●●○○○ **Level 2 · Science S2.6**

Light and shadows

Where light comes from, how you see, and why your shadow changes.

Find out where light comes from and how it reaches your eyes. Make shadows, measure them with a stick in the sun, and bounce light with a mirror.

YOU ARE READY FOR THIS BOOK IF

You can say which of these make their own light: Sun, Moon, candle, mirror.

One step up	S3.8 Energy stores and transfers
This book	**S2.6 Light and shadows**
One step down	S1.6 Light, dark and sound

Contents

S2.6.1 Where light comes from

S2.6.2 Light goes in straight lines

S2.6.3 How we see

S2.6.4 Opaque, translucent, transparent

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S2.6.6 A shadow stick through the day

S2.6.7 Mirrors and shiny things

Key words, A to Z

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S2.6.1 CHAPTER 1

Where light comes from

The Moon shines at night. Does the Moon make its own light?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

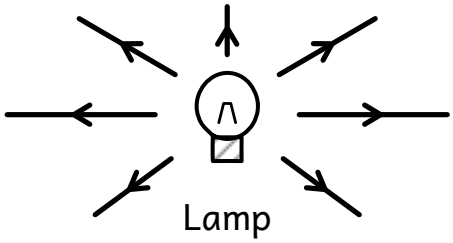
- ☐ **A** Yes. The Moon makes its own light.
- ☐ **B** No. The Moon sends back light from the Sun.
- ☐ **C** Yes. The Moon is a fire far away.

BY THE END YOU CAN

- Name things that make their own light
- Tell a light source from a thing that only sends light back
- Explain why you see nothing in total darkness

Look around the room. Some things seem to shine. Do they all make their own light?

A **light source** is a thing that makes its own light. The Sun is a light source. So is a fire. Lit candles, lamps and torches are sources too. Some animals, such as fireflies, make light in their bodies.



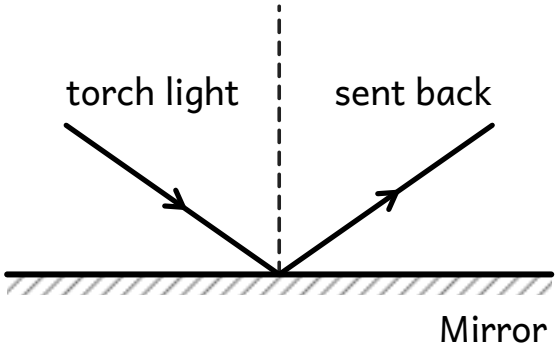
A lamp is a light source. Its light goes out in every direction.

Be safe. Never look at the Sun. Not even through glass, cloth, a tube or water. It can hurt your eyes. The harm may never go away.

The Moon looks bright at night. But the Moon makes no light of its own. Light from the Sun falls on it. The Moon sends some of it back. We say the Moon **reflects** light. To reflect is to send light back.

A mirror and white paper do the same. They make no light. They only reflect the light that falls on them.

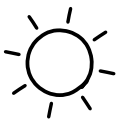
Shine a torch on a mirror. The mirror sends the torch light on. All the light came from the torch.



The mirror makes no light. It sends the torch light back.

DRAW IT FIRST

Draw how moonlight reaches you

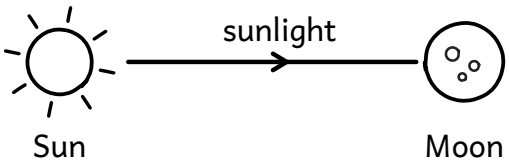


Sun

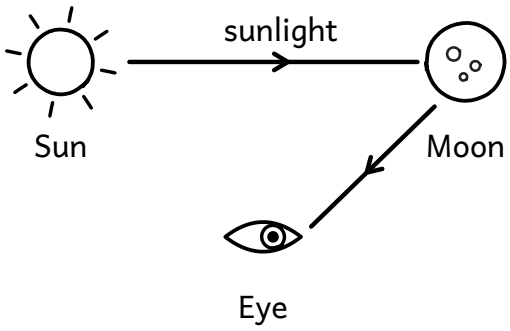
1 Draw the Sun on the left. Write "Sun" under it.



2 Draw the Moon on the right. Write "Moon" under it.



3 Draw an arrow from the Sun to the Moon. This is sunlight.



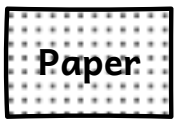
4 Draw an eye below. Draw an arrow from the Moon into the eye.

Darkness is no light at all. In total darkness you can see nothing. A white paper, a mirror and the Moon all vanish from sight.

no light at all



Eye

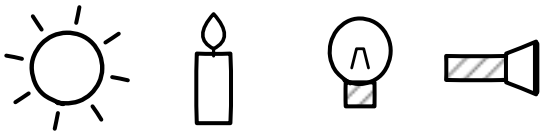


With no light at all, the eye sees nothing. Not even white paper.

SEE IT THREE WAYS

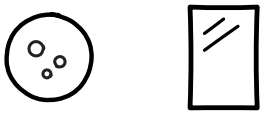
As a picture

makes its own light



Sun Candle Lamp Torch

only sends light back



Moon Mirror

In words

A source makes light. The Moon and a mirror only send light back. With no source, there is no light at all.

TRY IT

Does paper make light?

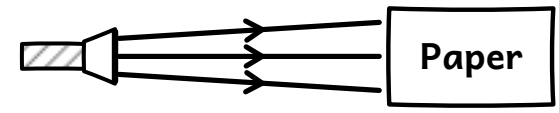
You need: a torch, a sheet of white paper, a room that you can make dim.

Be safe: Never shine a torch into anyone's eyes. Do not look into the torch.

1. Make the room as dim as you can. Close the curtains. If it stays bright, wait for evening.
2. Hold up the paper. Look at it. It looks dark.
3. Turn on the torch. Shine it on the paper.
4. Turn the torch off. Look at the paper again.

What you will see: The paper is bright only while the torch shines on it. The paper makes no light. It reflects the light of the torch.

If you cannot try it, this is what happens.



Torch on



Torch off

A WRONG IDEA MANY PEOPLE HAVE

~~The Moon makes its own light.~~

Why it feels right: The Moon is the brightest thing in the night sky.

The test that breaks it: Look at a thin Moon just after sunset. Its bright side faces where the Sun went down. Only the side that faces the Sun is lit. The Moon is like the paper. The Sun is like the torch.

What is true: The Moon only reflects sunlight. The Sun makes the light.

KEY WORDS

light source
a thing that makes its own light.

reflect
to send light back.

darkness
no light at all.

BACK TO YOUR GUESS

The answer is B: No. The Moon sends back light from the Sun.

The Moon makes no light of its own. Sunlight falls on it. The Moon sends some of it back to us.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which of these is a light source?

   A The Moon

   B A mirror

   C White paper

   D A lit candle

   Answer at the back of the book.

2. Why does the Moon look bright at night?

   A It sends back light from the Sun.

   B It makes its own light.

   C It burns like a fire.

   Answer at the back of the book.

3. You are in a room with no light at all. You hold up a white paper. What do you see?

   A The paper, shining white

   B Something faint, once my eyes get used to it

   C Nothing

   Answer at the back of the book.

4. A firefly glows in the dark. Is a firefly a light source?

   A Yes. It makes its own light.

   B No. It only reflects light.

   C No. Only the Sun makes light.

   Answer at the back of the book.

5. Write three things that make light. Write three that only send it back.

   Answer at the back of the book.

6. A torch shines on a mirror. A bright spot appears on the wall. Where does that light come from?

   A The mirror. It makes the light.

   B The wall. It makes the light.

   C The torch. The mirror sends it on.

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A light source makes its own light. The Sun, a fire and a lamp are sources. The Moon, a mirror and paper only send light back. With no light, we see nothing.

Draw: Draw the Sun and the Moon. Draw an arrow between them. Add an eye and an arrow into it.

S2.6.2 CHAPTER 2

Light goes in straight lines

Can light go round a corner?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

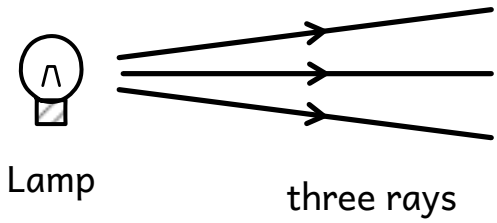
- ☐ **A** Yes. Light bends round corners easily.
- ☐ **B** No. In air, light goes in straight lines.
- ☐ **C** Only when the light is very bright.

BY THE END YOU CAN

- Show that light goes in a straight line
- Use three cards or a tube to test it
- Explain why a shadow has a sharp edge

A lamp is on in the next room. You cannot see it through the wall. Can light go round a corner?

Light goes in **straight lines** through air. A straight line has no bends. We draw one thin line of light as a **ray**. A ray has an arrow. The arrow shows which way the light goes.



Each ray is a straight line. Its arrow shows the way the light goes.

Light can bend where it goes from air into water or glass. That is why a spoon in a cup of water looks bent. But in air alone, light goes straight.

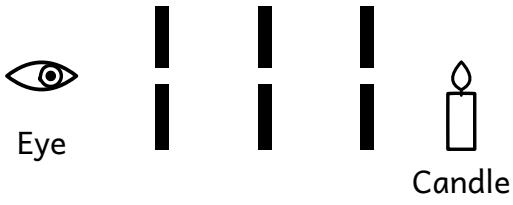
Be safe. Never do these tests with the Sun. Never look at the Sun. Not even through a hole, a tube, glass or cloth. It can hurt your eyes.

DRAW IT FIRST

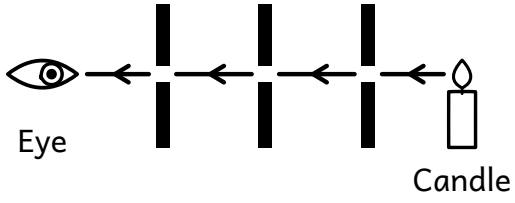
Draw light going through three holes



1 Draw an eye on the left and a candle on the right.



2 Draw three cards between them. Each card has a hole. Put the holes in a line.



3 Draw arrows from the candle, through the holes, to the eye.

TRY IT

Three cards and a flame

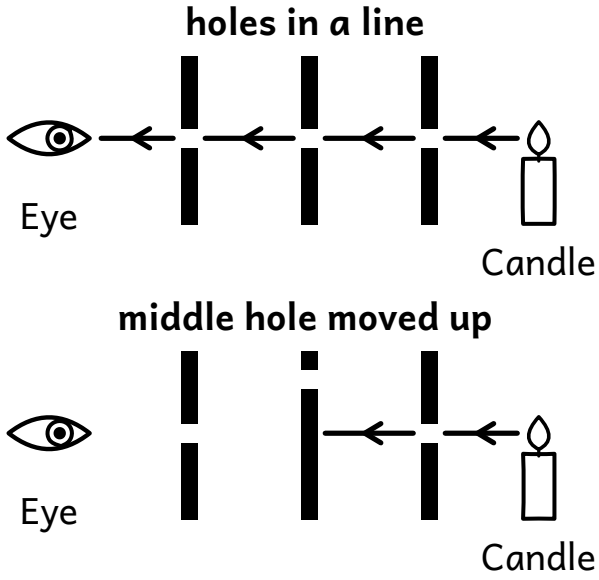
You need: three stiff cards, such as card from a box, a pencil, a ruler, a small lamp or a candle, clay or tape, to make the cards stand up.

Be safe: If you use a candle, a grown up must be nearby. Never use the Sun for this test.

1. Use the ruler to find the same height on each card. Make a hole there with the pencil.
2. Stand the cards in a row. Leave a hand of space between them.
3. Put the lamp or candle at one end. Keep it level with the holes.
4. Look through all three holes from the other end. Can you see the flame or the lamp?
5. Slide the middle card a little to one side. Look again.

What you will see: You see the light only when the holes are in line. Move one card and the light is blocked.

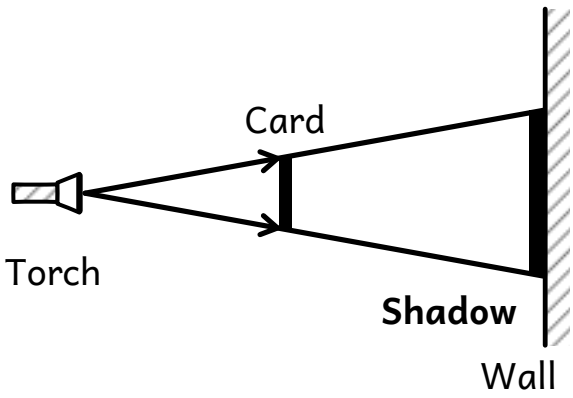
If you cannot try it, this is what happens.



Now think about a card in front of a torch. A **shadow** is a dark place where something blocks the light. The card blocks the rays. The rays that miss the card go straight on. So the edge of the shadow is sharp. A small light makes the sharpest edge. A big light makes it softer.

SEE IT THREE WAYS

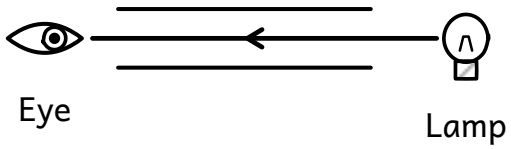
As a picture



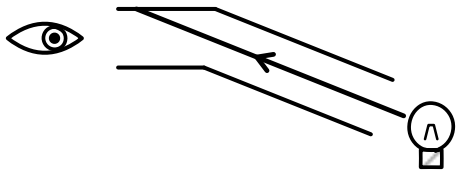
In words

Light goes straight. The card stops the rays in its path. The rays that miss it go on. The shadow has a sharp edge.

straight tube

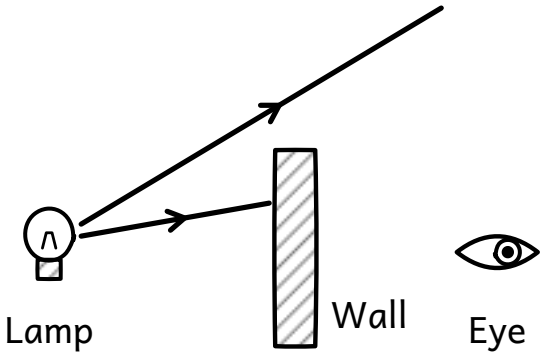


bent tube



Light goes straight along a straight tube. A bent tube stops it.

Think of a lamp behind a wall. The rays go straight. Some hit the wall and stop. Some pass over it and go on.



The light goes straight. It does not turn down to the eye.

A WRONG IDEA MANY PEOPLE HAVE

~~**Light can bend round a corner.**~~

Why it feels right: A lamp lights a whole room. It seems to reach round corners.

The test that breaks it: Roll paper into a tube. Look at a lamp through it. Then bend the tube. The lamp is gone from view. Never use the Sun for this.

What is true: In air, light goes in straight lines. It reaches round a corner only by bouncing off things.

KEY WORDS

straight line
a line with no bends.

ray
one thin line of light, drawn with an arrow.

shadow
a dark place where something blocks the light.

BACK TO YOUR GUESS

The answer is B: No. In air, light goes in straight lines.

In air, light goes in straight lines. It does not go round a corner. It can bounce off things. It also bends where it goes into water or glass.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. You look at a lamp through a bent paper tube. What do you see?

   A You cannot see the lamp

   B The lamp, as clear as before

   C The lamp, but small

   Answer at the back of the book.

2. Three cards have holes in a line. A candle burns behind them. Where must your eye be?

   A Above the cards

   B Anywhere in the room

   C In line with the holes

   Answer at the back of the book.

3. Which sentence explains why a shadow has a sharp edge?

   A Rays go straight past the edge of the card.

   B Light curls round the edge of the card.

   C The wall makes the edge sharp.

   Answer at the back of the book.

4. **From an earlier chapter**

   Which of these makes its own light?

   A A mirror

   B A fire

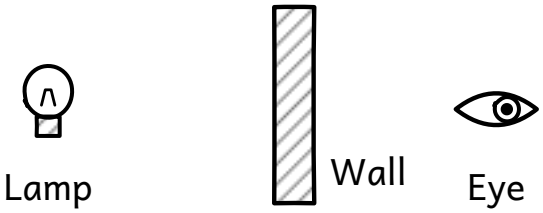
   C The Moon

   Answer at the back of the book.

5. Draw a torch, a card and a wall. Draw two rays past the card. Show the shadow.

   Answer at the back of the book.

6. A wall stands between a lamp and Ravi's eye. The lamp is on. Can he see the lamp itself?



A Yes. Light bends round the wall.

B Yes, if the lamp is very bright.

C No. Only a little light reaches him.

D No. Light goes straight and the wall blocks it.

Answer at the back of the book.

7. Which is the right way to draw a ray from a lamp?

A A wavy line with an arrow

B A straight line with an arrow that points to the lamp

C A straight line with no arrow

D A straight line with an arrow that points away from the lamp

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

In air, light goes in straight lines. A ray is one line of light, drawn with an arrow. A card blocks rays and makes a shadow. The shadow has a sharp edge.

Draw: Draw a torch, a card and a wall. Add two rays past the card. Shade the shadow.

S2.6.3 CHAPTER 3

How we see

How do I see *a* cup on the t*a*ble?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Sight comes out of my eyes *a*nd touches the cup.
- ☐ **B** The cup sends out light of its own.
- ☐ **C** Light goes from the l*a*mp into my eyes. The cup does nothing.
- ☐ **D** Light bounces off the cup *a*nd goes into my eyes.

BY THE END YOU CAN

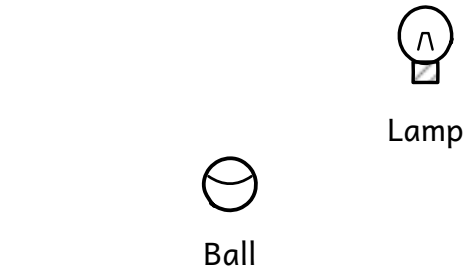
- S*a*y how light lets you see *a* thing
- Dr*a*w r*a*ys going into *a*n eye *a*nd never out of it
- Expl*a*in why you see nothing in tot*a*l d*a*rkness

You see *a* cup on *a* t*a*ble. The cup m*a*kes no light. A l*a*mp is *a* **light source**. It m*a*kes its own light.

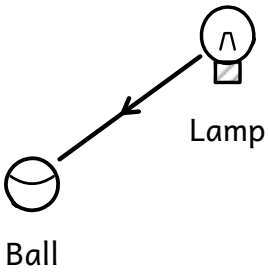
R*a*ys of light le*a*ve the l*a*mp. A **r*a*y** is one thin line of light. The r*a*ys hit the cup. The cup **reflects** them. To reflect is to send light b*a*ck. Some r*a*ys go into your eyes. Then you see the cup.

DRAW IT FIRST

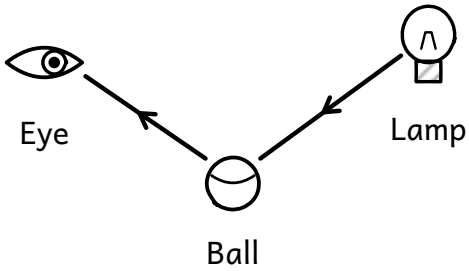
Draw how you see *a* ball



1 Draw *a* lamp and *a* ball. Write their names.



2 Draw an arrow from the lamp to the ball.



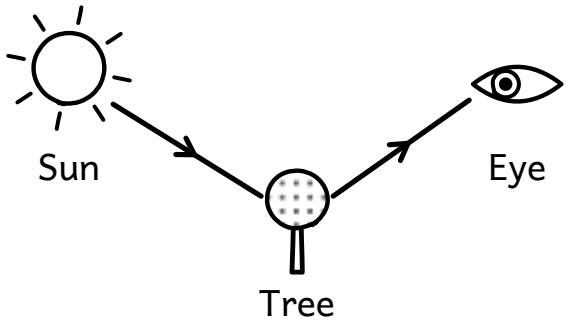
3 Draw an eye. Draw an arrow from the ball into the eye.

In the day, the Sun is the light source. Sunlight bounces off *a* tree. Some of it goes into your eyes. Then you see the tree.

Be safe. Never look at the Sun to test this. Not even through glass, cloth, *a* tube or water. Do not stare at *a* bright lamp.

SEE IT THREE WAYS

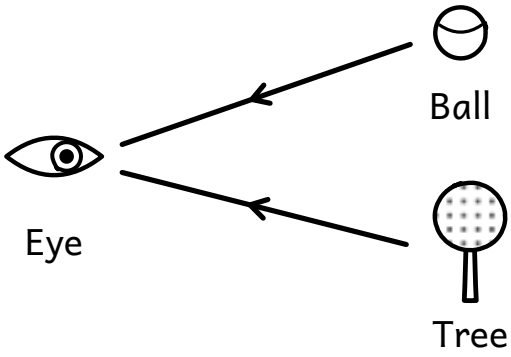
As a picture



In words

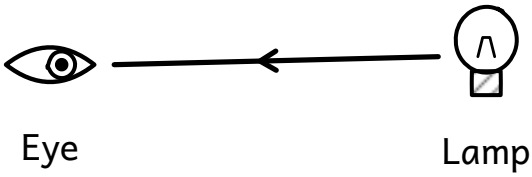
Light leaves a source. It bounces off the thing. It goes into your eye. Then you see the thing.

Look at the arrows. They point into the eye. Eyes take light in. They send no light out.



Rays go into the eye. None come out of it.

You see a lamp in a different way. Its own light goes straight into your eye.



A lamp makes its own light. The light goes straight into your eye.

With no light at all, no rays reach your eyes. You see nothing.

no light at all



No rays reach the eye. It sees nothing.

TRY IT

See inside a dark box

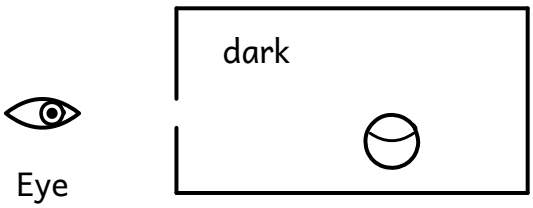
You need: a box with a lid, such as a shoe box, a pencil, a white stone, cup or piece of paper.

1. Push the pencil through one end of the box. Make a small hole.
2. Put the white thing inside. Shut the lid so that no light gets in.
3. Put your eye close to the hole. Keep your eye wide open. What do you see?
4. Lift the lid a little. Look through the hole again.

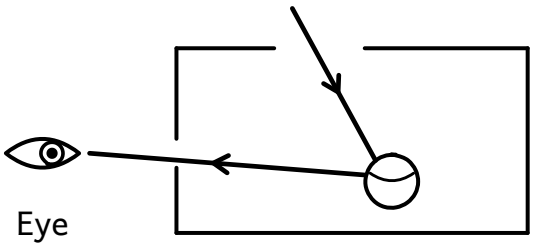
What you will see: With the lid shut, you see almost nothing. Lift the lid and light comes in. It bounces off the white thing. It goes through the hole into your eye. Now you see it.

If you cannot try it, this is what happens.

lid shut



lid open a little



A WRONG IDEA MANY PEOPLE HAVE

~~Sight comes out of our eyes.~~

Why it feels right: Looking feels like your eyes reach out to a thing.

The test that breaks it: Use the box. Your eye is wide open at the hole. If sight came from your eyes, you would see the white thing. With the lid shut, you see almost nothing. In a room with no light, you cannot see your hand. Wide open eyes do not help.

What is true: We see when light goes into our eyes. Eyes only take light in.

KEY WORDS

light source
a thing that makes its own light.

ray
one thin line of light.

reflect
to send light back.

BACK TO YOUR GUESS

The answer is D: Light bounces off the cup and goes into my eyes.

We see a cup when light bounces off it into our eyes. Nothing comes out of our eyes.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. How do you see a book on a table?

   A Light comes out of my eyes and touches the book.

   B The book sends out its own light.

   C Light bounces off the book and goes into my eyes.

   Answer at the back of the book.

2. You are in a room with no light at all. Your eyes are wide open. Can you see your hand?

   A No. There is no light to reach my eyes.

   B Yes. Light comes out of my eyes.

   C Yes, if I look very hard.

   Answer at the back of the book.

3. Look at a picture of seeing. Which way does the arrow at the eye point?

   A Out of the eye

   B Into the eye

   C Both ways

   Answer at the back of the book.

4. **From an earlier chapter**

   A lamp is on. A stiff card with no hole is between lamp and eye. Can you see the lamp?

   A Yes. Light bends round the card.

   B Yes, because the card is thin.

   C No. The card blocks the straight rays.

   Answer at the back of the book.

5. Draw how you see a cup. Show a lamp, a cup and an eye. Add the arrows.

   Answer at the back of the book.

6. Joseph looks at a lit candle across a dark room. How does its light reach his eyes?

   A It goes out of his eyes to the flame and back.

   B It must bounce off something first.

   C The light stays at the flame.

   D The flame's light goes straight into his eyes.

   Answer at the back of the book.

7. In the day, Joseph sees a tree. Which one is the light source?

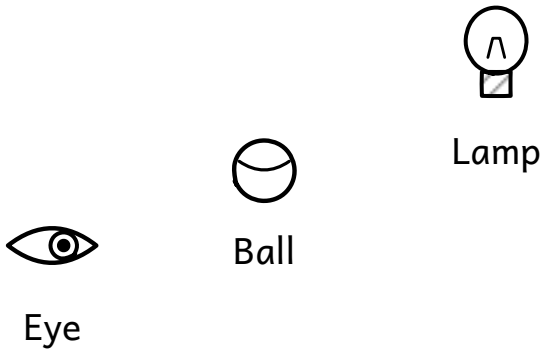
   A The Sun

   B The tree

   C Joseph's eyes

   Answer at the back of the book.

8. The lamp lights the ball. Which way does light go so the eye sees the ball?



   A From the eye to the ball

   B From the lamp straight into the eye

   C From the lamp to the ball, then into the eye

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

We see a thing when light bounces off it into our eyes. Eyes take light in. They send none out. With no light at all, we see nothing.

Draw: Draw a lamp, a ball and an eye. Draw an arrow from the lamp to the ball. Draw one from the ball into the eye.

S2.6.4 CHAPTER 4

Opaque, translucent, transparent

Why can I see through glass but not through a wooden door?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Glass lets light through. Wood does not.
- ☐ **B** Light cannot reach the door.
- ☐ **C** Light goes through anything that is thin.

BY THE END YOU CAN

- Sort things as transparent, translucent or opaque
- Say what light does at each kind of thing
- Explain how a shadow forms

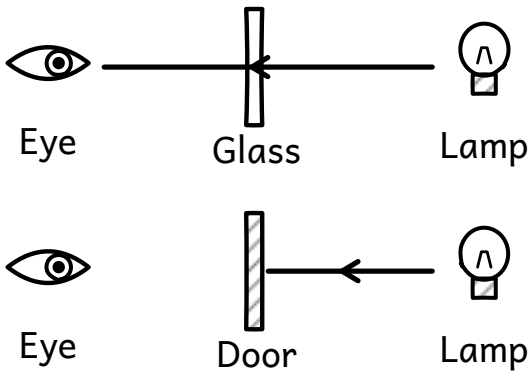
Light meets many things on its way. Some things let light through. Some do not.

A **transparent** thing lets almost all light through. Clear glass, clean water and clear plastic are transparent. You can see clearly through them.

A **translucent** thing lets some light through. It spreads the light out. Paper, thin cloth and frosted glass are translucent. You see a glow, but no clear shapes.

An **opaque** thing lets no light through. Wood, stone and a book are opaque. You cannot see through them.

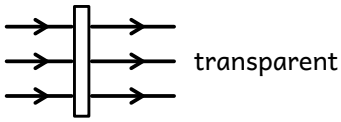
Now think of a window and a door. A lamp is on the far side of each. Glass lets the rays reach your eye. A wooden door stops them.



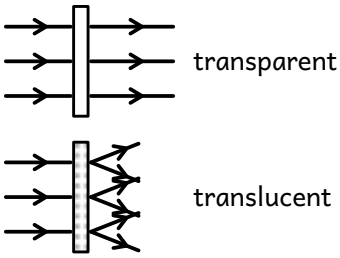
The rays pass through glass. They stop at the door.

DRAW IT FIRST

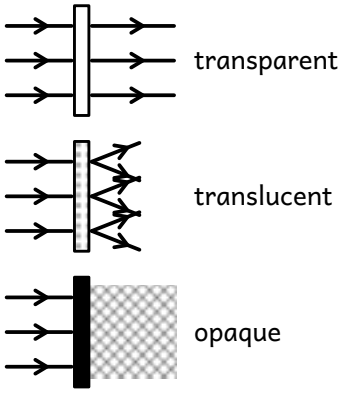
Draw light meeting three sheets



1 Draw a clear sheet. Draw three rays that go straight through it.

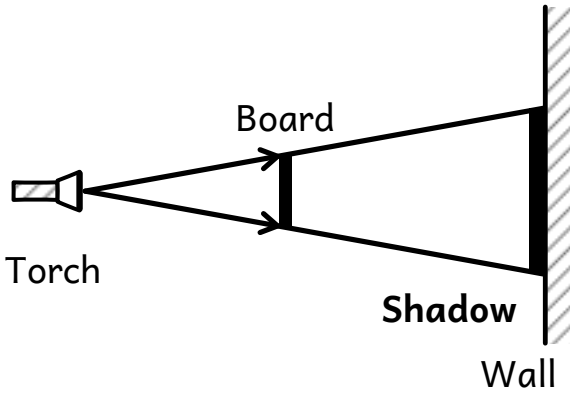


2 Draw a paper sheet. Draw the rays spreading out after it.



3 Draw a thick board. Stop the rays. Shade the dark place behind it.

A **shadow** forms where an opaque thing blocks light. The light cannot pass. So the place behind the thing is dark.

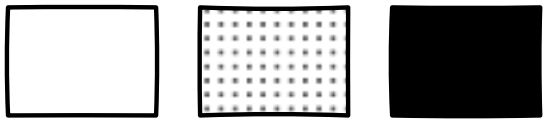


The board blocks the light. The wall behind it is dark.

A transparent thing makes almost no shadow. A translucent thing makes a pale shadow. An opaque thing makes a dark shadow.

SEE IT THREE WAYS

As a picture



In words

Glass is transparent, so it is bright behind it. Paper is translucent, so it is dim. Wood is opaque, so it is dark.

TRY IT

Which things make shadows?

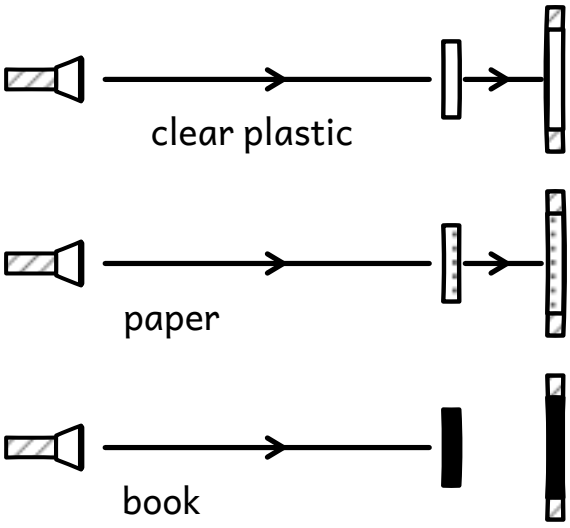
You need: a torch, a plain wall, a clear plastic bag or cup, a sheet of paper, a book.

Be safe: Never shine a torch into anyone's eyes.

1. Make the room dim. Shine the torch on the wall.
2. Hold the clear plastic in the light, near the wall. Look at the wall.
3. Do the same with the paper. Then do it with the book.
4. Which makes the darkest shadow? Which makes almost none?

What you will see: The clear plastic makes almost no shadow. The paper makes a pale shadow. The book makes a dark shadow.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~**If light gets through a thing, you can see through it clearly.**~~

Why it feels right: Clear glass lets light through, and you see clearly through it.

The test that breaks it: Hold a sheet of paper in front of a room lamp. Keep it away from the bulb. You see a glow. Now hold a pencil behind the paper. You see only a blurry shape. Never do this with the Sun.

What is true: Translucent things let light through, but spread it out. You see light, not clear shapes.

KEY WORDS

transparent
lets almost all light through. You see clearly through it.

translucent
lets some light through and spreads it out.

opaque
lets no light through.

shadow
a dark place where something blocks the light.

BACK TO YOUR GUESS

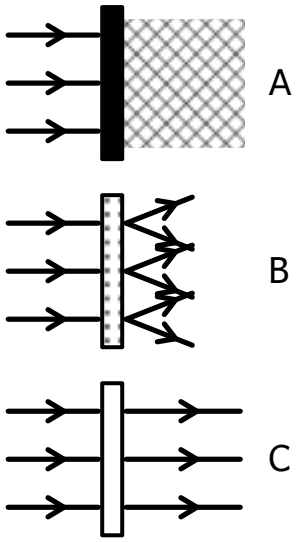
The answer is A: Glass lets light through. Wood does not.

Glass lets light through, so you see through it. A wooden door blocks the light.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Look at the picture. Which row shows a translucent sheet?



A A

B B

C C

Answer at the back of the book.

2. Which of these is transparent?

A A wooden door

B A sheet of thin paper

C Clear glass

Answer at the back of the book.

3. A thin white cloth lets some light through. You cannot see clear shapes through it. What is it?

A Translucent

B Transparent

C Opaque

Answer at the back of the book.

4. Why does a book make a dark shadow?

   A It lets all the light through.

   B It blocks the light.

   C It makes light of its own.

   Answer at the back of the book.

5. **From an earlier chapter**

   With no light at all, you cannot see your hand. Why?

   A Light comes out of my eyes, but it is too weak.

   B My eyes need more time to get used to it.

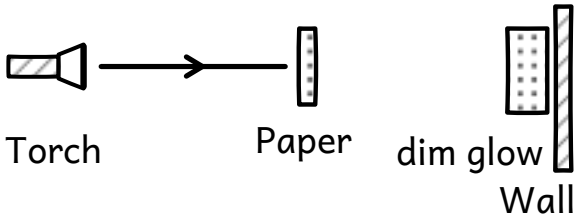
   C There is no light to bounce off my hand into my eyes.

   Answer at the back of the book.

6. Sort these into transparent, translucent and opaque: clear plastic, paper, wood, stone.

   Answer at the back of the book.

7. A torch shines on a sheet of paper. A dim glow shows on the wall behind it. Why?



   A The paper makes its own light.

   B The paper lets all the light through.

   C The paper blocks all the light.

   D The paper lets some light through.

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Transparent things let almost all light through. Translucent things let some through and spread it out. Opaque things let none through, so they make a dark shadow.

Draw: Draw three rows of rays meeting a sheet. Label them transparent, translucent and opaque.

S2.6.5 CHAPTER 5

Big and small shadows

Why is my shadow big near a lamp and small far away?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

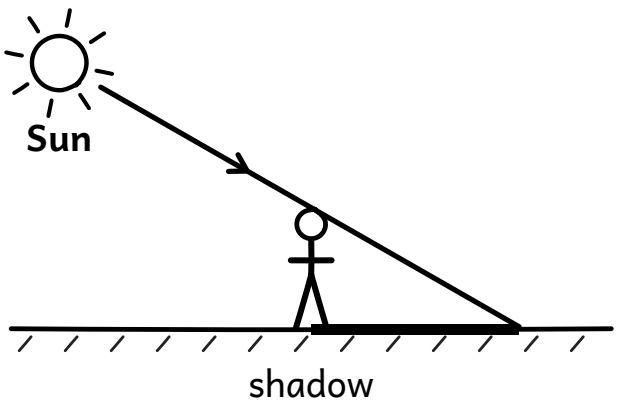
- ☐ **A** A shadow is always the same size as the thing.
- ☐ **B** A thing near the lamp makes a bigger shadow.
- ☐ **C** A thing near the lamp makes a smaller shadow.

BY THE END YOU CAN

- Say which side of a thing its shadow falls on
- Explain how a lamp makes a shadow bigger or smaller
- Say why this hardly shows in sunlight

Hold your hand in front of a lamp. A dark shape falls on the wall behind it. That is a **shadow**. A shadow is a place where a thing blocks the light.

The light is on one side of your hand. The shadow is on the other side. A shadow always falls away from the light.



The Sun is on the left. The shadow falls on the right.

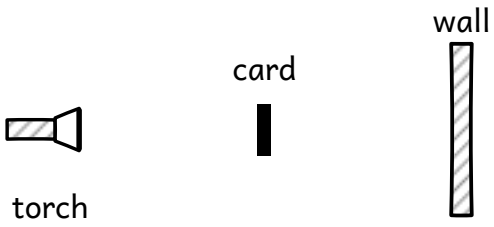
A shadow has the **outline** of the thing. The outline is the line round its edge. A shadow has no colour. It has no small details. A red cup and a blue cup make the same dark shadow.

DRAW IT FIRST

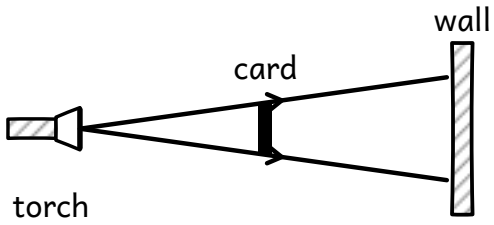
Draw the shadow of a card



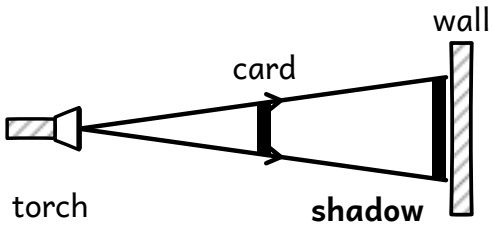
1 Draw a torch on one side and a wall on the other.



2 Draw a card between them.

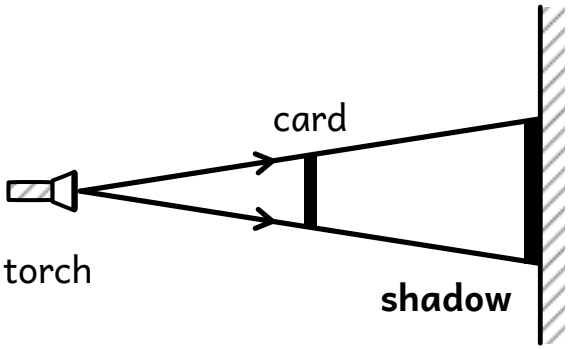


3 Draw lines from the torch past the edges of the card.



4 Light cannot pass the card. Fill in the wall between the lines. That is the shadow.

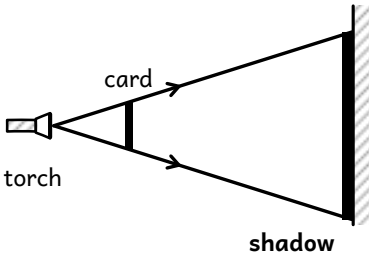
Now ask a question. What if the card moves? The wall stays where it is. How far the card is from the torch is its **distance**.



The card is halfway to the wall. The shadow is 2 times as tall as the card.

SEE IT THREE WAYS

As a picture



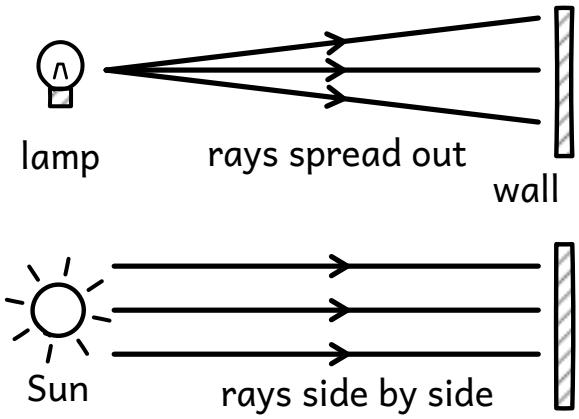
In words

Move the card nearer the torch. Light spreads out like a fan from the torch. Behind the card, it has more room to spread. So the shadow grows. Move the card away, and the shadow shrinks.

In symbols

Torch to wall: 4 steps. Card 2 steps from the torch: shadow 2 times as tall. Card 1 step from the torch: shadow 4 times as tall.

The Sun is a light too. But the Sun is very, very far away. Its light comes to us almost side by side. It does not spread like a fan. Hold a book in the sun, near a wall. Move it nearer the wall, or farther away. Its shadow stays about the same size.



A lamp is near, so its rays spread out. The Sun is far, so its rays run side by side.

Sunlight makes shadows change in a different way. A shadow changes when the Sun climbs or sinks in the sky. A later chapter shows how.

TRY IT

Make a shadow bigger

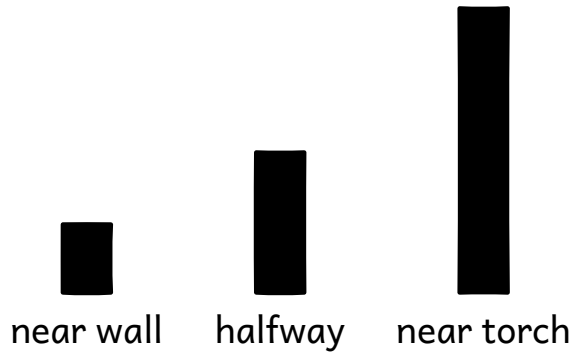
You need: a torch, or the torch on a phone, a plain wall in a dim room, your hand, or a book.

Be safe: Do not shine the torch at anyone's eyes.

1. Dim the room. Put the torch on a table, shining at the wall.
2. Hold your hand close to the wall. Look at its shadow.
3. Move your hand slowly toward the torch. Watch the shadow.
4. Stop halfway. Look. Then stop near the torch. Look again.

What you will see: The shadow grows as your hand gets nearer the torch. Close to the wall, it is about the size of your hand. It is dark, with no colour and no small details. Near the torch, the edge may look soft.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~A shadow is always the same size as the thing.~~

Why it feels right: In sunlight, a wall shadow is about the size of the thing.

The test that breaks it: Hold your hand near a torch. Look at the wall. The shadow is far bigger than your hand. Move your hand toward the wall, and watch it shrink.

What is true: A lamp can make a shadow much bigger than the thing. The nearer the lamp, the bigger the shadow.

KEY WORDS

shadow
a place where a thing blocks the light.

outline
the line round the edge of a shape.

distance
how far one thing is from another.

BACK TO YOUR GUESS

The answer is B: A thing near the lamp makes a bigger shadow.

Light spreads out from a lamp, like a fan. Behind a thing near the lamp, light has far to spread. So the shadow grows.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. **From an earlier chapter**

   Which of these makes the darkest shadow?

   A A wooden board

   B Clean window glass

   C Thin paper

   Answer at the back of the book.

2. Ana moves a book nearer to a lamp. The wall stays where it is. What happens to the shadow of the book?

   A It gets smaller.

   B It stays the same size.

   C It gets bigger.

   Answer at the back of the book.

3. A torch is 6 steps from a wall. A card is 2 steps from the torch. The card is 10 cm tall. How tall is the shadow?

   Answer at the back of the book.

4. In the sun, you move a book away from a wall. Why does its shadow hardly change size?

   A The Sun is very far away.

   B The Sun gives no light.

   C The Sun is very close.

   Answer at the back of the book.

5. Is the shadow of a yellow flower yellow? Say why.

   Answer at the back of the book.

6. A lamp is on your left, as high as your head. Which side of you does your shadow fall on?

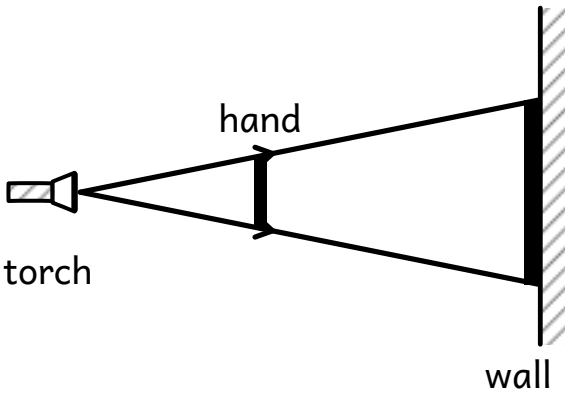
   A Your left side

   B Your right side

   C Straight down, under your feet

   Answer at the back of the book.

7. Tariq wants a smaller shadow of his hand on the wall. The torch stays still. What should he do?



A Move his hand toward the torch

B Nothing can change the size of a shadow

C Move his hand toward the wall

Answer at the back of the book.

8. Why is a shadow dark?

A The thing is heavy.

B The shadow is a reflection of the thing.

C The wall is a dark colour.

D The thing blocks the light.

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A shadow falls on the side away from the light. It has the outline of the thing, but no colour. Move a thing nearer a lamp and its shadow grows. In sunlight this hardly shows.

Draw: A torch, a card and a wall. Two lines from the torch past the card. Colour the wall between the lines.

S2.6.6 CHAPTER 6

A shadow stick through the day

Why is my shadow long in the morning and short at midday?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The Sun comes nearer to us at midday.
- ☐ **B** The Sun is low in the morning and high at midday.
- ☐ **C** The stick gets shorter in the heat.

BY THE END YOU CAN

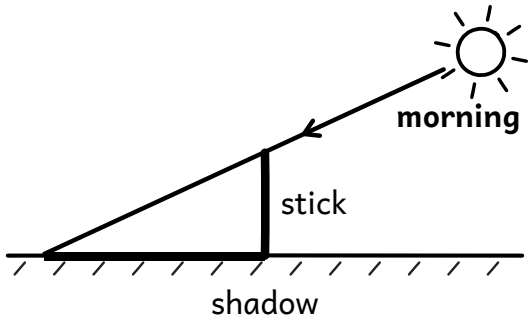
- Make a shadow stick and mark its shadow every hour
- Say when the shadow is longest and when it is shortest
- Explain why the Sun seems to cross the sky

A **shadow stick** is a stick pushed upright into flat ground. Its shadow moves all day. It can show you where the Sun is.

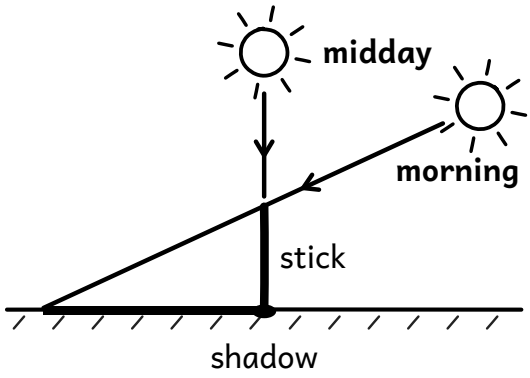
Be safe. Never look at the Sun. Not for one second. Not through glass, cloth, a tube or water. It can hurt your eyes for good. Look only at the shadow on the ground.

DRAW IT FIRST

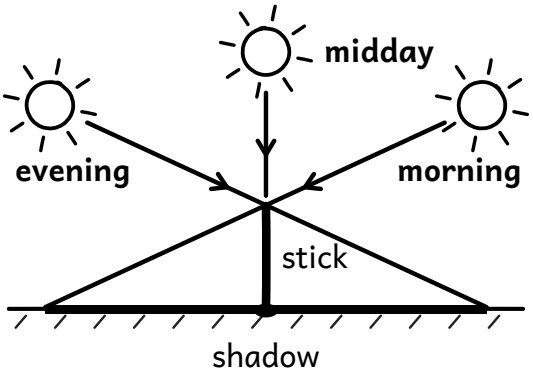
The shadow of a stick, three times in one day



1 In the morning the Sun is low. The shadow is long.



2 At midday the Sun is high. The shadow is short.



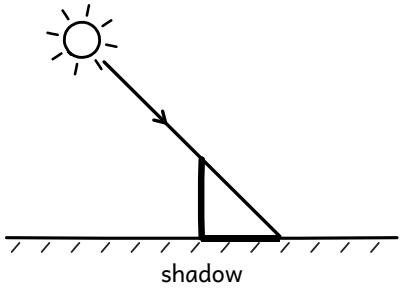
3 In the evening the Sun is low again. The shadow is long, on the other side.

The Sun is low in the morning, so the shadow is long. The Sun is high at midday, so the shadow is short. **Midday** is the middle of the day, when the Sun is highest. The shortest shadow of the day is at midday.

Midday is not always 12 o'clock on a clock. Clocks are set for a whole region. The Sun does not follow your clock. Midday may come an hour or more from 12 on your clock.

SEE IT THREE WAYS

As a picture



In words

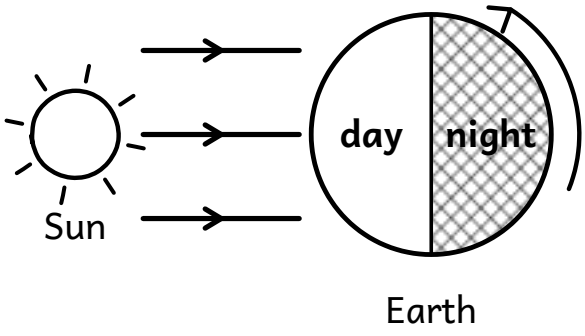
The Sun is halfway up the sky. Then the shadow is as long as the stick. A lower Sun makes it longer. A higher Sun makes it shorter.

In symbols

Sun halfway up: shadow 1 stick long. Sun higher: less than 1 stick. Sun lower: more than 1 stick.

Does the Sun move across the sky? It seems to. But it is the Earth that moves. The Earth turns round once a day.

Your home turns toward the Sun, and the Sun seems to rise. Later your home turns away, and the Sun seems to set.



The Earth turns round once a day. One half has day. The other half has night.

The Earth turns from west to east. So the Sun rises roughly in the east. It sets roughly in the west.

On two days a year, the Sun rises exactly in the east. On those days it sets exactly in the west. On other days it rises north or south of east. It sets north or south of west.

TRY IT

Make a shadow stick

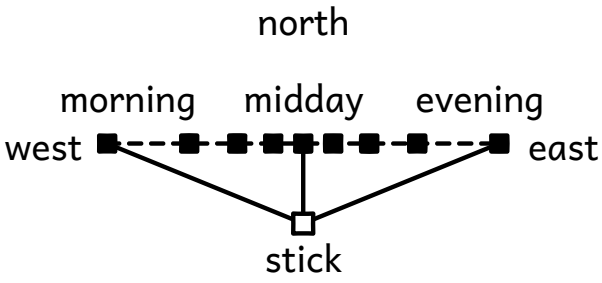
You need: a straight stick, as long as your arm, about ten small stones, flat ground in the sun all day, or a pot of sand, a clock or a watch, or someone who knows the hour, a string with a stone tied to one end, paper and a pencil, to write the times.

Be safe: Never look at the Sun. Look only at the shadow on the ground.

1. Push the stick into the ground. Press the soil round it.
2. Hold the string next to the stick. They should hang the same way.
3. Put a stone on the tip of the shadow. Write down the time.
4. Come back every hour and add a stone. Never touch the stick.
5. At the end of the day, look down at the stones.

What you will see: The first stones are far from the stick. Then they come closer, and then they go far again. The nearest stone marks midday. The stones make a line. On most days it bends a little. The picture is for a home north of the tropics. South of them, the stones lie south of the stick.

If you cannot try it, this is what happens.



Now look at where the shadow points. It depends on where your home is.

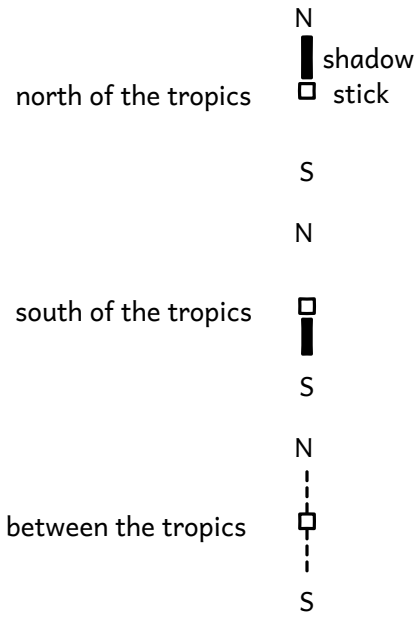
The **tropics** are the lands near the middle of the Earth. On a map, find the Tropic of Cancer. Find the Tropic of Capricorn. The tropics lie between them.

North of the tropics, the midday shadow points north. This is true all year.

South of the tropics, the midday shadow points south. This is true all year.

Between the tropics, it changes with the time of year. For part of the year it points north. For part of the year it points south. On one or two days a year, the midday

shadow almost vanishes. Then the Sun is almost straight overhead.



The midday shadow, seen from above. Dashed: it changes with the time of year.

To find north, face the place where the Sun comes up. Do not look at the Sun itself. North is on your left. This is roughly right.

Look down on your stones from above. **Clockwise** is the way the hands of a clock turn. North of the tropics, the shadow tip moves clockwise. South of the tropics, it moves the other way. Between the tropics, it depends on the time of year.

A WRONG IDEA MANY PEOPLE HAVE

~~The shadow is shortest when the clock says 12.~~

Why it feels right: People call 12 o'clock midday. So the Sun must be highest then.

The test that breaks it: Mark the tip every 15 minutes, for a few hours around 12. Find the shortest shadow. Then look at the clock.

What is true: The shortest shadow is at midday by the Sun. On a clock it can be an hour or more from 12.

KEY WORDS

shadow stick

a stick pushed upright into the ground, to study its shadow.

midday
the middle of the day, when the Sun is highest.

tropics
the lands near the middle of the Earth, between two map lines.

clockwise
the way the hands of a clock turn.

BACK TO YOUR GUESS

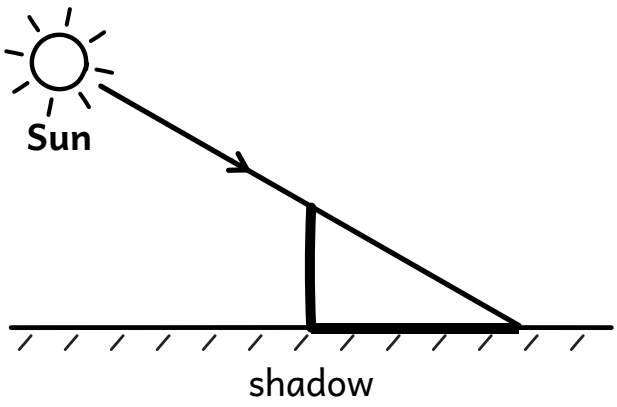
The answer is B: The Sun is low in the morning and high at midday.

The Sun is low in the morning, so the shadow is long. At midday the Sun is high, so the shadow is short.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. The shadow of this stick is long. Where is the Sun?



A High in the sky

B Straight above the stick

C Low in the sky

Answer at the back of the book.

2. Mei lives south of the tropics. At midday, which way does her stick shadow point?

   A North

   B East or west

   C It changes with the time of year

   D South

   Answer at the back of the book.

3. Why does the Sun seem to move across the sky?

   A The Earth turns.

   B The Sun goes round the Earth each day.

   C Clouds push the Sun along.

   Answer at the back of the book.

4. Kofi's clock says 12. Is his shadow sure to be the shortest now?

   A Yes. Midday is always 12 on a clock.

   B Yes, if his clock is exactly right.

   C No. It may be shortest an hour or more from 12.

   Answer at the back of the book.

5. **From an earlier chapter**

   Why does a stick make a shadow in the sun?

   A Light cannot go through the stick.

   B The stick makes its own dark.

   C Light bends round the stick.

   Answer at the back of the book.

6. You mark the shadow tip every hour. Which stone is the nearest to the stick?

   Answer at the back of the book.

7. How can you find the Sun with no risk to your eyes?

   A Look at it through dark glass

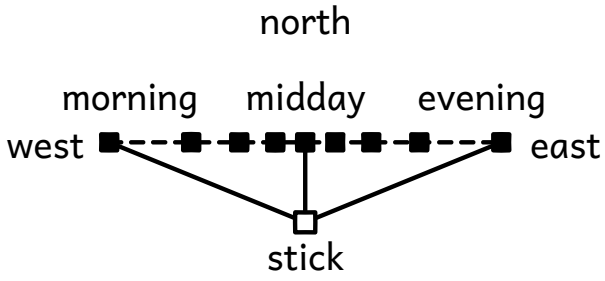
   B Look at it in a mirror

   C Look at it for one second only

   D Look at the shadow of a stick

   Answer at the back of the book.

8. Amina's stones are far from the stick, then near, then far. Why?



   A The stick shrinks, then grows.

   B The Sun climbs higher, then sinks lower.

   C The Earth moves nearer the Sun, then away.

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A shadow stick shows the path of the Sun. The shadow is long when the Sun is low. It is short at midday. The Earth turns, so the Sun seems to move. Never look at the Sun.

Draw: A stick with three Suns and three shadows: long, short, long.

S2.6.7 CHAPTER 7

Mirrors and shiny things

Why can I see myself in a mirror but not a wall?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The mirror makes its own picture of me.
- ☐ **B** The mirror sends light back in one direction.
- ☐ **C** A wall bounces no light at all.

BY THE END YOU CAN

- Say why a mirror shows a picture and a wall does not
- Say how a ray of light bounces off a mirror
- Use a mirror and a torch safely

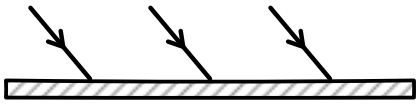
You see a wall because light bounces off it into your eyes. You see a mirror in the same way. But a mirror bounces light in a special way.

A mirror is **smooth**. Smooth means with no bumps. Light that hits a smooth, flat thing bounces off in one direction. Your eyes catch it, and you see a picture of things. That picture is an **image**.

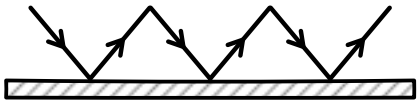
A wall is **rough**. Rough means bumpy. Light that hits a rough thing goes every way. You see the wall, but you see no image.

DRAW IT FIRST

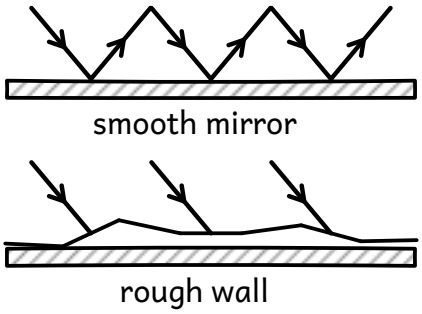
Smooth and rough, side by side



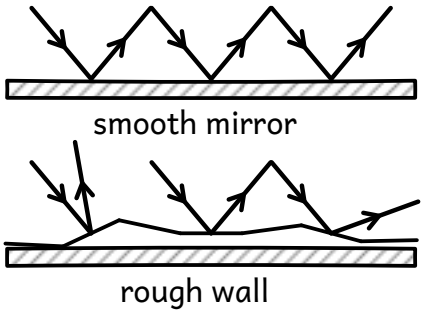
1 Draw a smooth mirror. Draw three rays of light going in.



2 Draw the three rays going out, side by side.



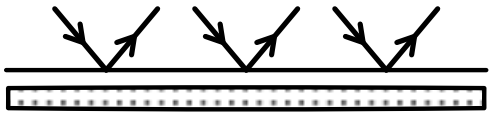
3 Now draw a rough wall. Draw three rays going in.



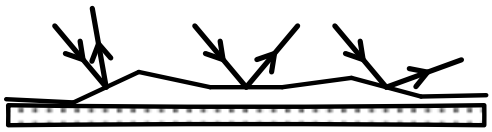
4 Each bump sends its ray a different way. Draw them going out.

Paper looks smooth. Up close it is rough. That is why you can read a page from any side.

Still water is smooth. You can see an image in it. Ripples make it rough. Then the image breaks up.



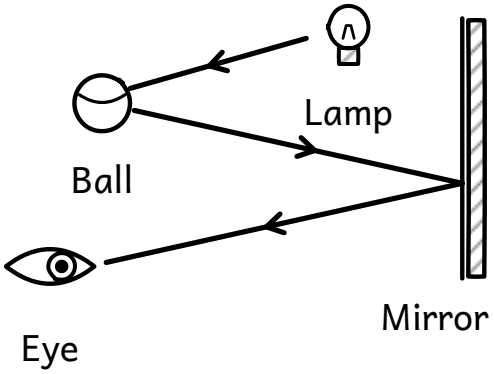
still water



rippled water

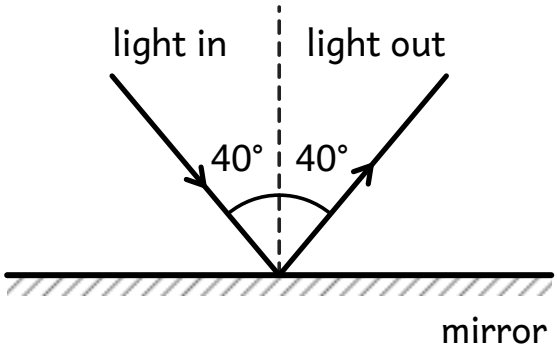
Still water bounces the rays side by side. Ripples send them every way.

You see an image by two bounces. Light bounces off the ball. Then it bounces off the mirror into your eye.



Lamp light bounces off the ball to the mirror. Then it bounces into the eye.

A narrow beam of light is a ray. Look at the dashed line in the picture. It stands straight up from the mirror. A ray leans away from this line. How far it leans is its ***angle***.



The angle in equals the angle out. Both are measured from the dashed line.

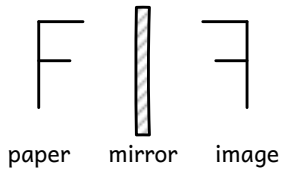
Be safe. Never shine sunlight from a mirror into anyone's eyes. That means people, animals and drivers. It can hurt their eyes.

SEE IT THREE WAYS

With things

Hold up your right hand to a mirror. The hand in the mirror looks like a left hand.

As a picture



In words

In a mirror, up is still up. Your head is still at the top. The mirror turns things front to back. So a right hand looks like a left hand. Writing looks backwards.

TRY IT

Bounce a beam off a mirror

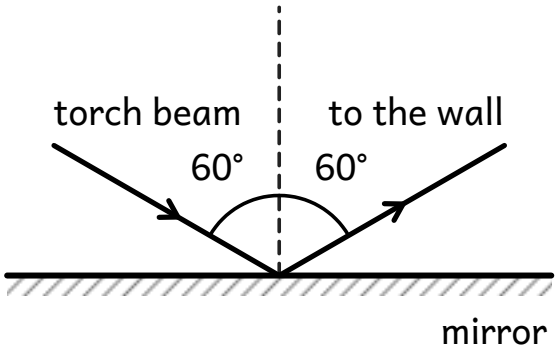
You need: a small flat mirror, a torch, or the torch on a phone, a plain wall in a dim room, a book to lean the mirror on.

Be safe: Use a torch, not the Sun. Use a mirror with no cracks and no sharp edges. If it breaks, do not touch the pieces. Call a grown up. Never shine a torch or a mirror into anyone's eyes.

1. Stand the mirror up, leaning on the book. Face it toward the room.
2. Dim the room. Shine the torch at the mirror from far to one side.
3. Find the bright spot on the wall. The mirror bounced the beam there.
4. Move the torch to a new place. Watch the bright spot move.

What you will see: The beam leaves on the other side, at the same angle. Swing the torch one way, and the spot swings the other way.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~A mirror makes its own light.~~

Why it feels right: A mirror looks bright and shows you a clear picture.

The test that breaks it: Take a mirror into a room with no light at all. Look in it. You see nothing. Switch a torch on. Now you see the image.

What is true: A mirror only bounces light. With no light to bounce, it shows nothing.

KEY WORDS

smooth
with no bumps.

rough
bumpy, not flat.

image
the picture you see in a mirror.

angle
how far a ray leans from the straight up line.

BACK TO YOUR GUESS

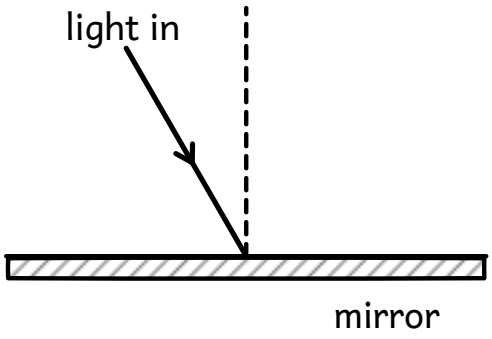
The answer is B: The mirror sends light back in one direction.

A mirror is smooth and shiny. It bounces light back in one direction. A wall is rough. It bounces light every way, so you see no picture.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. A ray hits the mirror at 30° to the dashed line. At what angle does it leave?



A 60°

B 90°

C 30°

Answer at the back of the book.

2. **From an earlier chapter**

Which of these makes its own light?

A A candle flame

B A mirror

C The Moon

Answer at the back of the book.

3. Why do you see no image in a rough wall?

A A wall bounces light every way.

B A wall bounces no light.

C A wall makes its own light.

Answer at the back of the book.

4. A sheet of foil is smooth and shiny. You crumple it, and the image breaks up. Why?

   A The foil makes less light.

   B The crumpled foil has many tiny flat parts that face different ways.

   C The foil turns into a wall.

   Answer at the back of the book.

5. A friend flashes sunlight from a mirror at a driver. What do you say?

   Answer at the back of the book.

6. Hold up your right hand to a mirror. What does the hand in the mirror look like?

   Answer at the back of the book.

7. Which is a safe way to play with a mirror and light?

   A Look at the Sun in the mirror, not at the Sun itself.

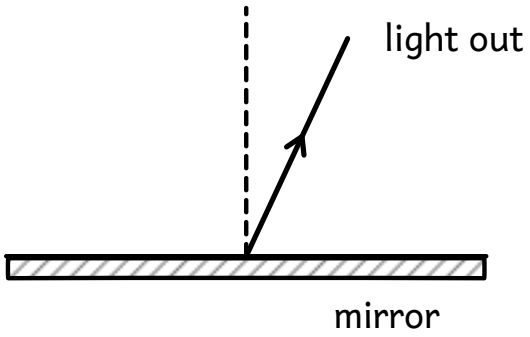
   B Flash sunlight from the mirror at a friend for fun.

   C Shine a torch into a friend's eyes to show the beam.

   D Shine a torch at a wall, away from all eyes.

   Answer at the back of the book.

8. A ray leaves the mirror at 25° to the dashed line. At what angle did it come in?



A 50°

B 65°

C 115°

D 25°

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A smooth, shiny thing bounces light one way. You see an image. A rough thing sends light every way. The angle in equals the angle out. Never shine sunlight from a mirror into eyes.

Draw: A mirror line with a dashed line standing up from it. Draw a ray in and a ray out at the same angle.

Key words, A to Z

Every key word in this book, what it means, and the chapter that teaches it.

angle
how far a ray leans from the straight up line. S2.6.7

clockwise
the way the hands of a clock turn. S2.6.6

darkness
no light at all. S2.6.1

distance
how far one thing is from another. S2.6.5

image
the picture you see in a mirror. S2.6.7

light source
a thing that makes its own light. S2.6.1, S2.6.3

midday
the middle of the day, when the Sun is highest. S2.6.6

opaque
lets no light through. S2.6.4

outline
the line round the edge of a shape. S2.6.5

ray
one thin line of light, drawn with an arrow. S2.6.2, S2.6.3

reflect
to send light back. S2.6.1, S2.6.3

rough
bumpy, not flat. S2.6.7

shadow
a dark place where something blocks the light. S2.6.2, S2.6.4, S2.6.5

shadow stick
a stick pushed upright into the ground, to study its shadow. S2.6.6

smooth
with no bumps. S2.6.7

straight line
a line with no bends. S2.6.2

translucent
lets some light through and spreads it out. S2.6.4

transparent
lets almost all light through. You see clearly through it. S2.6.4

tropics
the lands near the middle of the Earth, between two map lines. S2.6.6

Answers

S2.6.1. Where light comes from

1. **A lit candle**

   A flame makes its own light. The Moon, a mirror and paper only send light back.

   - **If you chose A:** The Moon looks bright. It only sends back light from the Sun.
   - **If you chose B:** A mirror makes no light. It only sends back the light that falls on it.
   - **If you chose C:** Paper makes no light. It looks bright only when light falls on it.

2. **It sends back light from the Sun.**

   The Sun is the light source. The Moon reflects some of its light to us.

   - **If you chose B:** It looks that way, but the Moon makes no light. Think of the paper and the torch.
   - **If you chose C:** The Moon does not burn. It shines because sunlight falls on it.

3. **Nothing**

   With no light, nothing can be seen. Paper only reflects light, and here there is none to reflect.

   - **If you chose A:** Paper makes no light. With no light to send back, it cannot be seen.
   - **If you chose B:** Eyes cannot make light. With no light at all, there is nothing to see.

4. **Yes. It makes its own light.**

   A firefly glows with no other light near it. It makes its own light.

   - **If you chose B:** A firefly still glows in the dark. A thing that only reflects light would vanish.
   - **If you chose C:** A flame, a lamp and a firefly make light too. The Sun is only one source.

5. **Make light: the Sun, a candle, a torch. Only send light back: the Moon, a mirror, white paper.**

   A thing that makes light is a source. A thing that only reflects light is not a source.

6. **The torch. The mirror sends it on.**

   The torch is the source. The mirror reflects its light to the wall. Switch the torch off and the spot is gone.

   - **If you chose A:** A mirror makes no light. It only sends back the torch light.
   - **If you chose B:** A wall makes no light either. The spot is bright only because light reaches it.

S2.6.2. Light goes in straight lines

1. **You cannot see the lamp**

   Light from the lamp goes straight. It hits the wall of the bend. It cannot reach your eye.

   - **If you chose B:** Light goes in straight lines. It cannot follow the bend in the tube.
   - **If you chose C:** The light would have to go round the bend. It cannot, so the lamp is hidden.

2. **In line with the holes**

   The light goes through the holes in a straight line. Your eye must be on that line.

   - **If you chose A:** Light goes straight from the flame through the holes. It does not go up and over.
   - **If you chose B:** Only the light in a straight line gets through all three holes.

3. **Rays go straight past the edge of the card.**

   The rays that miss the card go straight on. The rays that hit it stop. The line between them is sharp.

   - **If you chose B:** Light goes straight past an edge. It does not curl round it.
   - **If you chose C:** The wall does not change the edge. The straight rays do.

4. **A fire**

   A fire makes its own light. A mirror and the Moon only send light back.

   - **If you chose A:** A mirror only sends back light. It makes none. Go to S2.6.1.
   - **If you chose C:** The Moon only reflects light from the Sun. Go to S2.6.1.

5. **The torch is on the left and the wall on the right. One ray passes the top of the card. One passes the bottom. The dark place on the wall between them is the shadow.**

   Rays go straight. The rays that touch the card stop. The wall behind the card gets no light.

6. **No. Light goes straight and the wall blocks it.**

   Rays go straight from the lamp. The wall stops the ones that go toward Ravi.

   - **If you chose A:** In air, light goes in straight lines. It does not bend round a wall.
   - **If you chose B:** A brighter lamp makes more light. The light still goes straight.
   - **If you chose C:** Some light may bounce to him off the ceiling. But no ray goes straight from the lamp to his eye. So he cannot see the lamp.

7. **A straight line with an arrow that points away from the lamp**

   A ray is one thin line of light. It is straight. Its arrow shows the way the light goes.

   - **If you chose A:** In air, light goes in straight lines. So a ray is a straight line.
   - **If you chose B:** The arrow shows the way the light goes. Light goes away from the lamp.
   - **If you chose C:** With no arrow, the line does not show the way light goes.

S2.6.3. How we see

1. **Light bounces off the book and goes into my eyes.**

   A lamp or the Sun lights the book. The book reflects some of that light into your eyes.

   - **If you chose A:** Eyes only take light in. They send none out. Think of the dark box.
   - **If you chose B:** A book makes no light. It only reflects light from a source. Go to S2.6.1.

2. **No. There is no light to reach my eyes.**

   To see your hand, light must bounce off it into your eyes. In a room with no light, there is none.

   - **If you chose B:** Nothing comes out of your eyes. With no light to bounce off your hand, you see nothing.
   - **If you chose C:** Looking hard does not make light. Without light, you cannot see.

3. **Into the eye**

   The arrows show the way light travels. It goes from the thing into the eye.

   - **If you chose A:** The arrow shows which way light goes. Light goes into the eye.
   - **If you chose C:** Light goes one way only, from the thing into the eye.

4. **No. The card blocks the straight rays.**

   Light goes in straight lines. The card stops the rays, so none reach your eye.

   - **If you chose A:** Light goes in straight lines. It does not bend round the card. Go to S2.6.2.
   - **If you chose B:** A thin card may let a faint glow through. But you still cannot see the lamp. The card stops the straight rays. Go to S2.6.2.

5. **One arrow goes from the lamp to the cup. A second arrow goes from the cup into the eye.**

   The light goes from the source to the cup. Then it goes into the eye. No arrow leaves the eye.

6. **The flame's light goes straight into his eyes.**

   A flame is a light source. Its rays go out in every direction. Some go straight into his eyes.

   - **If you chose A:** Nothing goes out of his eyes. Eyes only take light in.
   - **If you chose B:** A flame makes its own light. Its rays can go straight into an eye.
   - **If you chose C:** Light leaves the flame in every direction. Some of it goes into his eyes.

7. **The Sun**

   The Sun makes the light. The tree reflects some of it into Joseph's eyes.

   - **If you chose B:** A tree makes no light. It only reflects sunlight. Go to S2.6.1.
   - **If you chose C:** Eyes make no light. They only take light in.

8. **From the lamp to the ball, then into the eye**

   The lamp lights the ball. The ball reflects some of that light into the eye. Then you see the ball.

   - **If you chose A:** Eyes take light in. They do not send light out to the ball.
   - **If you chose B:** That light shows you the lamp. To see the ball, light must bounce off it into the eye.

S2.6.4. Opaque, translucent, transparent

1. **B**

   In row B, some light gets through and it spreads out. That is translucent.

   - **If you chose A:** In row A, no light gets through. That is an opaque sheet.
   - **If you chose C:** In row C, the rays go straight through. That is a transparent sheet.

2. **Clear glass**

   Clear glass lets almost all light through. You see clearly through it.

   - **If you chose A:** Wood lets no light through. It is opaque.
   - **If you chose B:** Paper lets some light through, but you cannot see clearly. It is translucent.

3. **Translucent**

   Some light gets through, but it is spread out. That is translucent.

   - **If you chose B:** A transparent thing lets you see clear shapes. This cloth does not.
   - **If you chose C:** An opaque thing lets no light through. This cloth lets some through.

4. **It blocks the light.**

   A book is opaque. The light cannot pass, so the place behind it is dark.

   - **If you chose A:** If it let light through, the place behind it would be bright.
   - **If you chose C:** A book makes no light. It is not a light source. Go to S2.6.1.

5. **There is no light to bounce off my hand into my eyes.**

   We see when light goes into our eyes. With no light, none can reach them.

   - **If you chose A:** Nothing comes out of your eyes. Light must go into them. Go to S2.6.3.
   - **If you chose B:** Waiting does not help. With no light, there is nothing for the eyes to take in. Go to S2.6.3.

6. **Transparent: clear plastic. Translucent: paper. Opaque: wood and stone.**

   Clear plastic lets almost all light through. Paper lets some through. Wood and stone let none through.

7. **The paper lets some light through.**

   Paper is translucent. Some light gets through and spreads out. So the glow is dim.

   - **If you chose A:** Paper makes no light. The glow is torch light that came through. Go to S2.6.1.
   - **If you chose B:** Then you would see a clear, bright patch. Paper spreads the light out.
   - **If you chose C:** Then the wall behind it would stay dark. Paper lets some light through.

S2.6.5. Big and small shadows

1. **A wooden board**

   Wood is opaque. It blocks all the light, so the shadow behind it is dark.

   - **If you chose B:** Light goes through clear glass. It is transparent, so it makes almost no shadow. Go to S2.6.4.
   - **If you chose C:** Some light goes through thin paper. It is translucent, so the shadow is faint. Go to S2.6.4.

2. **It gets bigger.**

   Light spreads out like a fan from the lamp. Near the lamp, it has more room to spread behind the book.

   - **If you chose A:** You may think the shadow shrinks as the light gets closer. Light spreads like a fan, so it grows.
   - **If you chose B:** That is nearly true in sunlight. The Sun is so far away. A lamp is close, so the size changes.

3. **30 cm**

   6 steps to the wall, and 2 steps to the card. 6 ÷ 2 = 3. So the shadow is 3 times as tall. 10 cm × 3 = 30 cm.

4. **The Sun is very far away.**

   The Sun is very far away. Its light does not spread like a fan. So the shadow stays about the same size.

   - **If you chose B:** The Sun is our best source of light. It is not a thing that only bounces light. Go to S2.6.1.
   - **If you chose C:** It is the other way round. The Sun is far, far away. Its light comes almost side by side.

5. **No. A shadow has the outline of the flower, but no colour.**

   The flower blocks the light. Little light reaches the shadow. It is dark and shows no colour.

6. **Your right side**

   A shadow falls on the side away from the light. The lamp is on your left. So the shadow is on your right.

   - **If you chose A:** That is the side of the lamp. A shadow falls away from the light.
   - **If you chose C:** The lamp lights you from the side. So the shadow falls to the side, away from it.

7. **Move his hand toward the wall**

   A hand near the wall gives the light less room to spread. So the shadow shrinks.

   - **If you chose A:** That makes the shadow bigger. The light has more room to spread behind it.
   - **If you chose B:** The size does change. A lamp makes a thing's shadow bigger as the thing comes near.

8. **The thing blocks the light.**

   An opaque thing stops the rays. The place behind it gets no light, so it is dark.

   - **If you chose A:** Weight does not matter. A thin card and a heavy stone both block light.
   - **If you chose B:** A reflection sends light back. A shadow is a place the light cannot reach.
   - **If you chose C:** The same wall is bright where light reaches it. A shadow is dark because light is missing.

S2.6.6. A shadow stick through the day

1. **Low in the sky**

   A low Sun makes a long shadow. A high Sun makes a short one.

   - **If you chose A:** A high Sun makes a short shadow. Look at where the Sun is in the picture.
   - **If you chose B:** Then the shadow would be a small pool at its foot.

2. **South**

   South of the tropics, the Sun is north of you at midday. So the shadow points south.

   - **If you chose A:** North of the tropics, the midday shadow points north. Mei lives south of them.
   - **If you chose B:** Mei lives south of the tropics. Her midday Sun is to the north, so the shadow points south.
   - **If you chose C:** That happens between the tropics. Mei lives south of them.

3. **The Earth turns.**

   The Earth turns round once a day. Your home turns toward the Sun, and then away.

   - **If you chose B:** It looks that way. But it is the Earth that turns.
   - **If you chose C:** Clouds do not move the Sun. The Earth turns, so the Sun seems to move.

4. **No. It may be shortest an hour or more from 12.**

   The Sun does not follow the clock. The shortest shadow is at midday by the Sun.

   - **If you chose A:** Clocks are set for a whole region. Midday by the Sun can be an hour or more from 12.
   - **If you chose B:** A right clock still keeps the time of a whole region. The Sun does not follow it.

5. **Light cannot go through the stick.**

   A stick is opaque. Light goes in straight lines, so the stick blocks it.

   - **If you chose B:** A shadow is not made by the stick. It is a place light cannot reach. Go to S2.6.4.
   - **If you chose C:** Light goes in straight lines. It cannot bend round a stick. Go to S2.6.2.

6. **The stone at midday, when the Sun is highest.**

   A high Sun makes the shortest shadow. So the stone for midday is nearest.

7. **Look at the shadow of a stick**

   The shadow points away from the Sun. Its length shows how high the Sun is. You look at the ground, not at the Sun.

   - **If you chose A:** Dark glass does not make the Sun safe to look at. Never look at the Sun.
   - **If you chose B:** A mirror sends the Sun's light into your eye. That can hurt as much.
   - **If you chose C:** Even one second can hurt your eyes. Never look at the Sun.

8. **The Sun climbs higher, then sinks lower.**

   A low Sun makes a long shadow. A high Sun makes a short one. The Sun seems to climb and then sink as the Earth turns.

   - **If you chose A:** The stick stays the same height. The Sun changes its height in the sky.
   - **If you chose C:** The Earth is not nearer the Sun at midday. The Sun looks higher because the Earth turns.

S2.6.7. Mirrors and shiny things

1. **30°**

   The angle in equals the angle out. Both are measured from the dashed line.

   - **If you chose A:** You may be measuring from the mirror. Measure from the dashed line, both times.
   - **If you chose B:** The ray does not go straight up. It leaves at the same angle it came in.

2. **A candle flame**

   A flame makes its own light. A mirror and the Moon only bounce light.

   - **If you chose B:** A mirror only bounces light. In the dark you see nothing in it. Go to S2.6.1.
   - **If you chose C:** The Moon bounces light from the Sun. It makes none of its own. Go to S2.6.1.

3. **A wall bounces light every way.**

   The bumps send light in many directions. No one picture reaches your eyes.

   - **If you chose B:** You can see a wall. So light must bounce off it into your eyes. Go to S2.6.3.
   - **If you chose C:** A wall is not a light source. It bounces light from lamps and the Sun. Go to S2.6.1.

4. **The crumpled foil has many tiny flat parts that face different ways.**

   Each tiny part bounces light a different way. So no clear picture reaches your eyes.

   - **If you chose A:** Foil makes no light at all. It only bounces light. Go to S2.6.1.
   - **If you chose C:** It is still foil. But it is now rough. A rough thing sends light every way.

5. **Never shine sunlight from a mirror into anyone's eyes.**

   It can hurt their eyes. A driver who is dazzled can also crash.

6. **A left hand. Up is still up.**

   A mirror turns a picture front to back. So a right hand looks like a left hand.

7. **Shine a torch at a wall, away from all eyes.**

   A torch on a wall shows the bounce and hurts nobody. Never look at the Sun, even in a mirror.

   - **If you chose A:** A mirror sends the Sun's light into your eye. It can hurt as much.
   - **If you chose B:** A mirror sends back almost all the Sun's light. It can hurt your friend's eyes.
   - **If you chose C:** A torch can dazzle and hurt eyes. Keep the beam away from faces.

8. **25°**

   The angle in equals the angle out. Both are measured from the dashed line.

   - **If you chose A:** The two angles are equal. They do not add up.
   - **If you chose B:** You may be measuring from the mirror. Measure from the dashed line, both times.
   - **If you chose C:** You may have measured from the far side of the mirror. Measure from the dashed line, both times.

About this book

For learners who can read short sentences. In many schools this fits children of about 8 to 10, and older learners can use it too. Every activity uses things most homes have: the sun, a stick, paper, a candle or a lamp. Never let a learner look at the Sun, even through anything. A learner can work alone: every exercise has its answer and the reason for it.

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This book is free. You may read it, print it, copy it and share it with anyone.

The newest copy is at https://attnom.com/academy/light-and-shadows.