

How light bounces, bends and is absorbed

Grade 7 science (Year 8 · Class 7) · Lesson

Quick answer: Light is reflected, refracted or absorbed when it meets matter. The law of reflection says the angle of incidence equals the angle of reflection, both measured from the normal. Refraction bends light towards the normal when it slows down in glass or water. We see objects because they reflect light into our eyes.

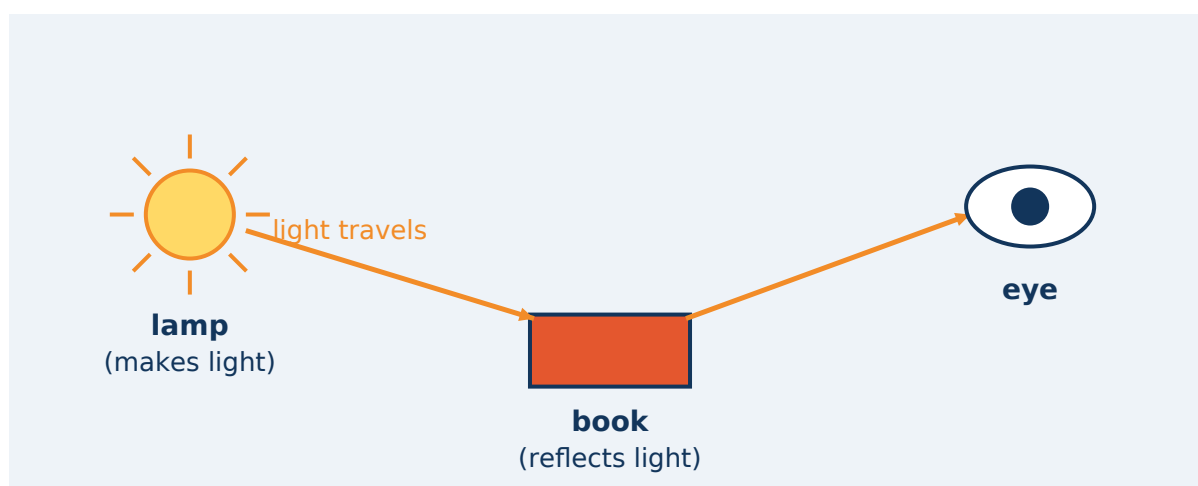
Level: Grade 7 science (Year 8 · Class 7) · **Curriculum:** MS-PS4-2

How do we see objects?

A lamp, a candle or the Sun is a *luminous* source: it makes its own light. Most things around you, such as a book, a tree or a friend, are not luminous. You can see them only because light from a source bounces off them and enters your eye.

Definition

Reflection is the bouncing of light off a surface. **Refraction** is the bending of light as it passes from one transparent material into another, for example from air into water.



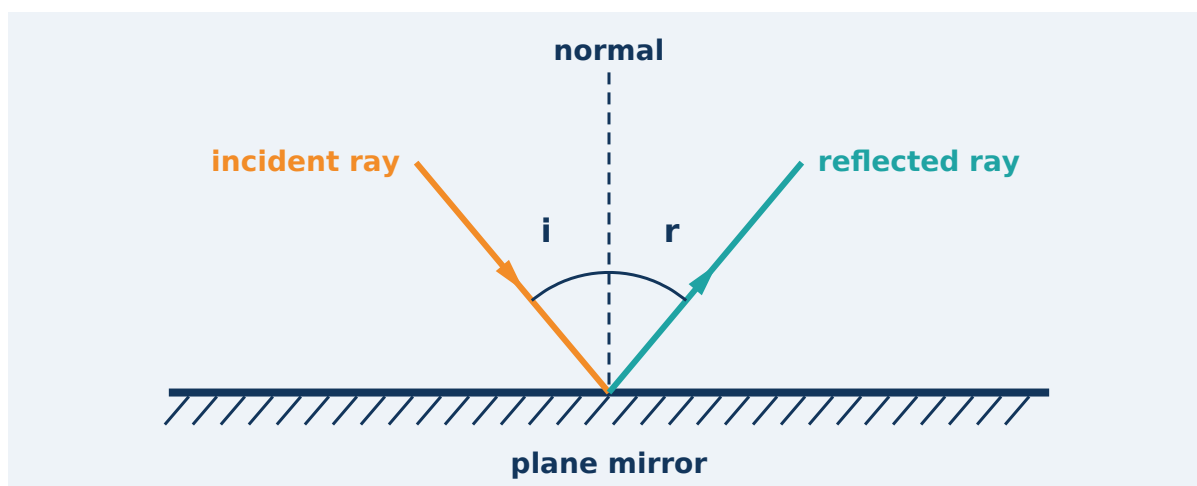
A book is seen because it reflects light from the lamp into the eye.

What is the law of reflection?

To describe a reflection we draw a dashed line at right angles to the surface at the point where the ray lands. This line is called the **normal**. The ray coming in is the incident ray and the ray leaving is the reflected ray. Angles are always measured from the normal, not from the surface.

Key law

Law of reflection: the angle of incidence i equals the angle of reflection r , $i = r$. The incident ray, the reflected ray and the normal all lie in the same flat plane.



Reflection from a plane mirror: $i = r = 40^\circ$.

Worked example

A ray hits a plane mirror and makes an angle of 35° with the mirror surface. Find the angle of incidence and the angle between the incident and reflected rays.

The normal is 90° from the surface, so $i = 90^\circ - 35^\circ = 55^\circ$. Then $r = 55^\circ$, and the angle between the rays is $55^\circ + 55^\circ = 110^\circ$. **$i = 55^\circ$, angle between rays = 110°**

In a plane (flat) mirror the image appears as far behind the mirror as the object is in front of it. It is the same size, upright and reversed left to right, and it cannot be caught on a screen because the light only seems to come from behind the mirror.

Worked example

Emma in Leeds stands 1.5 m in front of a plane mirror. How far is she from her image?

The image is 1.5 m behind the mirror, so the distance is 1.5 m + 1.5 m. **3.0 m**

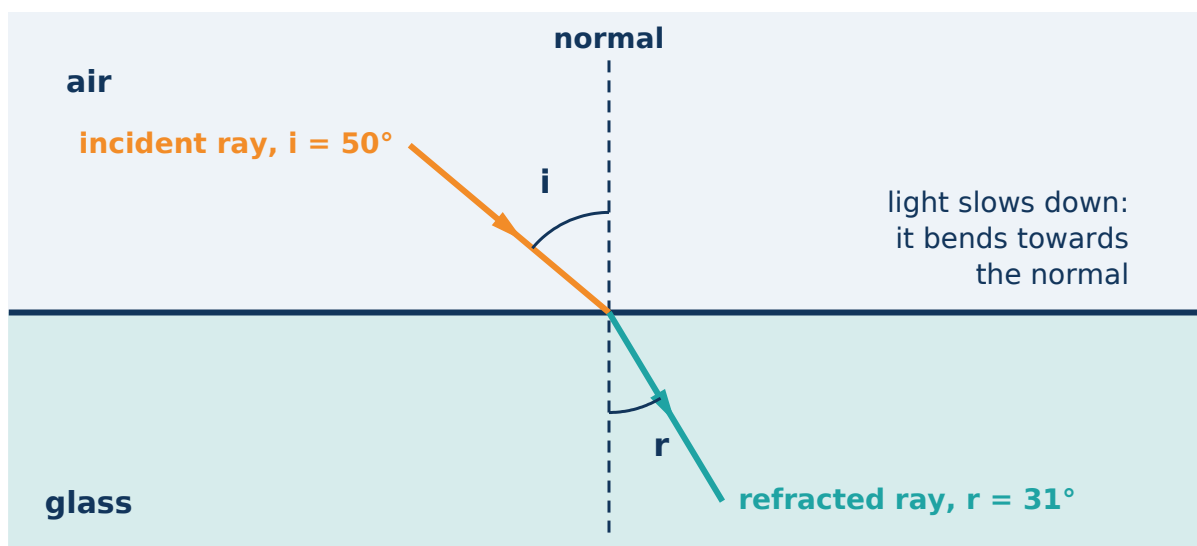
What is the difference between regular and diffuse reflection?

A very smooth surface reflects parallel rays in one direction, which gives a clear image. A rough surface has many tiny faces tilted differently, so each ray still obeys $i = r$, but the reflected rays scatter everywhere. That scattering lets us see paper from any side.

Surface	Type of reflection	What you see
Mirror, still water	Regular (specular)	A clear image
Paper, wall, cloth	Diffuse (scattered)	The object, from any angle, but no image

What happens when light enters glass or water?

Light travels at 3.0×10^8 m/s in air but more slowly in glass, about 2.0×10^8 m/s. When a ray enters a slower material at an angle, one side of the beam slows first and the ray bends. Entering glass or water, it bends *towards* the normal; leaving, it bends *away*. A ray along the normal is not bent. This is why a straw looks broken at the water surface.



Refraction at an air-glass boundary: r is smaller than i .

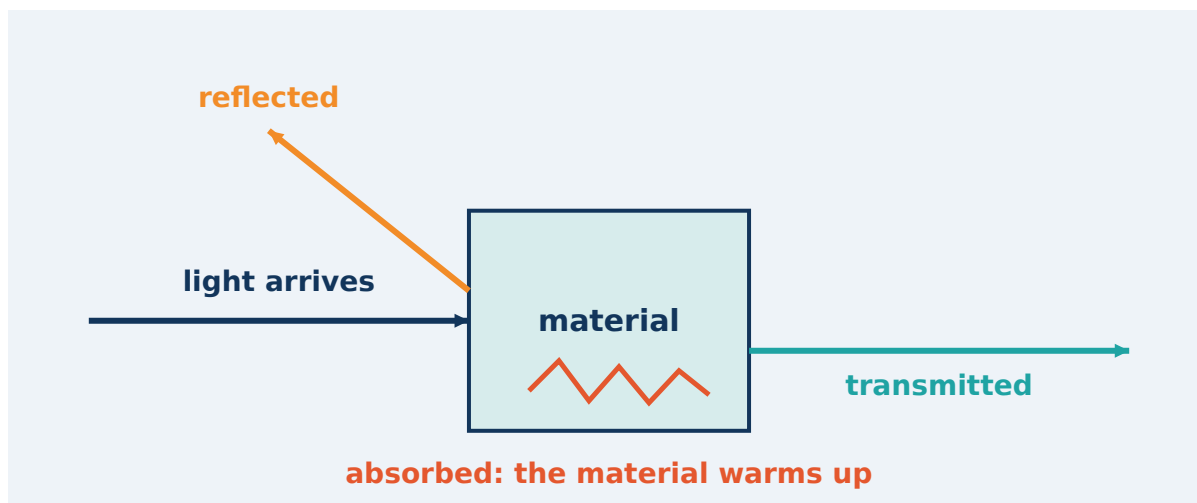
Worked example

Light crosses a glass block 0.30 m thick at 2.0×10^8 m/s. How long does it take?

$$t = d \div v = 0.30 \div (2.0 \times 10^8) = 1.5 \times 10^{-9} \text{ s. } \mathbf{t = 1.5 \times 10^{-9} \text{ s}}$$

What happens to light that is not reflected?

When light hits an object it can be reflected, transmitted or absorbed. Clear glass transmits most light. A black T-shirt absorbs most visible light, which is why it feels hot in the Sun. A red book reflects mostly red light and absorbs the rest, so it looks red.



Three things can happen to light at a material.

Common mistake

Do not measure the angle of incidence from the mirror surface. Always measure from the normal. If a ray makes 30° with the mirror, the angle of incidence is 60° .

Lina's tip

Draw the normal first, in dashed pencil, every time. Then label i and r and check that both

angles touch the normal. Most lost marks come from skipping this step.

Key points to remember

- We see non-luminous objects because they reflect light into our eyes.
- Law of reflection: angle of incidence i = angle of reflection r , both measured from the normal.
- A plane mirror image is as far behind the mirror as the object is in front.
- Light entering glass or water slows down and bends towards the normal.
- Dark surfaces absorb more light energy; rough surfaces scatter light (diffuse reflection).

How light bounces, bends and is absorbed: frequently asked questions

What is the law of reflection?

The angle of incidence equals the angle of reflection, $i = r$. Both angles are measured from the normal, the line at right angles to the surface.

Why does light bend when it enters water?

Light travels more slowly in water than in air. When a ray enters at an angle, the change of speed makes the ray change direction, bending towards the normal.

What is the difference between reflection and refraction?

In reflection light bounces back from a surface into the same material. In refraction light passes into a second material and changes direction because its speed changes.

Why can we see a book that gives off no light?

A book reflects light from a lamp or the Sun in all directions, and some of that light enters our eyes. Without a light source we cannot see it.

Why does a black surface get hotter than a white one in sunlight?

A black surface absorbs most of the light energy that hits it, which warms it. A white surface reflects most of the light, so less energy is absorbed.