WJEC (Eduqas) Physics GCSE

6.3: Lenses

Detailed Notes

(Content in **bold** is for higher tier **only**)

Types of Lens

Lenses are pieces of shaped glass that can be used to focus images. They are generally drawn as a **dashed vertical line**. **Focal points** are points on either side of the lens at which light **converges**. If light passes through the centre of a lens, it does not change direction.

Real or Virtual Images

The images produced through lenses can be **real** or **virtual**. Real images are formed **within two focal lengths** behind the lens and can be **projected** onto a screen. Virtual images are formed at a **greater distance** than two focal lengths and appear to come from **behind the lens**.

When describing the images formed from lenses, they can be described as:

- Upright or Inverted
- Magnified or Diminished
- Real or Virtual

Concave Lenses

These lenses cave **inwards** so they are thinner at centre than at edges. Concave lenses **spread** the light outwards. Light appears to have come from the focal point. The image formed is **virtual**, **upright** and **diminished**.

Concave lenses are used to spread out light further for things such as correcting **short-sightedness**. Light is focused **in front** of the retina, so needs to be spread out slightly to be able to be focused **on** the retina.

Convex Lenses

These lenses bulge **outwards** so they are thicker at centre than at the edges. They **focus** the light inwards. The properties of the image produced **vary** depending on the **exact lens** used and the **distance** of the object from the lens.

Convex lenses are used to **magnify** things, for example in magnifying glasses and binoculars. They are also used to correct **long-sightedness**, as it focuses the rays closer.

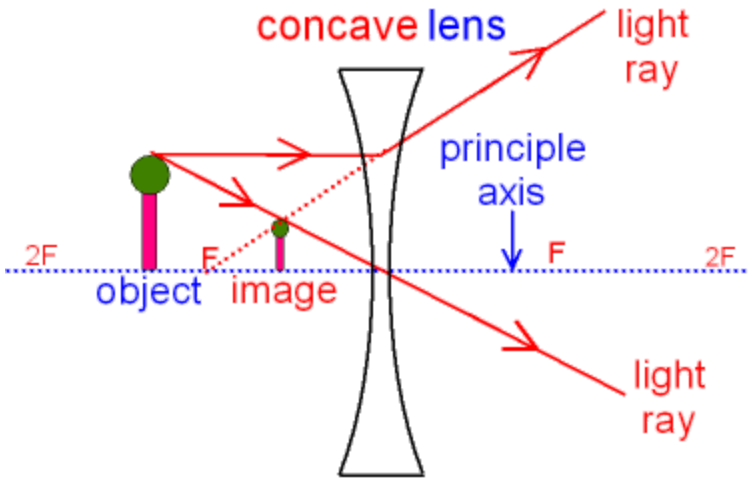
Ray Diagrams

Concave Lenses

To construct a concave lens ray diagram:

1. Draw a horizontal ray from top of object to lens.
2. Draw a dashed line from focal point (F) in front of the lens, to the point where the ray hits the lens.
3. Draw the ray exiting the lens along the same direction as the dashed line.

4. Next draw an angled ray from the top of the object, that passses through the center of the lens. This will continue on its original path behind the lens.
5. Where the two refracted rays cross, the image will be formed.



Concave lens diagram (gcsescience.com).

Convex Lenses

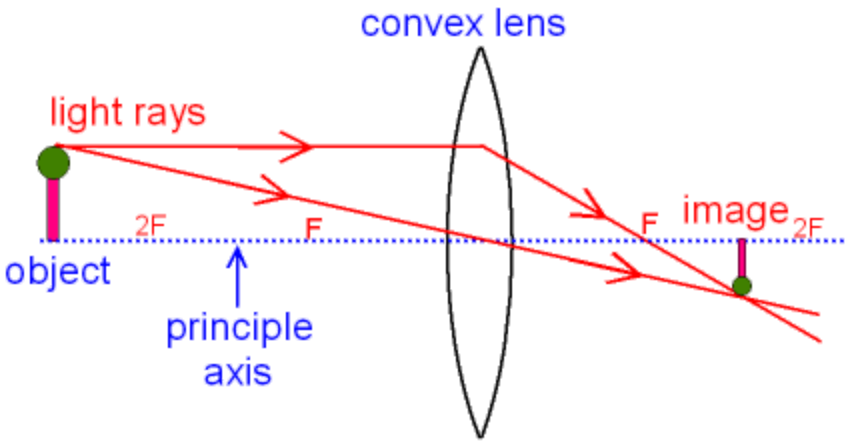
With convex lenses there are **three different situations** depending on the lens used and where the object is positioned in front of the lens.

Object > 2 Focal lengths

To construct a convex lens ray diagram where the object is **greater than two focal lengths** from the lens:

1. Draw a horizontal ray from top of object to lens.
2. Refract this ray behind the lens so that it passes through the focal point (F).
3. Next draw an angled ray from the top of the object, that passses through the center of the lens. This will continue on its original path behind the lens.
4. Where the two refracted rays cross, the image will be formed.

This setting is typical of the **human eye** or a **camera lens**. The image produced is **real**, **inverted** and **diminished** in size compared to the object.



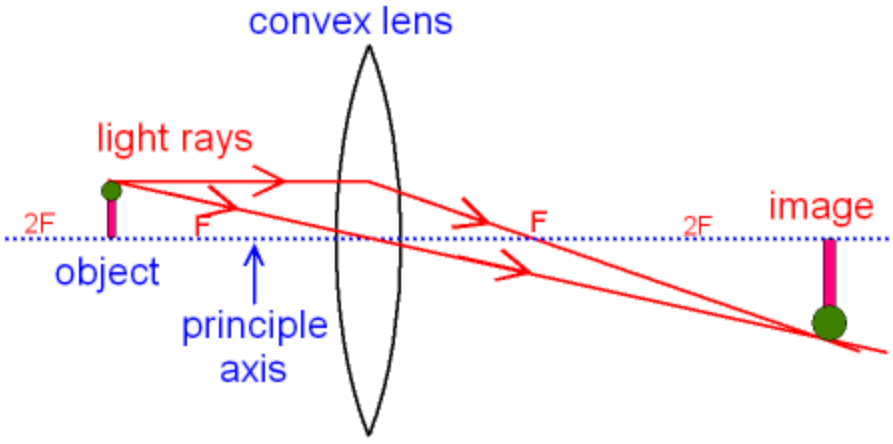
Convex lens diagram (gcsesciene.com).

Object > 1 Focal Length

To construct a convex lens ray diagram where the object is closer than two focal lengths from the lens but greater than a single focal length:

1. Draw a horizontal ray from top of object to lens.
2. Refract this ray behind the lens so that it passes through the focal point (F).
3. Next draw an angled ray from the top of the object, that passses through the center of the lens. This will continue on its original path behind the lens.
4. Where the two refracted rays cross, the image will be formed.

This setting is typical of a **projector lens**. The image produced is **real**, **inverted** and **magnified** in size compared to the object.



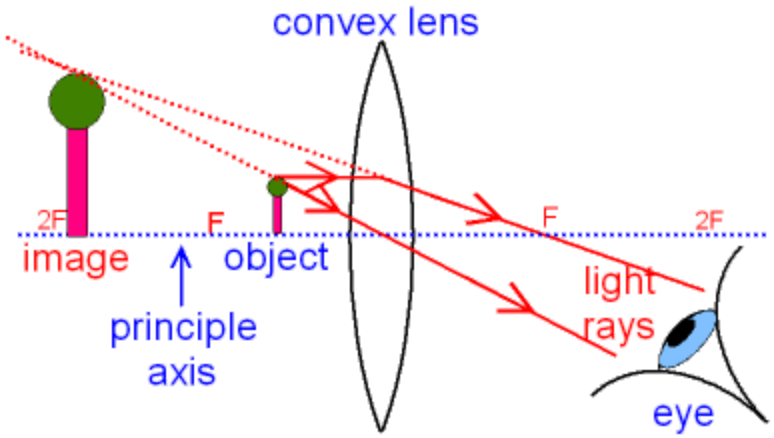
Convex lens diagram (gcsesciene.com).

Object < 1 Focal Lengths

To construct a convex lens ray diagram where the object closer than a focal length from the lens:

1. Draw a horizontal ray from top of object to lens.
2. Refract this ray behind the lens so that it passes through the focal point (F).
3. Extend this line back in front of the lens using a dashed line.
4. Next draw an angled ray from the top of the object, that passses through the center of the lens. This will continue on its original path behind the lens.
5. Where the two refracted rays cross, the image will be formed.
6. The observer will view the light rays behind the lens.

This setting is typical of a **magnifying glass**. The image produced is **virtual**, **upright** and **magnified** in size compared to the object.



Convex lens diagram (gcsesciene.com).