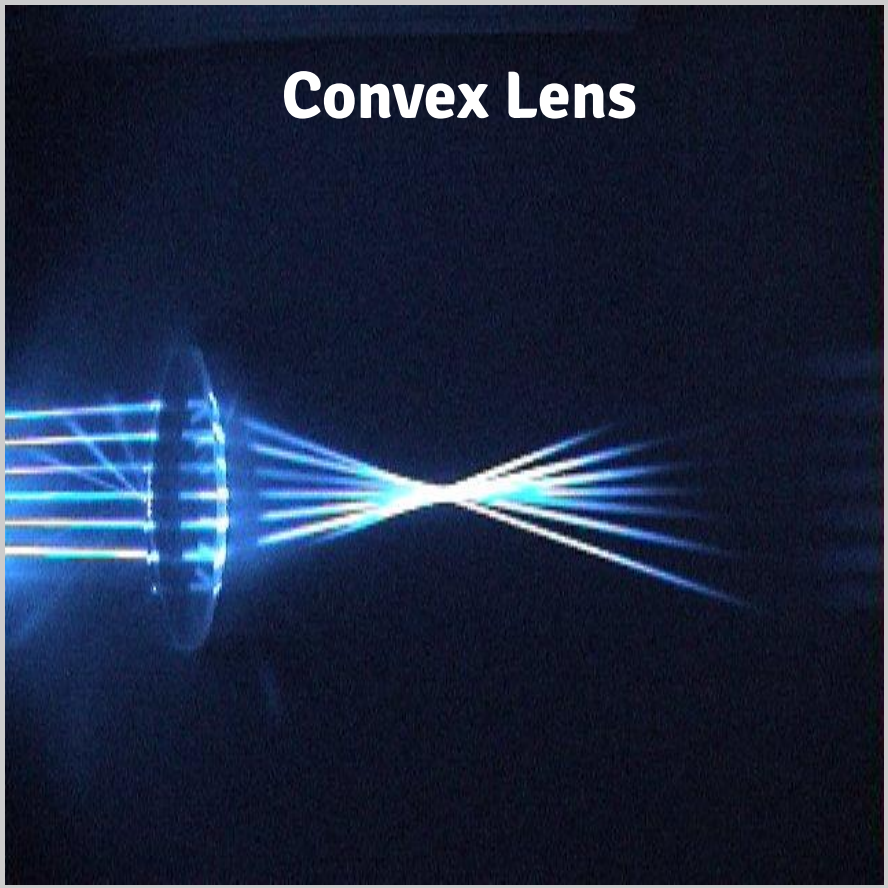
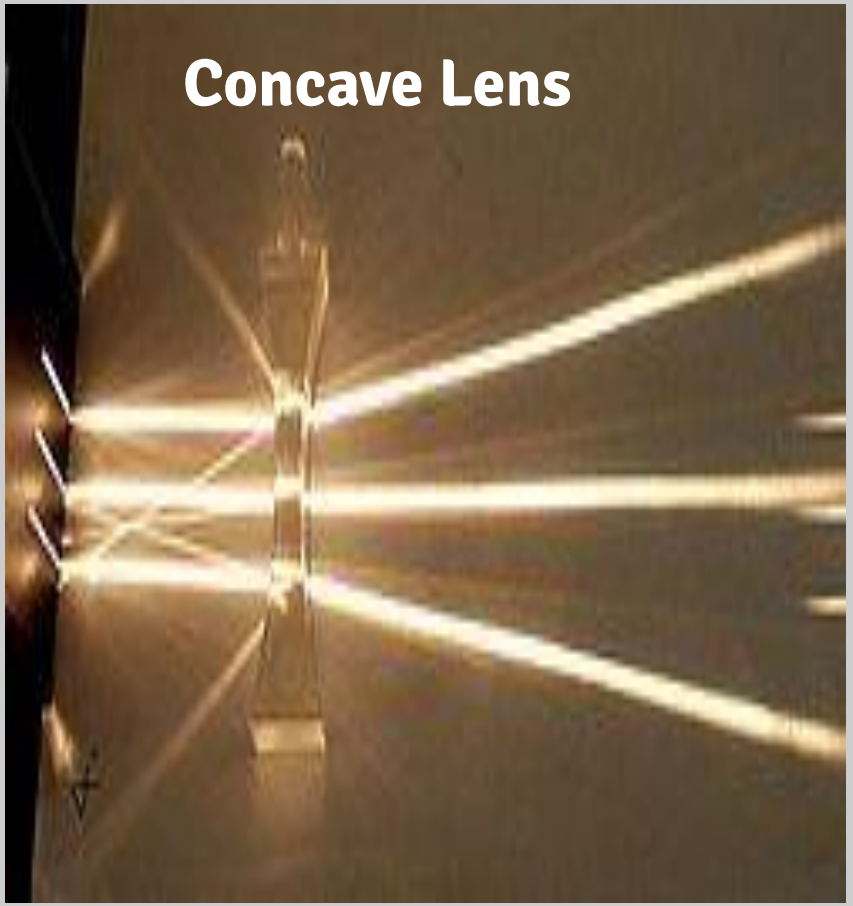
Lenses





Refraction

- Refraction Fact #1: As light goes from one medium to another, the velocity CHANGES!

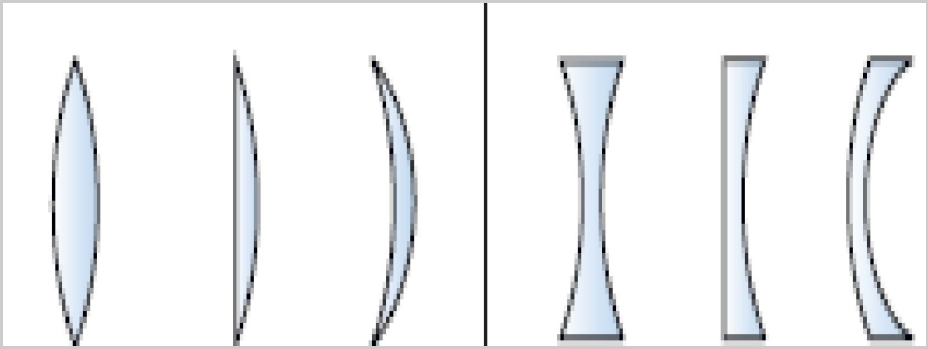
- Refraction Fact #2: As light goes from one medium to another, the path CHANGES!

EXCEPTION:

That is when light hits ‘head-on’, perpendicular to the boundary. The light does not bend but its speed still changes.

Lenses

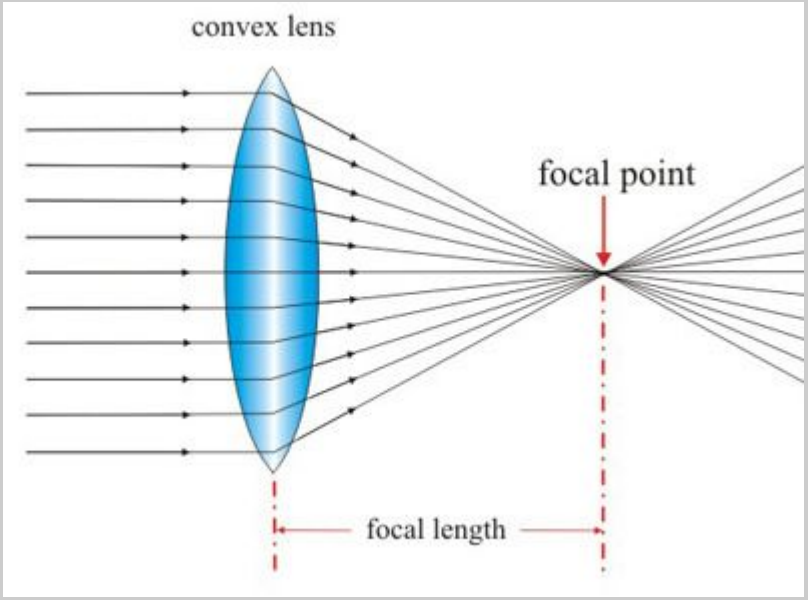
- There are two main types of lenses:
- **convex lenses—these curve** outwards and are fatter in the middle
- **concave lenses—these curve inwards** (a little like a cave) and are thinner in the middle.

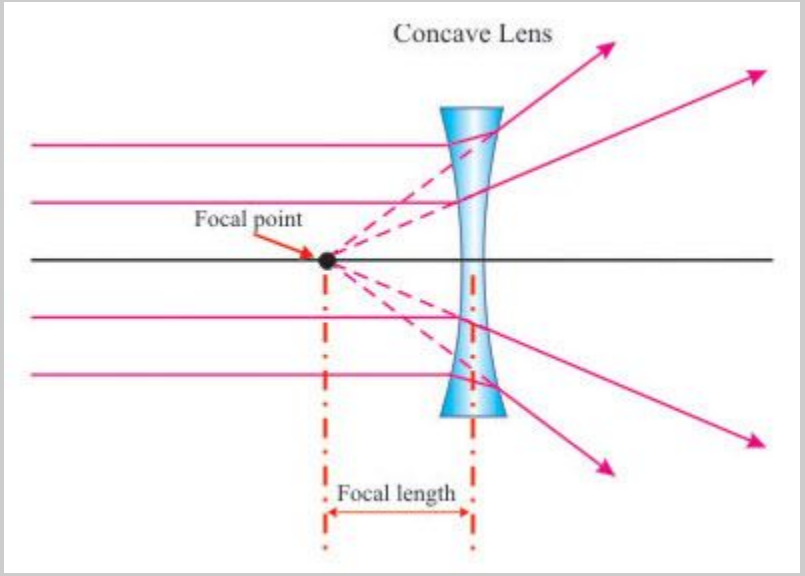


Convex lenses Concave Lenses

Lenses – An application of refraction

- There are 2 basic types of lenses





A converging lens (Convex) takes light rays and bring them to a point.

A diverging lens (concave) takes light rays and spreads them outward.

Movement of Light through Lenses

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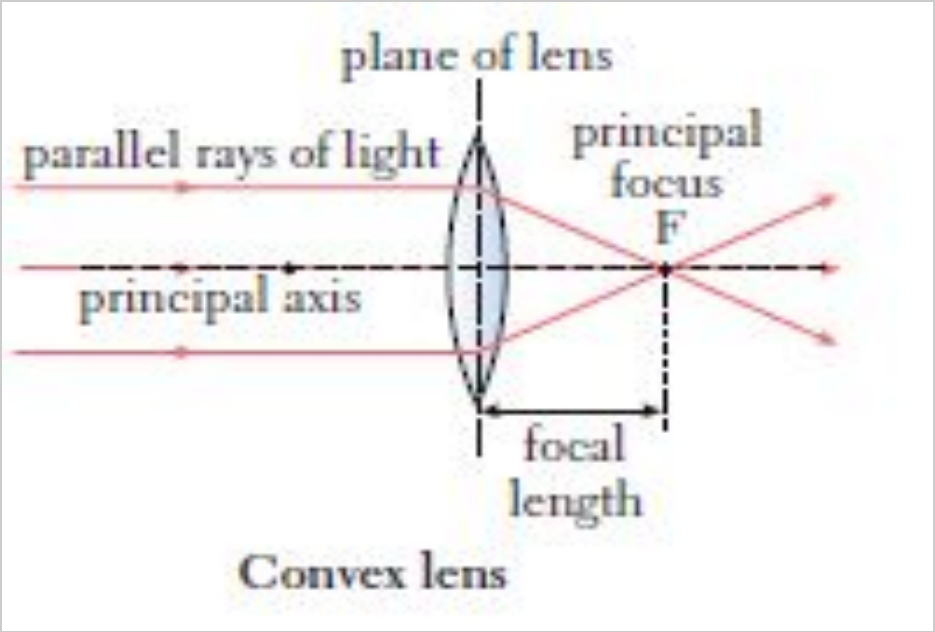
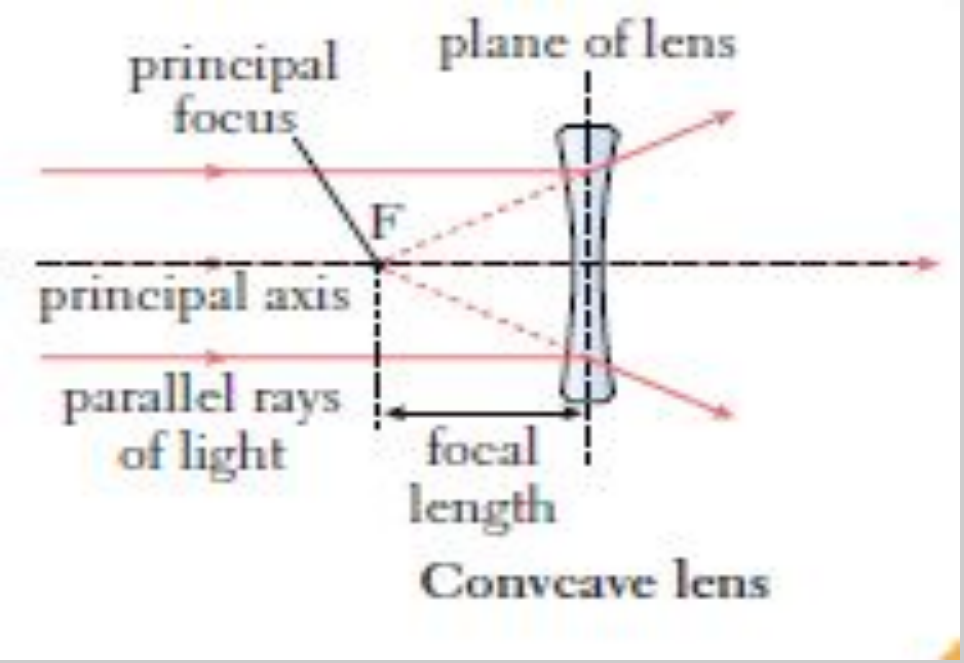
CONVEX LENS

- In a convex lens, an incoming ray parallel to the principal axis is refracted through the **principal focus** (F).



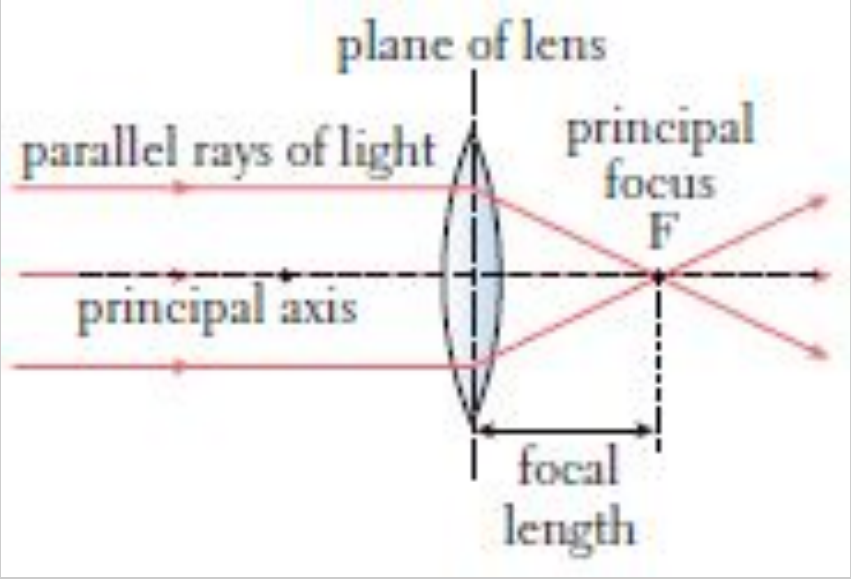
Movement of light through Concave Lens

- In a concave lens, an incoming ray parallel to the principal axis is refracted so that it *appears* to come from the principal focus (F).



Movement of Light through a Lens

- The distance from the centre line (plane) of the lens to the principal focus is called the **focal length** of the lens.



- A ray passing through the centre of either type of lens is unaffected.
- As with all images, rays of light that come from a part of the object come together again at that same part of the image.

Focal Length

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- Focal length in simple words is distance between centre of the lens and the focus.

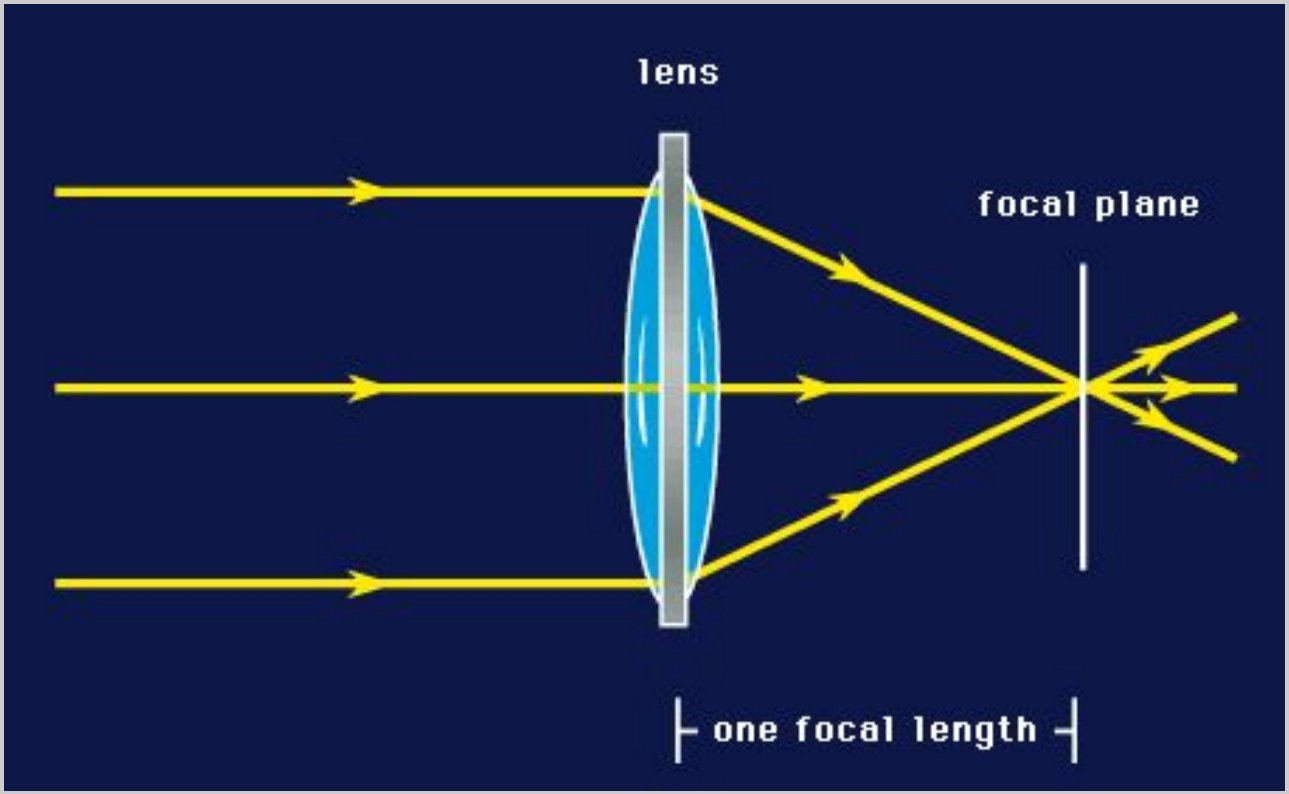
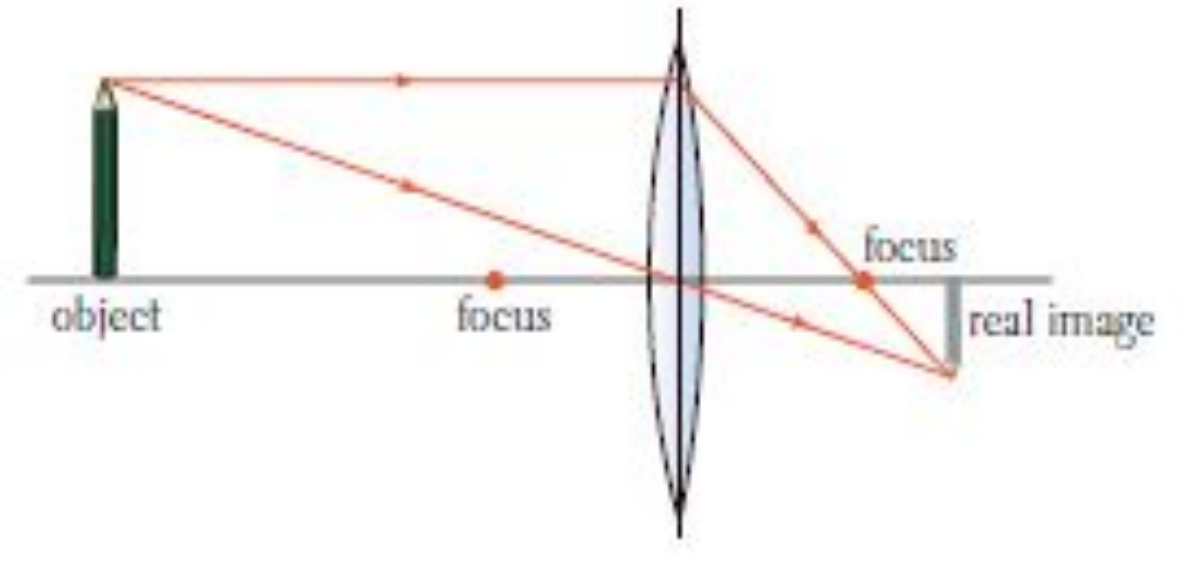


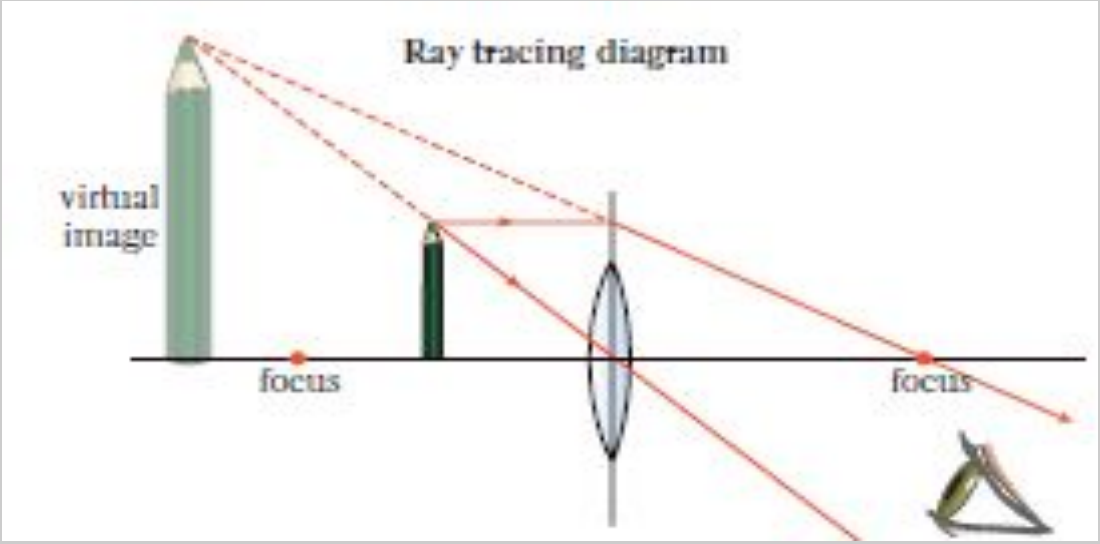
Image type and Location

- **Convex lenses** produce two different types of images, depending on where the object is located.
- If the object is at a distance **greater** than the focal length of the lens, a **real** image is formed.
- A real image can be projected onto a screen



Convex Lenses

- If the object is at a distance **less** than the focal length of the lens, a **virtual** image is formed.
- This image can't be projected onto a screen.



Images formed in Convex lens

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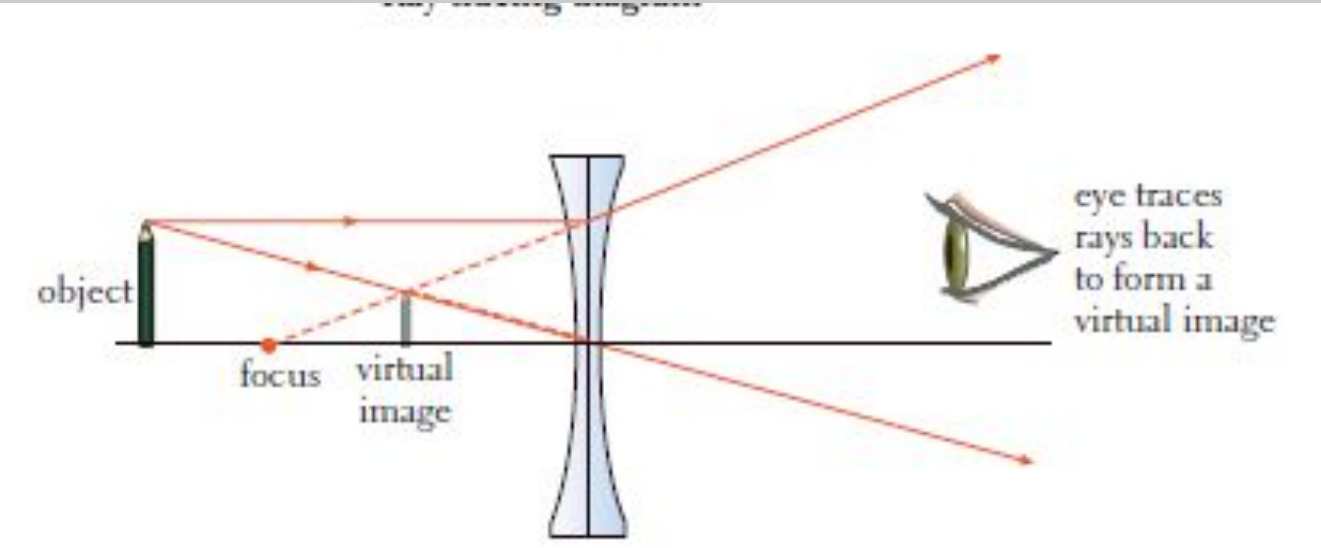
S. No.	Position of the object	Position of the image	Size of the image	Nature of the image
1	At infinity	At focus F_2	Point image	Real and inverted
2	Beyond $2F_1$	Between F_2 and $2F_2$	Smaller	Real and inverted
3	At $2F_1$	At $2F_2$	Same size	Real and inverted
4	Between F_1 and $2F_1$	Beyond $2F_2$	Larger	Real and inverted
5	At focus F_1	At infinity	Very large	Real and inverted
6	Between F_1 and O	On the same side of the lens as the object	Very large	Virtual and erect

Images formed by convex lenses for differet positions of the object

Concave Lenses

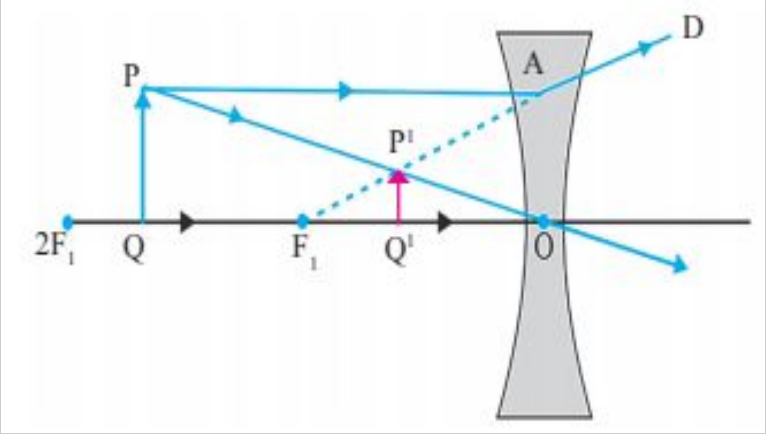
- **Concave lenses** produce only **virtual** images.



Characteristics of an image formed by a concave lens :

The image formed by a concave lens is always **V**irtual, **E**rect and **D**iminished than the object. It is on the same side of the lens as the object.

Generally, it is formed between the optical centre of the lens and the principal focus F_1 If the object is at infinity, the image is a point image formed at F_1.



Tip to remember....

VED for Concave lens

Images formed in Concave lens

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Sr. No.	Position of the object	Position of the image	Size of the image	Nature of the image
1	At infinity	On the first focus F_1	Point image	Virtual and erect
2	Anywhere between optical centre O and infinity	Between optical centre and focus F_1	Small	Virtual and erect

Images formed by cocave lenses

Image formed... Try these fun learning sites when online

Image formed in convex and concave lens

https://javalab.org/en/lens_en/

https://simbucket.com/lensesandmirrors/

Long sightedness Short sightedness

https://javalab.org/en/correction_of_near_sightedness_en/

Eyeball is nearly spherical with diameter of 2.4 cm

It can change its focal length to obtain clear Image.

Image is formed on the retina of our eye (screen).

Minimum distance of distinct vision= 25cm

See and understand...

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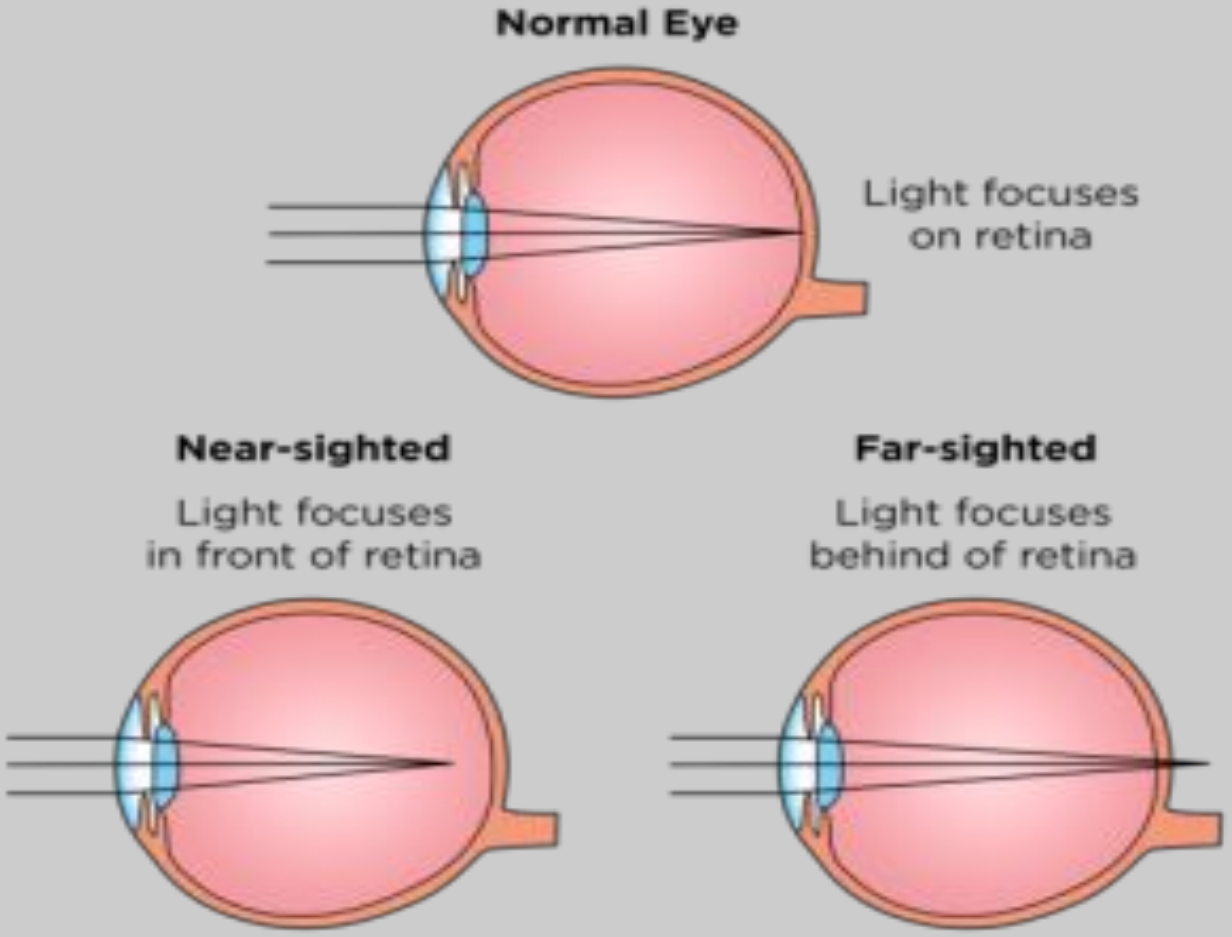
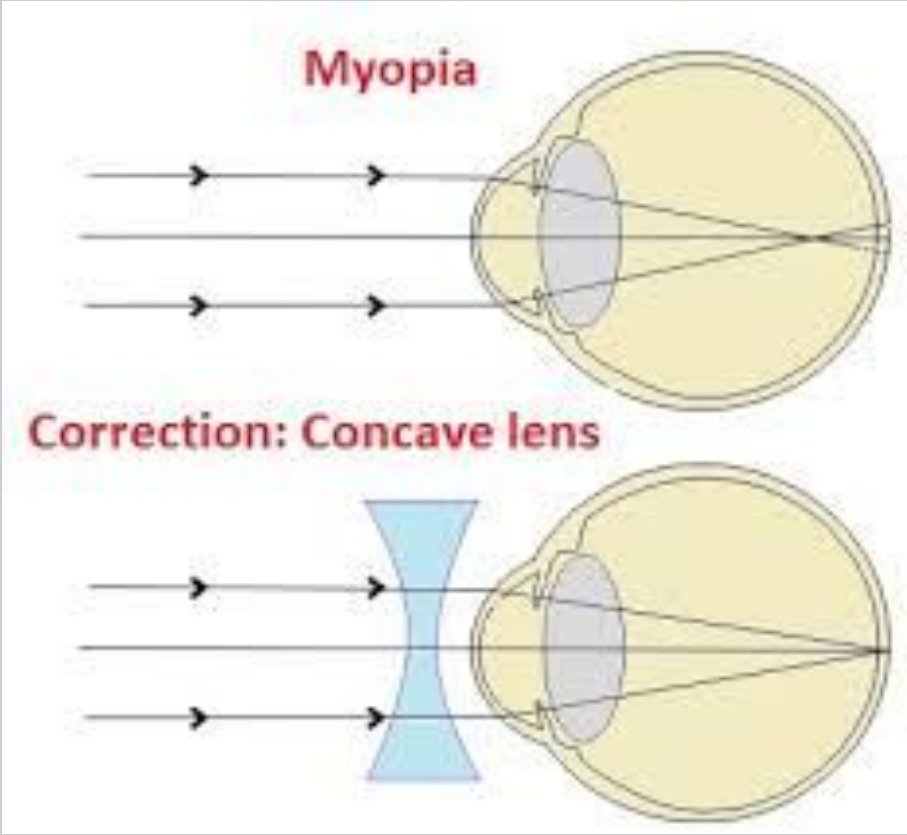
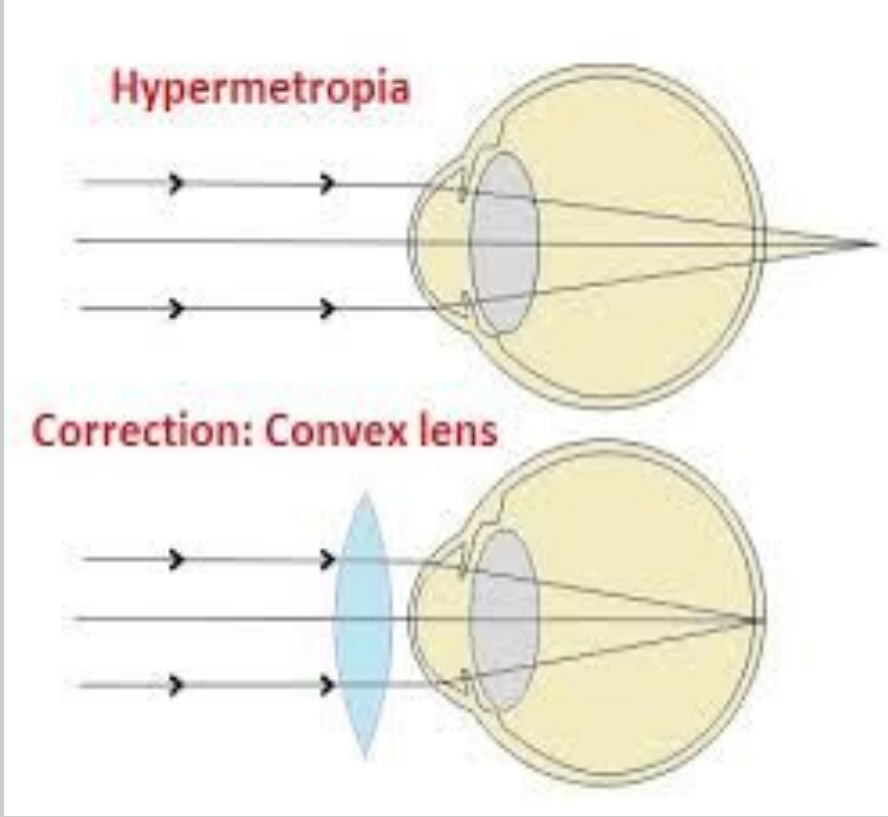


Images in Myopia and Hypermetropia





Defects in Vision

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Nearsightedness/ Myopia	Can see nearby objects, but not the far ones Reason- Ciliary muscles not functioning properly Increase in size of eyeball	Image is formed in front of retina (not on retina) so objects are not seen	Concave lens/ Diverging lens
Farsightedness/ Hypermetropia	Can see far objects, cannot see nearby objects. Reason- Ciliary muscles not functioning properly Decrease in size of eyeball	Image is formed behind the retina (not on retina) so objects are not seen	Convex lens/ Converging lens
Presbyopia	Seen in old people. Person cant see near as well as far objects		Bifocal lens

Convex Lens has + tive focal length

Concave Lens has -tive focal length

Important formula

Lens Formula: $$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

Magnification $$m = \frac{Height\ of\ image}{Height\ of\ Object}$$

$$m = \frac{v}{u}$$

Note: If Magnification (m) is positive- image formed is virtual and erect.
If magnification (m) is negative, image formed is real and inverted.

- If Virtual image is formed,v is negative
- If Real Image is formed, v is positive
- Object Distance (u) is always negative as it is on left side of the lens
- Focal Length of Convex Lens is Positive
- Focal Length of Concave Lens is Negative