

# Chapter 14: Light

## Knowledge organiser

### Visible light

Each colour within the visible light spectrum has its own narrow band of wavelength and frequency.

Reflection from:

- a smooth surface in a single direction is called **specular** reflection
- a rough surface causes *scattering* of light (**diffuse** reflection).

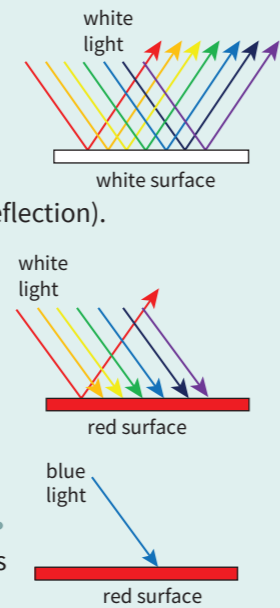
**Transparent** objects transmit visible light.

**Translucent** objects transmit visible light, but light rays are scattered or refracted inside them.

**Opaque** objects do not transmit visible light, but absorb and reflect it.

The colour of an object depends on the wavelengths they transmit and reflect.

Coloured filters work by absorbing certain wavelengths of light and transmitting others.



### Magnification

Images formed by a lens can be:

- magnified or diminished
- upright or upside down (inverted).

The magnification of an image can be calculated using:

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

**Magnification** has no units because it is a ratio.

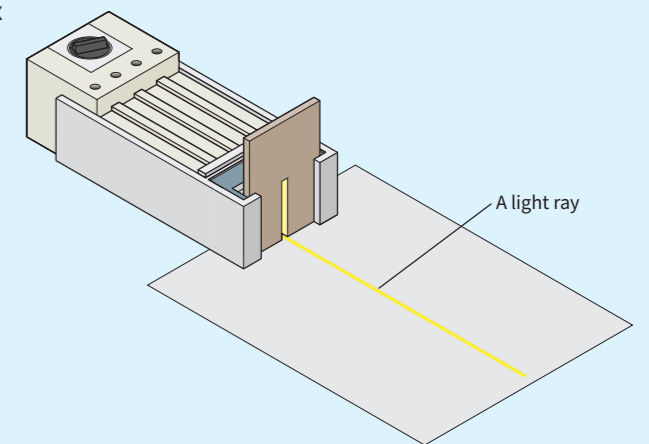
### Reflection and refraction (required practical)

In this practical, you should have traced rays of light from a ray box as they interact with different surfaces or materials.

This includes investigating how light refracts as it passes through different materials, and how light is reflected by different surfaces.

To carry out accurate and precise investigations you need to:

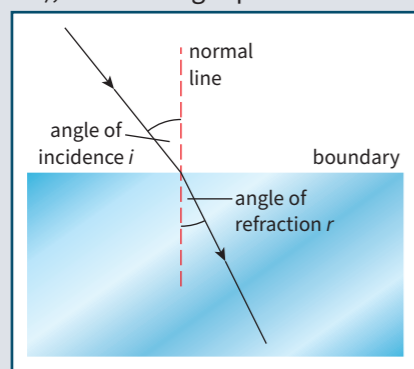
- use low light conditions
- place the slit in the ray box as far from the bulb as possible
- use a sharp pencil and ruler to draw the rays
- draw a line at 90° to any surface or boundary and measure all angles from this line to the ray
- mark either side of solid block to work out the path of a ray inside the block.



### Refraction of light

**Ray diagrams** show what happens when a wave is **refracted** (changes direction) at the boundary between two different substances.

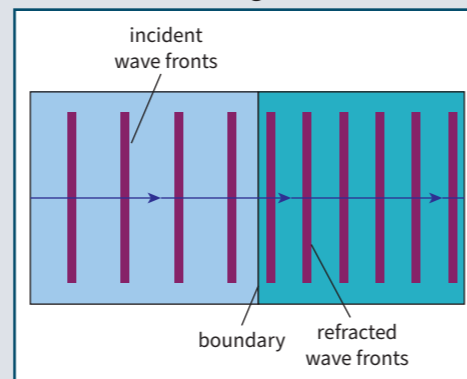
- If a wave slows down when it crosses the boundary, the refracted ray will bend towards the **normal**.
- If a wave speeds up when it crosses the boundary, the refracted ray will bend away from the normal.
- If a wave travels at a right angle to the boundary (along the normal), it will change speed but not direction.



**Wave front diagrams** can be used to explain refraction in terms of the change of speed that occurs when a wave travels from one substance to another.

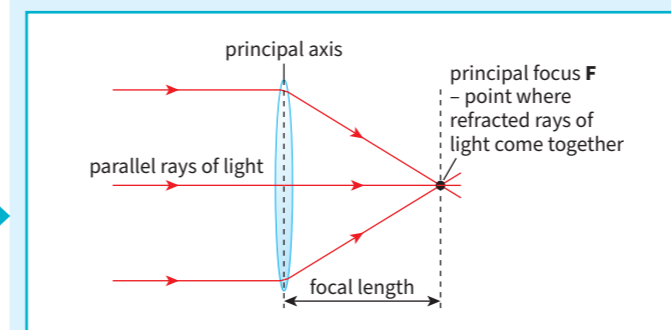
The wave front is an imaginary line at right angles to the direction the wave is moving.

- If a wave slows down as it crosses a boundary, the wave fronts become closer together.
- When a wave crosses a boundary at an angle, one end of the wave front changes speed before the other, so the wave changes direction.



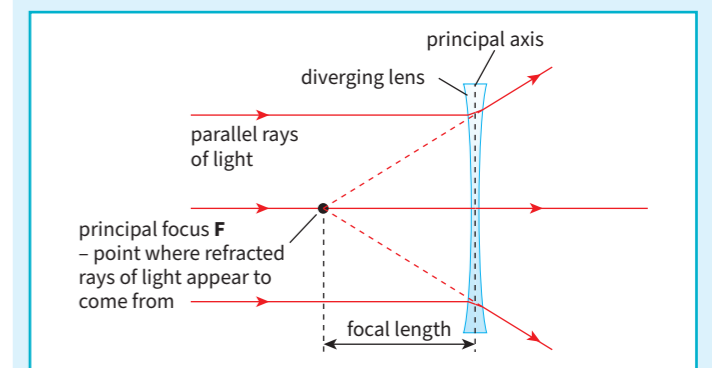
### Convex lenses

Convex lenses curve outwards. They make parallel rays of light **converge** at a point. **Focal length** is the distance from the centre of the lens to the principal focus.



### Concave lenses

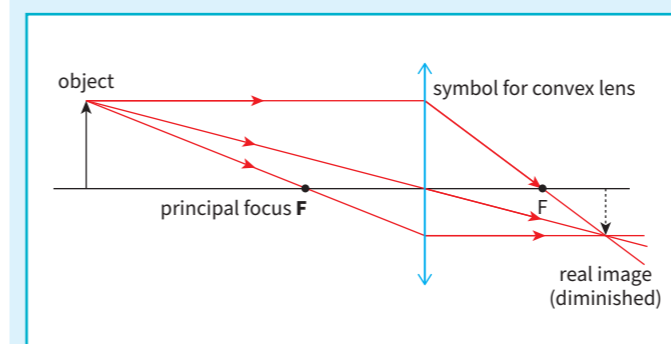
Concave lenses curve inwards. They make parallel rays of light **diverge** (so they appear to come from a point).



### Forming images

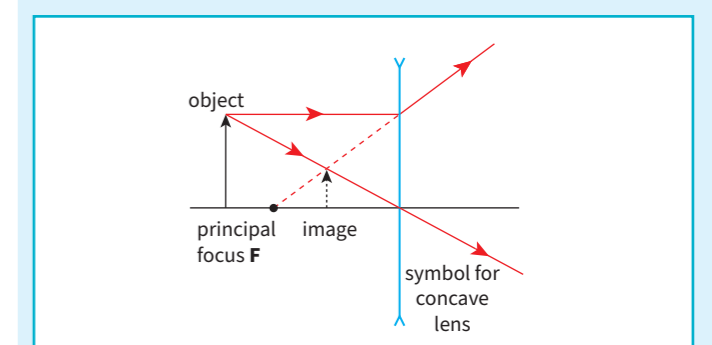
Images formed by **convex** lenses can be either real or virtual.

**Real images** can be projected onto a screen. **Virtual images** appear to come from behind the lens.



### Forming images

Images formed by **concave** lenses are always virtual.



### Key terms

Make sure you can write a definition for these key terms.

concave	converge	convex	diffuse	diverge	focal length
magnification	normal	opaque	ray diagram	real image	refract
specular	translucent	transparent	virtual image	wave front diagram	

# Chapter 14: Light

## Retrieval questions

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many as you can. Check and repeat.

### P14 questions

### Answers

1	What is the difference between a concave and convex lens?	Put paper here	convex bulges out in the middle, concave is thinner in the middle than at the edges
2	What does a convex lens do to parallel rays of light?	Put paper here	light converges (comes together) at the principal focus
3	What does a concave lens do to parallel rays of light?	Put paper here	light diverges (spreads out) so they appear to have come from the principal focus
4	What is the focal length of a lens?	Put paper here	distance from the centre of the lens to the principal focus
5	What kind of images do concave and convex lenses produce?	Put paper here	concave = virtual, convex = real or virtual
6	What properties do all EM waves of the same colour share?	Put paper here	same range of wavelengths and frequencies
7	What four things can happen to visible light when it hits an object?	Put paper here	transmitted, absorbed, reflected, or refracted
8	What is the difference between specular and diffuse reflection?	Put paper here	specular = reflection from smooth surface, diffuse = reflection from rough surface
9	What words describe an object that transmits visible light?	Put paper here	transparent or translucent
10	Why does an object appear opaque?	Put paper here	does not transmit visible light – absorbs and reflects it
11	How do colour filters work?	Put paper here	absorb certain wavelengths of light, transmit others
12	What is refraction?	Put paper here	waves change speed and direction as they cross the boundary from one substance to another due to the change in velocity
13	What happens to the direction of a refracted EM wave when it slows down as it crosses the boundary from one substance to another?	Put paper here	bends towards the normal