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Physics Topic P14 Waves, electromagnetism & space – Light (triple)

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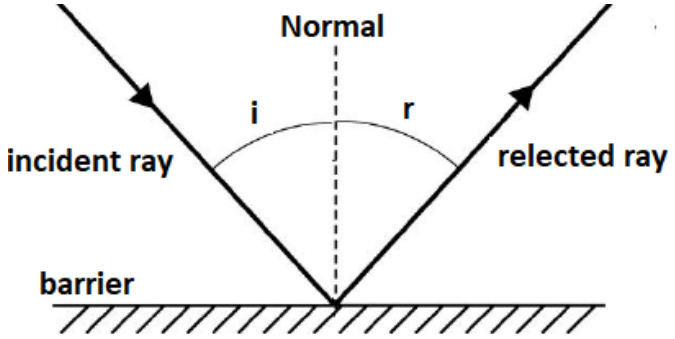
Section 1: Key terms (triple)	
Reflect	The wave **bounces off a surface**; the **angle of incidence** is **equal** to the **angle of reflection**.
Refract	The wave **changes direction** when it enters a **medium of different density** where it has a **different speed**.
Normal	The normal at a point on a mirror is a **line drawn perpendicular** to the mirror at the **point of incidence**.
Law of reflection	The law of reflection states that the **angle of incidence** = **the angle of reflection**.
Plane mirror	A mirror with a **flat** (planar) **reflective surface**.
Real image	An image that can **seen on a screen** because it is formed by focussing light rays onto the screen.
Virtual image	An image formed at a place where the **light rays appear to come from** after they've been reflected (or refracted.)
Specular reflection	**Reflection** from a **smooth surface**, **parallel rays** are **reflected** in a **single direction**.
Diffuse reflection	**Reflection** from a **rough surface**, **parallel rays** are **scattered** in **different directions**.
Transparent	A transparent object **lets all light** that enters it **pass through** (and doesn't scatter or refract the light.)
Translucent	A translucent object **lets light pass** though but it **scatters** (or refracts) **the light** inside it.
Convex lens	**Focuses parallel rays** to a **point** called the **principal focus**.
Principal focus	The point where **parallel rays** are **focussed** to.
Concave lens	A concave lens (or diverging lens) makes **parallel rays spread out** as if they had come from a point called the principal focus.
Magnification	The image height ÷ the object height.
Focal length	**Distance** from the **centre of a lens to** the **point where light rays parallel** to the principal axis **are focussed**.
Magnifying lens	A convex lens used to form a **virtual image of an object**.

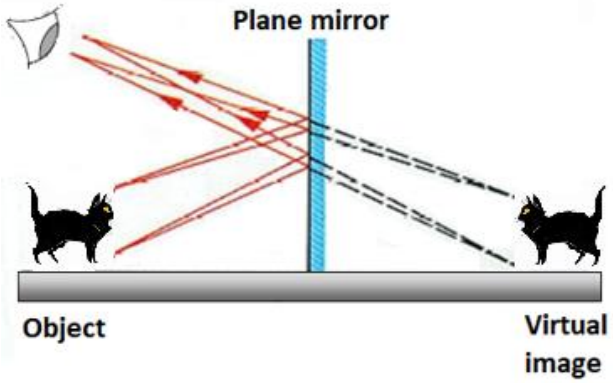
Section 2: Reflection of light (triple)

Law of reflection



The angle of incidence (i), is the angle between the incident ray and the normal.
The angle of reflection (r), is the angle between the reflected ray and the normal.
The **Law of reflection** states that:
the angle of incidence = the angle of reflection.

Image formed by a plane mirror



The image formed by a plane mirror is **virtual, upright** and **laterally inverted** (back to front but not upside down.)

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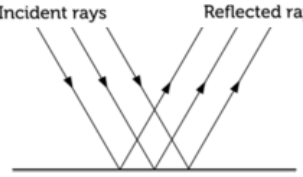
Section 2: Reflection of light (continued)

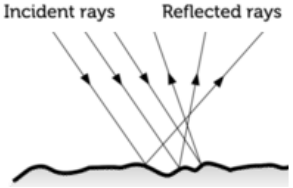
Specular reflection

Reflection from a **smooth surface** is called **Specular reflection** because reflection occurs in a **single direction without scattering**.



Diffuse reflection

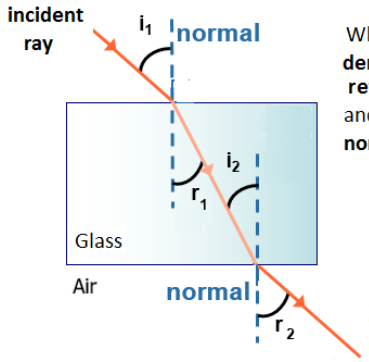
Reflection from a **rough surface** is called **diffuse reflection** because the **light is scattered**.



Section 2: Refraction of light (triple)

Refraction

Refraction is a **change in direction of waves** when they travel across a boundary from one medium to another.



When light enters a **more dense medium,** the **refracted** wave **slows down** and **bends towards** the **normal**.

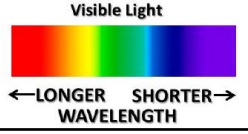
When light enters a **less dense medium,** the **refracted** wave **speeds up** and **bends away** from the **normal**.

When a light enters a **more dense** medium **(air into glass**) the **angle of refraction r_1** is **less** than the **angle of incidence i_1**. When light enters a **less dense** medium **(from glass into air,)** the **angle of refraction r_2** is **more** than the **angle of incidence i_2**.

Section 3: Light and colour (triple)

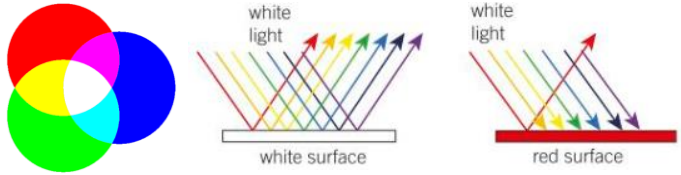
Wavelength

The wavelength of light **decreases** from **red** to **violet** across the **visible** spectrum.



Colour of a surface

Depends on the **pigments** of the surface materials and the **wavelengths of light** the **pigments absorb** & **transmit**.



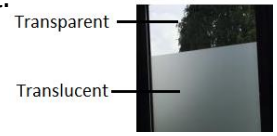
A **white surface** has **no pigments** so it **reflects light** of **any wavelength** either partially or totally.
The colour of an **opaque object** is determined by which **wavelengths of light** are **more strongly reflected**, **wavelengths** that are **not reflected are absorbed**.
A book that has a **red colour** has **pigments** that **absorb all** the **colours** of light **except for red**. If all wavelengths are absorbed the object appears **black**.

Translucent

Objects that transmit light are either translucent or transparent. A **translucent** object **lets light pass through** it **but scatters** or refracts the light. This is because the material of the object has lots of **internal boundaries** that **change the direction** of light rays repeatedly. You **can see light** that passes through but you **can't see images** through it. E.g**. bathroom windows** are translucent.

Transparent

A transparent object **transmit all the incident light** (lets all the light that enters it pass through it) and **does not scatter** or refract the light inside the object. This is why you can clearly see through a transparent object.



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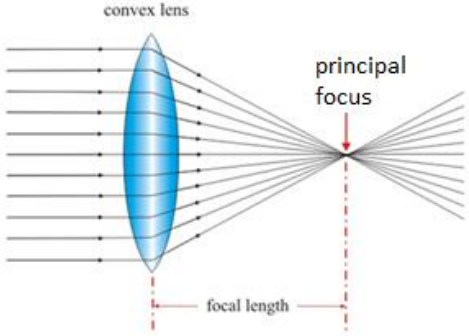
Section 4: Lenses (triple)

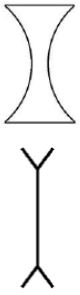
Convex (converging lens)

A convex lens **focuses parallel rays** to **a point** called the **principal focus** (or focal point).

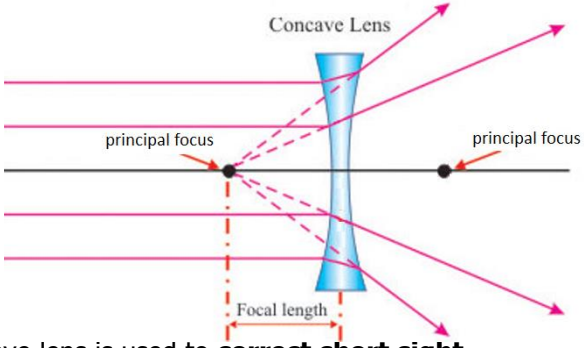


The **distance** from the **centre of the lens** to the **principal focus** is called the **focal length**. The image can be either **real or virtual**. Used as a **magnifying glass** and in a **camera** to form a clear image of a distant object.

Concave (diverging lens)



A concave lens **makes parallel rays spread out** as if they had come from a point called the **principal focus** (or focal point). The **image produced** is always **virtual**.



A concave lens is used to **correct short sight**.

Magnification

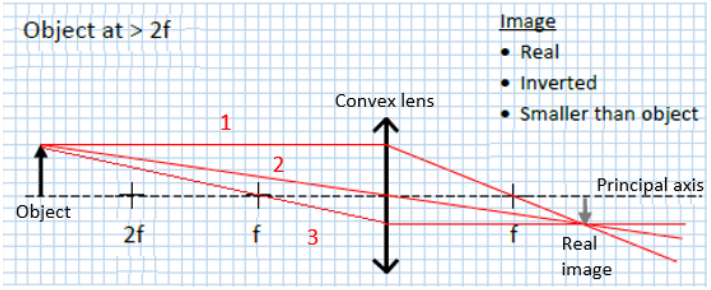
Magnification = $\frac{\text{image height}}{\text{object height}}$

As magnification is a ratio, there are **no units**.

Section 4: Using lenses (triple)

Real image (convex lens)

A real image is formed by a **convex lens** if the object is **further away** than the **principal focus f** of the lens.

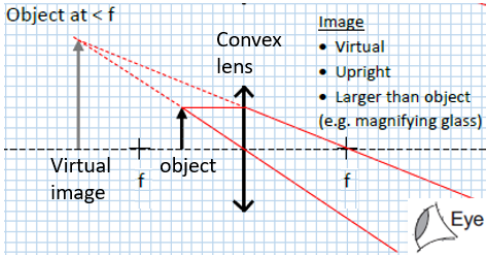


To locate the image and determine its nature:

- Ray 1 is **parallel to axis** and is refracted through f.
- Ray 2 **passes straight through** the **centre** of the lens.
- Ray 3 **passes through f** and is refracted parallel to the axis.

Virtual image (convex lens)

When an object is placed between a convex lens and its principal focus f, the image formed is **virtual**, **upright, magnified** and on the **same side** of the lens as the **object**.



Virtual image (concave lens)

The image formed by a concave lens is **always virtual**, **upright** and **smaller than the object.**