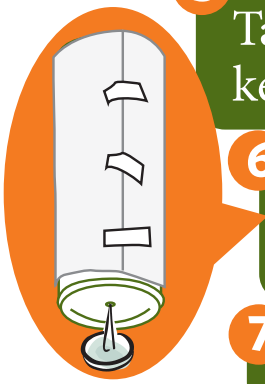
Making your camera ...



1. Mark a line around the tube about 5 cm up from the bottom.
2. Cut the tube into two pieces along this line.
3. Put the plastic lid onto the short piece, then tape the longer piece on top.



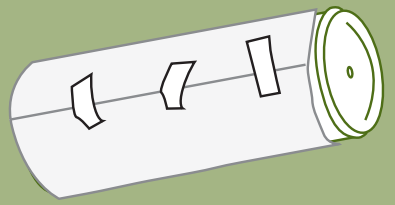
4. Cover the sides of the tube with foil.
5. Tape the foil down firmly to keep the light out.



6. Make a hole in the middle of the end of the shorter piece with a drawing pin.
7. Your camera is now ready to use.

Using your camera ...

1. Look down the tube towards the plastic lid. This is the screen.
2. Point the pinhole at a brightly lit object – perhaps a candle flame.



- What do you notice about the image?
- What happens if you make the hole bigger, or a different shape, or if you make several holes?
- How could you improve your camera?

Pinhole vs digital – comparing cameras

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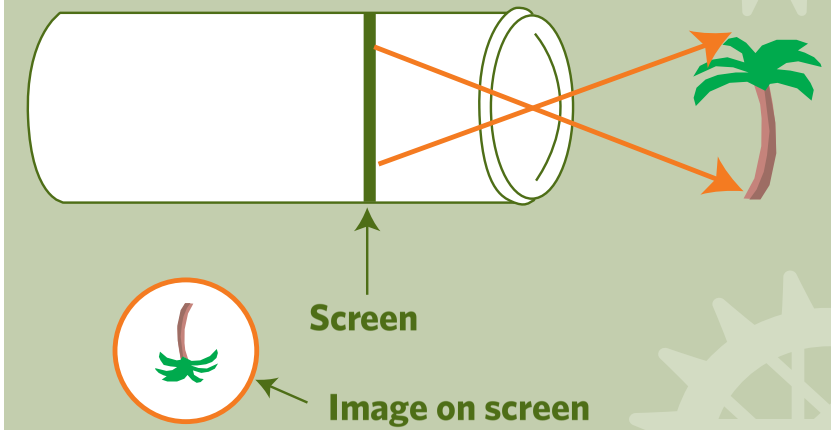
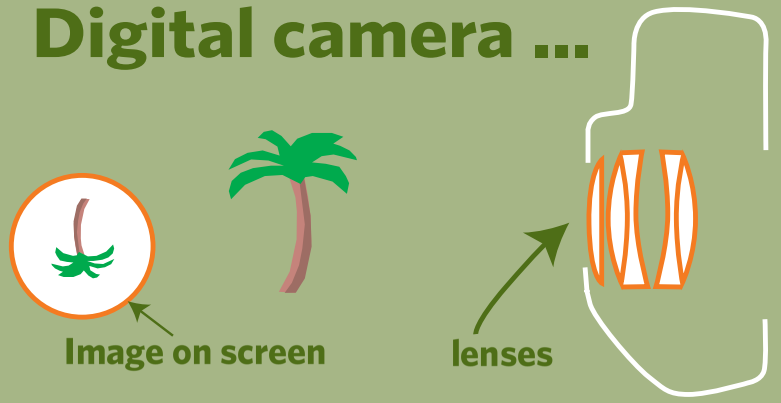
Pinhole camera ...



Digital camera ...



- Light sensitive receptors capture the image
- A removable storage device stores the image

Answers for pinhole camera		Answers for digital camera
	Light enters the camera through …	
	The image is formed on ...	
	The image looks ... clear / 'fuzzy' upright / upside-down smaller / larger than the object	
	The image can be stored if ...	