FORM 4 SPM PHYSICS SHORTHAND NOTES
Chapter 6 Light and Optics
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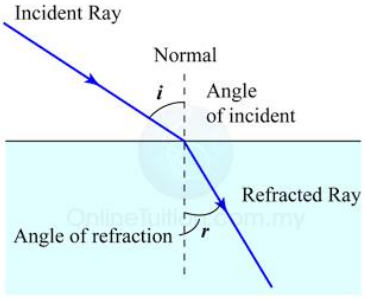
6.1 Refraction of Light

Refraction is the bending of light ray at the boundary of two medium as the light ray propagates from a medium to another with different density.



When light passes through a medium which is denser

$$i > r$$

When light passes through a medium which is less dense

$$i < r$$

Snell's law states that the value of (sin i) / (sin r) is constant for light passing from one given medium into another

$$\frac{\sin i}{\sin r} = constant, n$$

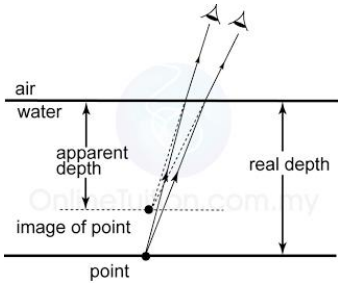
Here *n* is the refractive index. Remember that *n>1*
Another equation for refractive index is

$$Refractive\ index, n = \frac{speed\ of\ light\ in\ vacuum}{speed\ of\ light\ in\ medium} = \frac{c}{v}$$

Note: The greater the refractive index, the denser is the medium. Hence, the speed of light in the medium will be slower.

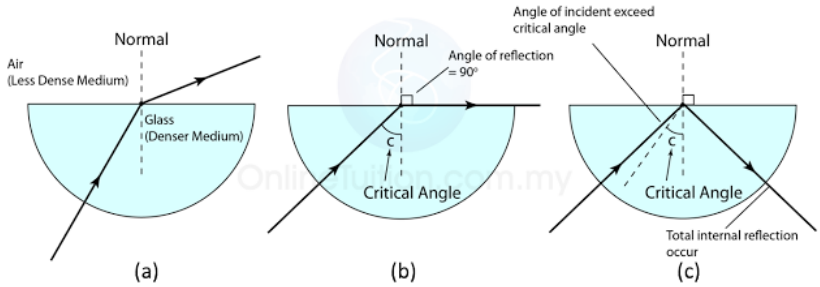
A light ray travels from water (refractive index = 1.33) to air (refractive index = 1.00). If the incident angle in water is 45 degrees, determine whether total internal reflection will occur or not.

The refractive index can also be rewritten for real and apparent depth



$$Refractive\ index, n = \frac{real\ depth}{apparent\ depth} = \frac{D}{d}$$

6.2 Total Internal Reflection



Where

$$n = \frac{1}{\sin c}$$

Note: The light ray must propagate from an optically denser medium to an optically less dense medium. The angle of incident must exceed the critical angle.

Some phenomenon related to internal reflection and the critical angle

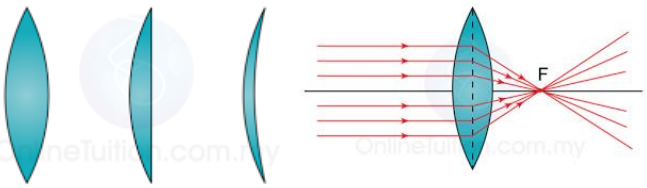
1) Mirage
2) Rainbow

A light ray travels from water (refractive index = 1.33) to air (refractive index = 1.00). If the incident angle in water is 45 degrees, determine whether total internal reflection will occur or not.

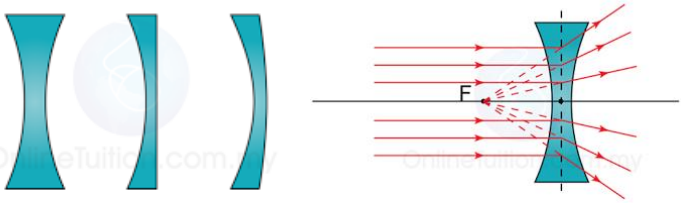
6.3 Image Formation by Lenses

There are 2 types of lenses

1) Convex lenses



2) Concave lenses

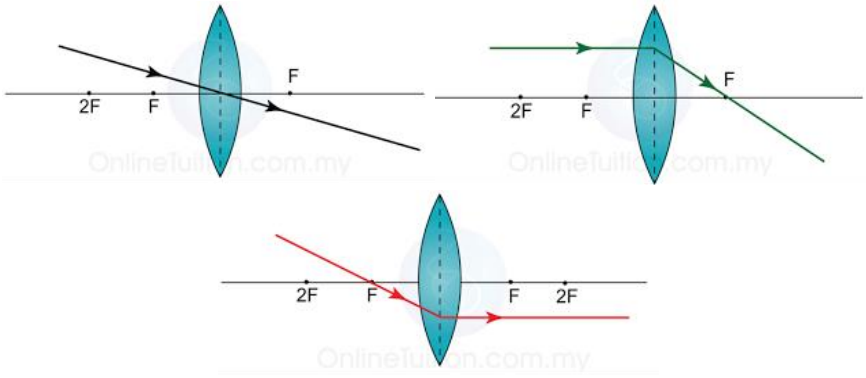


The power of a lens is defined as the inverse of the focal length, f in unit meter.

$$P = \frac{1}{f}$$

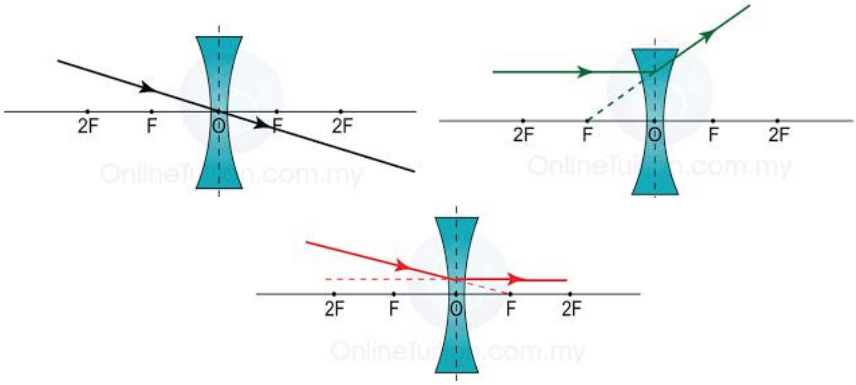
The unit of power is in dioptre (D)
Note: That for convex lens the power is positive while for concave it's negative.
The power of a lens is labelled as +5D. What is the focal length of the lens (in cm)? Is this a concave lens or a convex lens?

Again there are 3 rules for drawing ray diagram for convex lens

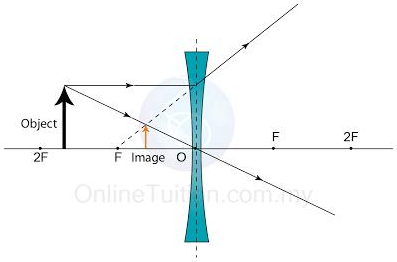


Note: The characteristics of the image form using a convex lens is always either virtual or real; upright or inverted; magnify or diminish. DO NOT memorize the characteristics for different object positions. Try to use the 3 rules and draw them out!!!!

There are also another 3 rules for concave lens



Note: The image form from concave lens always has the same characteristics namely virtual, upright and diminishes. E.g.



6.4 Thin Lens Formula

Here are some equations related to lenses

$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$$

Here *u* is the object distance, *v* is the image distance and *f* is the focal length. When solving problems using this equation be careful of positive or negative signs.

	+	-
u	Real	Virtual
v	Real	Virtual
f	Convex	Concave

The following equation is used to calculate the magnification factor for lenses (e.g. magnifying glass)

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

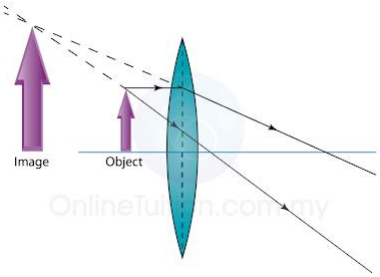
Here *m* is the linear magnification (magnification factor), *u* is the distance of object, *v* is the distance of image, h_i is the height of image and h_o is the height of object.

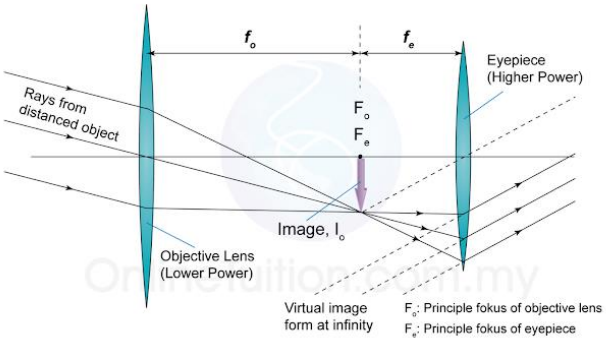
A converging lens with a focal length of 15 cm forms an image of an object located 30 cm from the lens. Determine the image distance.

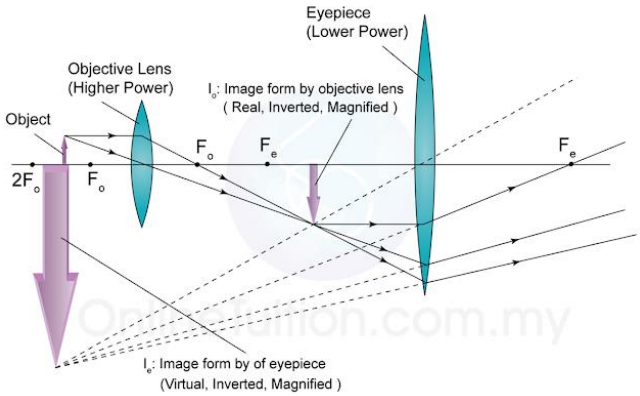
6.5 Optical Instruments

Some applications of lenses

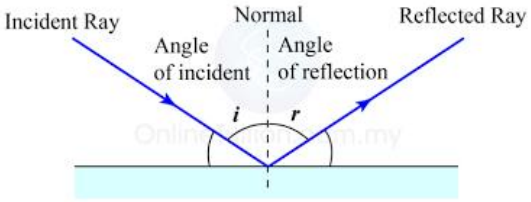
1) magnifying glass –
2) camera –
3) projector –
4) telescope –





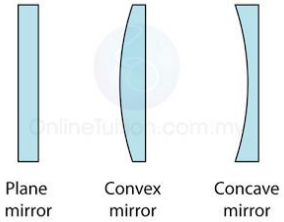


6.6 Image Formation by Spherical Mirrors

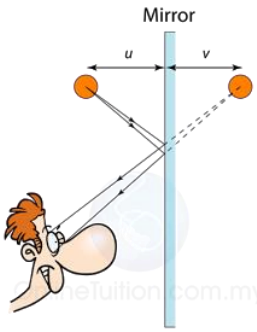


$i = r$

Types of mirror



Reflection in plane mirror

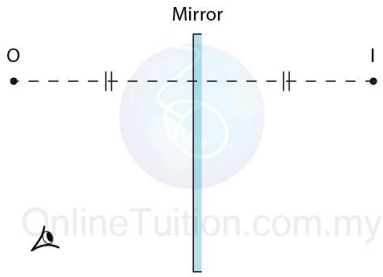


The image form is

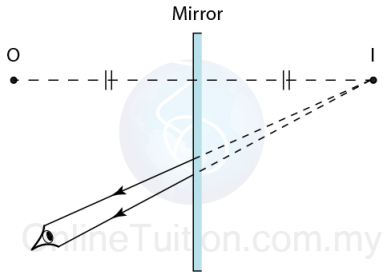
1) Upright
2) Virtual
3) Laterally inverted
4) Same size as object

Steps to draw a ray diagram for an image in a plane mirror

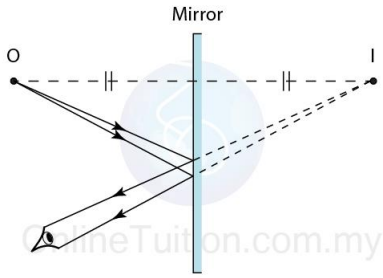
Step 1



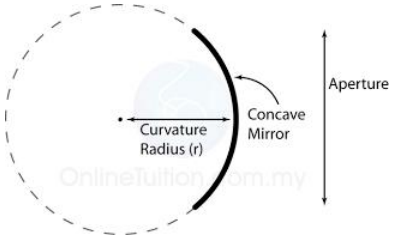
Step 2

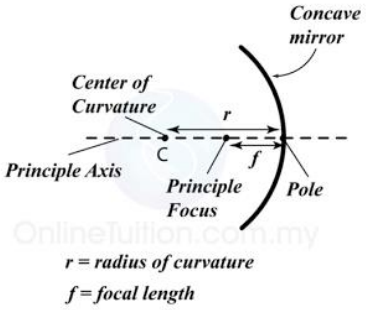


Step 3

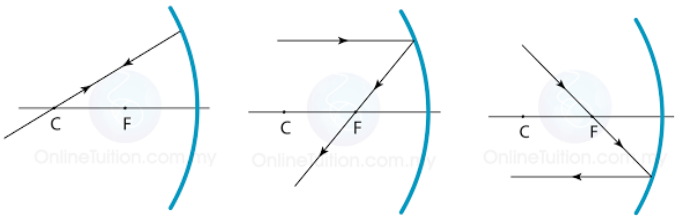


Reflection in curved mirror



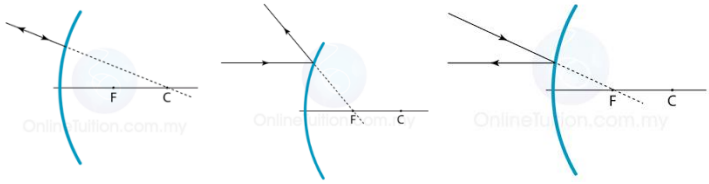


For concave mirror there are 3 rules to draw the reflection

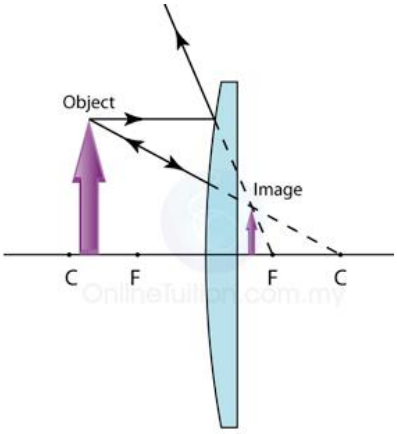


Rule 1
The ray of light through C will be reflected back through C.
Rule 2
The ray of light parallel to the principal axis will be reflected through F.
Rule 3
The ray of light through F will be reflected parallel to the principal axis.

For convex mirror there are also 3 rules



Example



You need a minimum of 2 rays to fix the position and size of the image. Look for the point where both rays cross. The interception of the two rays is the focus of the ray.