Physics Knowledge Organiser
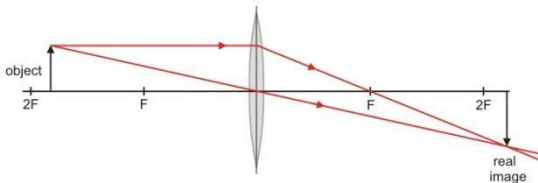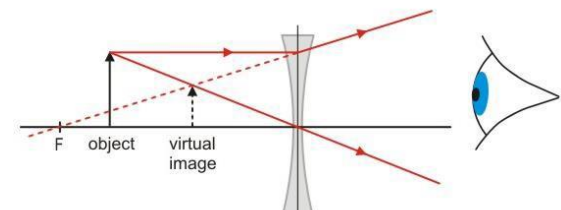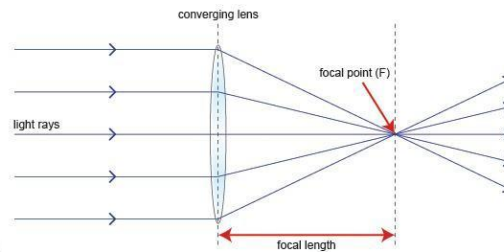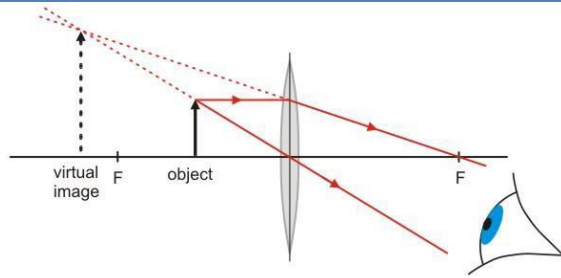## P14 – Light (Physics only)

Lenses

Lenses are curved bits of glass. They **refract** light coming from an **object** to produce an **image**. How the image looks depends on the type of lens and where the object is positioned relative to the lens.

You can work out how the image looks (e.g. bigger/smaller than the object) by drawing ray diagrams, which are drawn to show the whole situation from the side. There are just a few simple rules to follow:

- To produce your **image**, draw rays of light from the top of the **object**. Two rays will do: wherever they cross is where the top of the image will be.
- The first ray goes from the top of the object through the centre of the lens. It does not refract, because this is already the shortest route through the medium.
- Draw the next ray from the top of the object to the lens parallel with the principal axis. At the lens, it refracts.
  - For a **convex lens**, the ray refracts to go through the focal point. Keep it going until it crosses the other ray. If it won't meet your first ray, a virtual image will form. Follow both of the rays back behind the lens until they cross – this produces a magnified virtual image.
  - For a **concave lens**, the ray refracts 'outwards' – it diverges. It should continue as though it came from the focal point, which is behind the lens. This makes it virtual – because it looks like it came from somewhere it didn't.

There are three example diagrams – you'll see they follow these rules.

Key Terms	Definitions
Lens	A curved piece of transparent material (like glass) used to produce images of objects.
Convex lens (symbol -)	A lens that is fatter in the middle than the edges. It causes parallel rays of light heading for the lens to refract so they come together at the **focal point/principal focus**. We say the rays of light **converge**. See diagram.
Concave lens (symbol -)	A lens that is fatter at the edges than the middle. It causes parallel rays of light heading for the lens to refract so they spread apart, or **diverge**.
Object	The thing you look at through a lens.
Image	The way the object looks when viewed through a lens.
Principal focus	The point near a lens where the rays of light converge (for a convex lens) OR the point where they look like they come from (for a concave lens).
Principal axis	Line through the middle of the lens. Rays of light travelling along the principal axis don't refract – they go straight through the lens.
Converge	Bring together.
Diverge	Spread apart.
Real image	An image produced by converging rays of light.
Virtual image	An image produced by diverging rays of light.

Types of image

Images produced by convex lenses can be real or virtual, depending on where the object is placed relative to the lens. Images produced by concave lenses are always virtual, because the image forms from **diverging** rays.

Convex lenses magnify objects if the object is closer to the lens than the focal point. You already know about magnification, but you can work it out from ray diagrams too – measure the image and object height in matched units and divide. See equation.

Equation	Meanings of terms in equation
$magnification = \dfrac{image\ height}{object\ height}$	*Magnification has no unit as it is a ratio. Heights must be in matched unit (e.g. mm)*