SNC2D

# Light and Optics Learning Goals Review

- Different types of light – be familiar with the different types of light i.e. direct and indirect, natural and artificial and be able to describe the different categories of luminous objects: incandescent, fluorescent, phosphorescent etc.

| Type of Light | Definition |
|---|---|
| **Direct** | comes from **luminous objects** which are able to **produce their own light** (ex: **Sun, firefly**, etc…) |
| **Indirect** | comes from **non-luminous** objects which **reflect light** and are not able to produce their own (ex: **Moon, bicycle reflectors** etc…) |
| **Natural** | Natural sources of light include sunlight, the stars, volcanoes, meteorological lightning and biochemical sources. These types of light are **naturally occurring** and do not necessarily need humans to create light. |
| **Artificial** | Light created by humans (flash light, laser, etc) |

**Examples of luminous objects**

**INCANDESCENT**
-emit light by heat
-old light bulb

**FLUORESCENT**
-emit light by radiation
– fluorescent light bulb

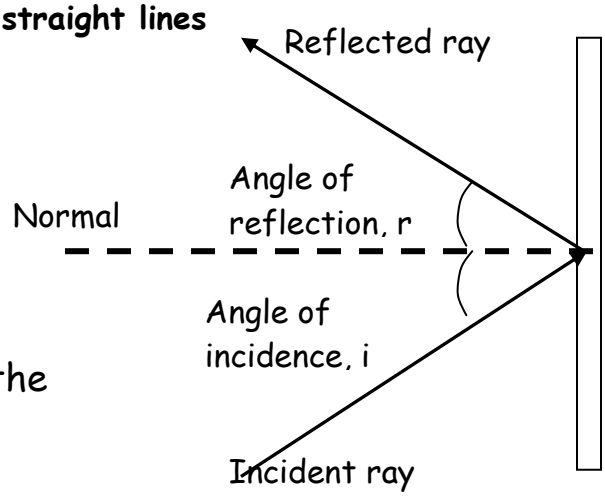
**CHEMILUMINESCENT**
- emit light by chemical reaction
- glow stick

**BIOLUMINESCENT**
-emit light by living things
- fireflies

**PHOSPHORESCENT**
- emit light once light removed
- glow-in-the-dark sticker

- Properties of Light – understand the different properties of light including how it travels, the speed in which in travels and the properties of reflection

**RECTILINEAR PROPOGATION:** Light travels in **straight lines**

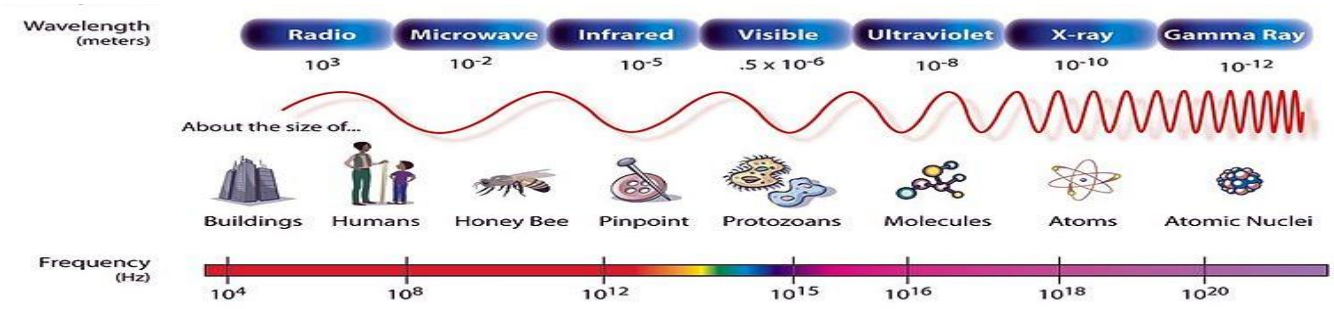



**SPEED OF LIGHT = ($3.00 \times 10^8$ m/s)**

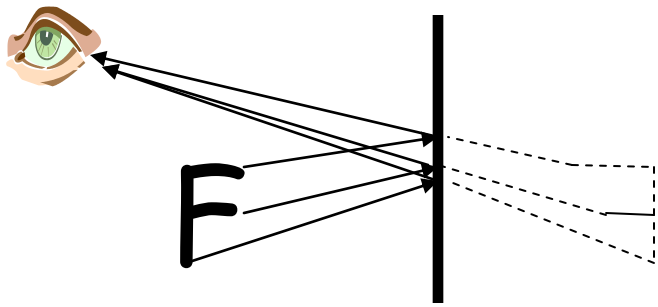
**LAWS OF REFLECTION:**

1. The incident ray, reflected ray, and the normal always lie on the **same plane**.
2. The angle of reflection (*<r*) is **equal** to the angle of incidence, (*<i).*

- Electromagnetic Spectrum – know what the ES is and be familiar with the different forms of energy, their wavelength and frequency relative to each other (i.e. know where each form lies in the ES)

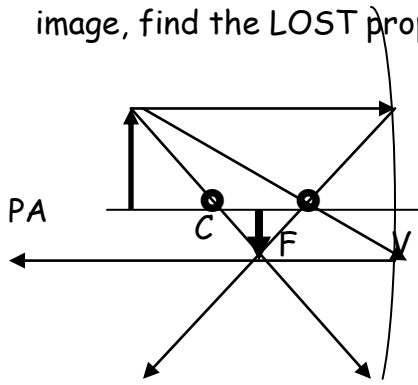



- Images in Plane Mirrors – be able to draw the image of an object in a plane mirror and find the LOST properties for the image

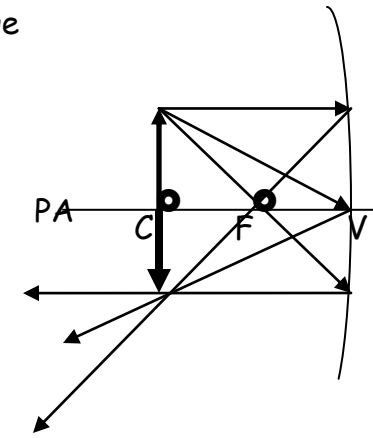



| | |
|---|---|
| L | same |
| O | upright |
| S | same |
| T | virtual |

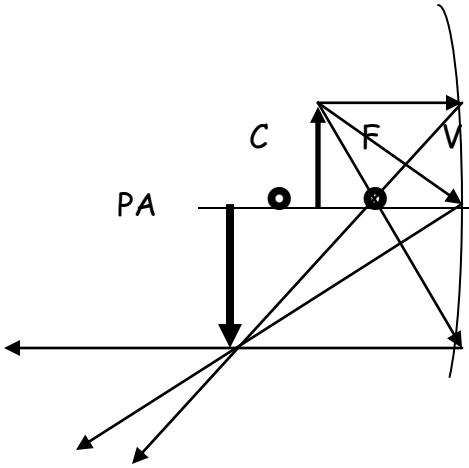
- Properties of Concave Mirrors and Convex Mirrors - understand the difference in properties of both types of curved mirrors, be able to draw the image of an object, or the object given the image, find the LOST properties for the image



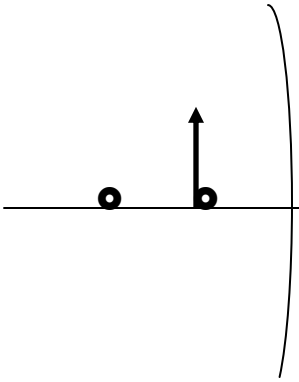

| | |
|---|---|
| L | closer |
| O | inverted |
| S | smaller |
| T | real |



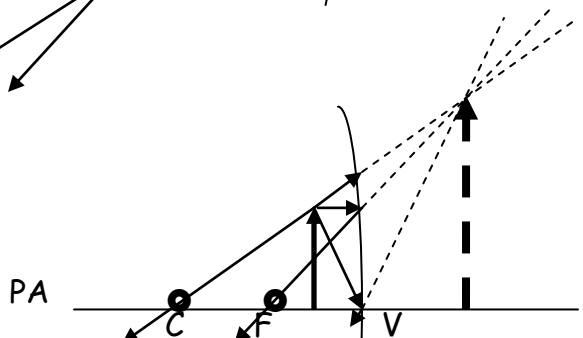

| | |
|---|---|
| L | same |
| O | inverted |
| S | ~~same~~ |
| T | real |




| | |
|---|---|
| L | farther |
| O | inverted |
| S | larger |
| T | real |



| | |
|---|---|
| | No image |
| | |
| | |
| | |




| | |
|---|---|
| L | farther |
| O | upright |
| S | larger |
| T | virtual |

- Know how to use and rearrange the magnification and curved mirror equation to perform calculations to find an unknown value

**Magnification Equation**

$$m = \frac{hi}{ho} = \frac{-di}{do}$$

**Curved Mirror Equation**

$$\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$$

1. A concave mirror has a focal length of 15 cm. The height of the object is 4.0 cm and is placed 35 cm in front of a concave mirror. Determine the images distance and height.

G: f = + 15 cm, $h_o$ = + 4.0 cm, $d_o$ = +35cm
R: $d_i$ = ?
A: 1/di = 1/f – 1/do
S: 1/di = 1/15 – 1/35
di = 26.25 cm

R: $h_i$ = ?
A: hi = (-di x ho)/do
S: hi = (-26.25 x 4)/35
hi = -3 cm

S: Therefore the image is inverted and 3 cm tall and 26.25 cm from the mirror.

2. An object 25 cm tall is placed 80 cm in front of a convex mirror that has a radius of curvature of 1.5 m. Calculate the image distance and the image height.

f = C/2 = - 150/2 = -75 cm

G: $h_o$ = 25 cm, $d_o$ = +80 cm, C = 150 cm
R: di=?
A: 1/di = 1/f – 1/do
S: 1/di = 1/75 – 1/80
di = -38.7 cm

R: hi = ?
A: hi = (-di x ho)/do
S: hi = (38.7x25)/80
hi =+12.1 cm

S: Therefore the image is upright and 12.1 cm Tall and is 38.7 cm on the opposite side of mirror

- Properties of Refraction – define the terms: refraction, angle of refraction, medium, barrier, optical density, dispersion.

**REFRACTION:** bending of light

**ANGLE OF REFRACTION:** angle between normal and refracted ray

**MEDIUM:** substance light is travelling through (eg. Air, water, glass, etc)

**BARRIER:** boundary between two mediums

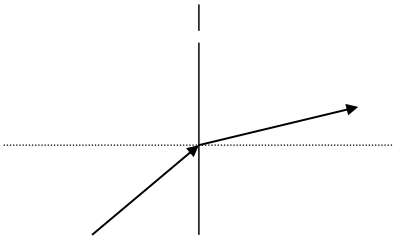
**OPTICAL DENSITY:** a measure of how much light's speed is reduced

**DISPERSION:** light rays move apart

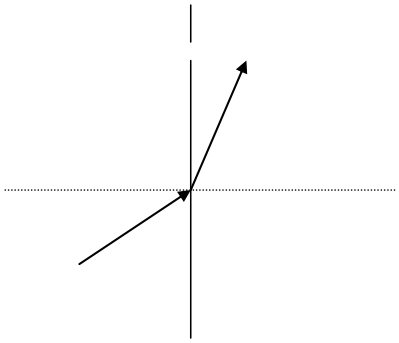
- Be familiar with the rules of refraction as well as the equation for calculating the index of refraction, or speed of light in a given medium.

**RULES OF REFRACTION:**

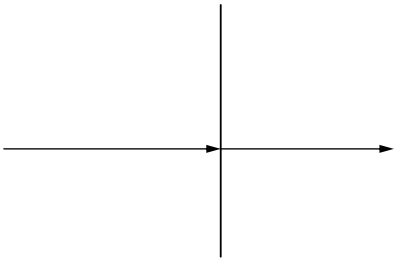
**1.** When light travels from a less **optically** dense medium to a more optically dense medium the refracted ray bends **towards** the **normal**



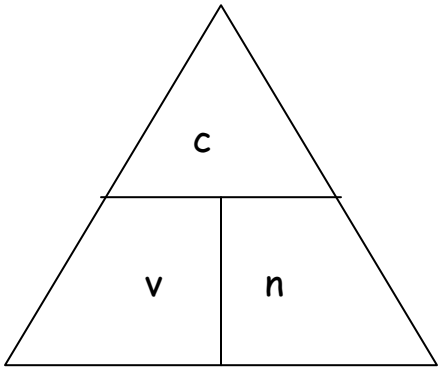
**2.** When light travels from a more optically dense medium to a less optically dense medium the **refracted ray** bends **away** from the **normal**



**3.** When the angle of incidence is 0, no **refraction** occurs



1. You are told that the index of refraction for glass is 1.5. What is the speed of light in glass? (use the G.R.A.S.P. method)




**G: n = 1.5, c = 3.0 x $10^8$ m/s**
**R: v = ?**
**A: v =c/n**
**S: v = (3.0 x $10^8$)/1.5**
**V = 2.0 x $10^8$ m/s**
**S: Therefore, the speed of light in glass is 2.0 x $10^8$ m/s**

- Critical Angle, Partial Refraction and Total Internal Reflection – be familiar with these terms as well as the conditions that must occur in order for each to happen.

**Critical Angle:** the angle of incidence beyond which rays of light passing through a denser medium to the surface of a less dense medium are no longer refracted but totally reflected.

**Partial Refraction:** the angle of incidence in which rays of light passing through a denser medium to the surface of a less dense medium are both refracted and reflected

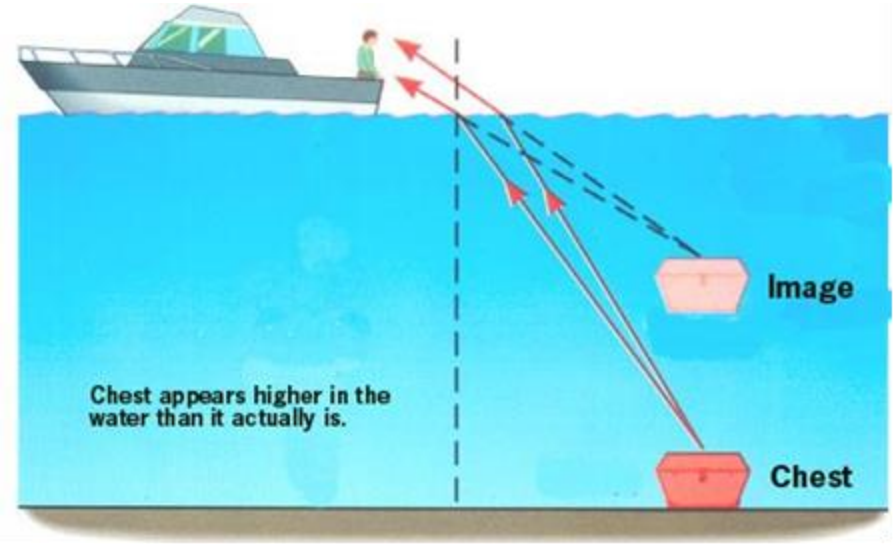
**Total Internal Reflection:** rays of light passing through a denser medium to the surface of a less dense medium are no longer refracted but totally reflected

- Optical Phenomena in Nature – be able to explain what causes the following phenomena:

**RAINBOWS**

A rainbow forms when sunlight enters a water droplet and **refracts**, then **reflects** off the inners surface of the raindrop and then **refracts** again when leaving the droplet. The two refractions result in the **dispersion** of light. The different colour layers in a rainbow are created by water droplets at different **heights** in the sky.

**APPARENT DEPTH**




**SHIMMERING**

Shimmering and mirages are caused by the **refraction** of light in **unevenly heated air**. When light travels through air at different temperatures, it refracts because hot air is **less** dense than cooler air. Since there is no distinct **boundary** between sections of air and the fact that air is constantly **moving** the location and amount of **bending** is constantly **changing**.

**MIRAGES**

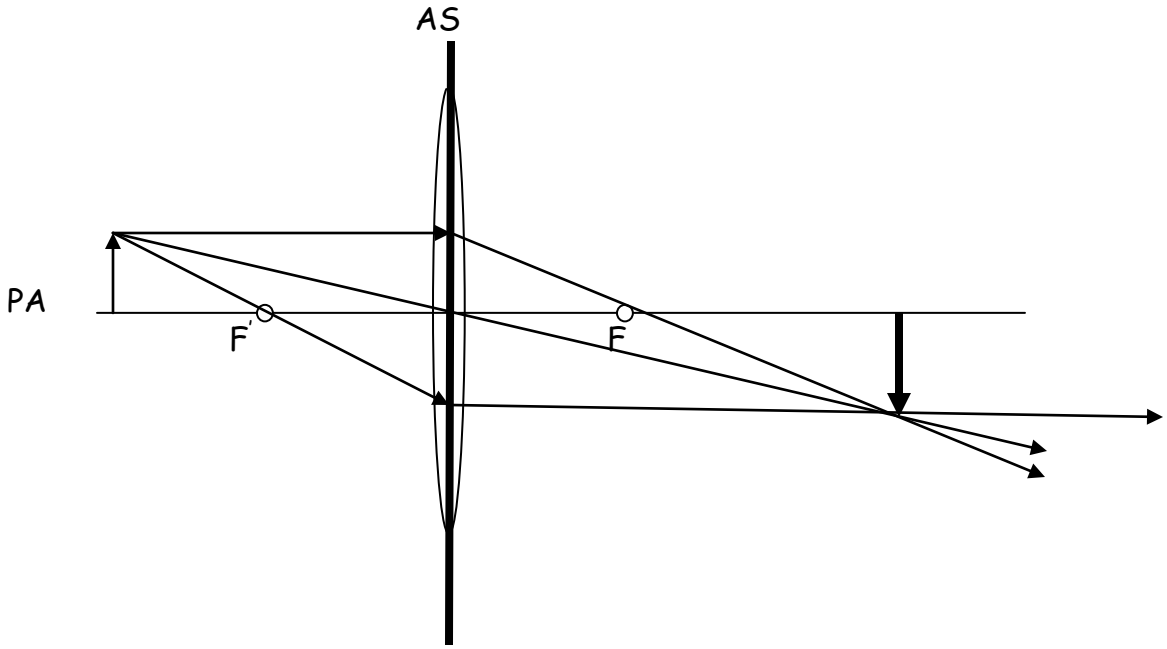
A mirage occurs on a much larger scale than shimmering and is typically seen over **large**, **hot**, **land masses** like the desert. The air over the desert heats up faster than the surrounding air. When sunlight reaches the hot air, the sunlight is **refracted upward**. You will interpret the origin of the light as being on the **ground**. An object that appears to be on the ground but is not really there is called a **mirage**.

The opposite type of mirage can happen when **wind** brings **warm air** over a very **cold ocean** or land mass. This condition is known as a **temperature inversion**. When this type of mirage occurs, people will think they are seeing an object in the **air**.

- Lenses (diverging and converging) – understand the difference in properties of both types of lenses, be able to draw the image of an object, find the LOST properties for the image

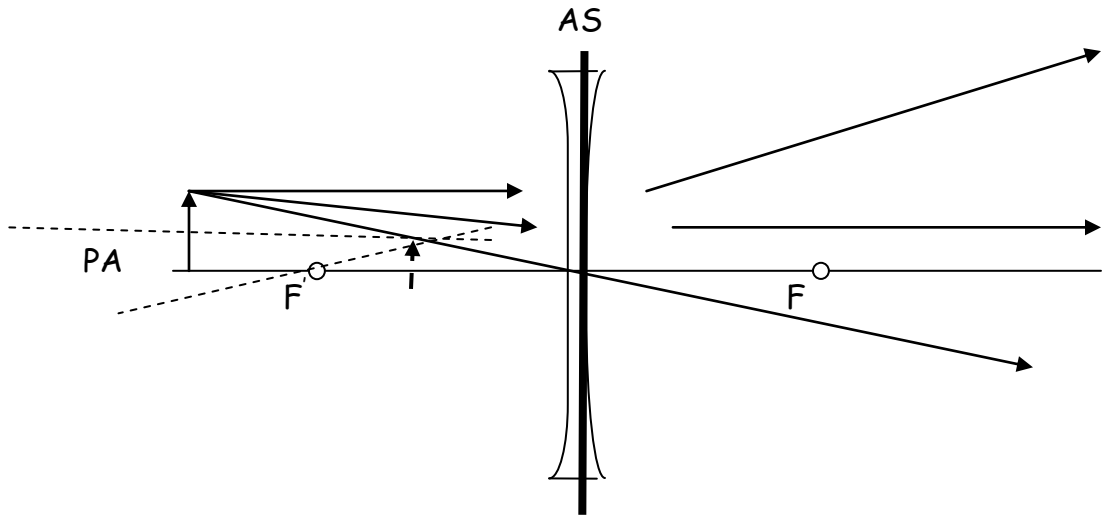
## RULES FOR DRAWING RAY DIAGRAMS FOR CONVERGING LENSES:

| Step 1 | Step 2 | Step 3 | Step 4 | Step 5 |
|---|---|---|---|---|
| · Draw principal axis and vertical line through lens<br>· Draw focal points on both sides of the lens at the same distance of the lens<br>· Add an object that is farther from the lens than the focal point | · Draw the 1st ray parallel to the principal axis until it reaches the axis of symmetry<br>· From the principal axis the ray goes through the focal point on the opposite side | · Draw the 2nd ray from the top of the object through the centre of the lens | · Draw the 3rd ray through the focal point on the same side of the lens as the object to the axis of symmetry<br>· From the axis of symmetry, continue ray until it meets the other 2 rays. | · Draw the real image<br>· The top of the image is at the point where the three rays meet<br>· The bottom of the image is on the principal axis |



RULES FOR DRAWING RAY DIAGRAMS FOR DIVERGING LENSES:

| Step 1 | Step 2 | Step 3 | Step 4 | Step 5 |
|---|---|---|---|---|
| · Draw principal axis and vertical line through lens<br>· Draw focal points on both sides of the lens at the same distance of the lens<br>· Add an object that is farther from the lens than the focal point | · Draw the 1st ray parallel to the principal axis until it reaches the axis of symmetry<br>· From the principal axis the ray leaves as though it were coming from the virtual focal point on the object side | · Draw the 2nd ray from the top of the object through the centre of the lens | · Draw the 3rd ray going from the top of the object to the focal point on the opposite side of the lens. STOP at the axis of symmetry and then draw it PARALLEL to the principal axis | · Because the rays do NOT meet, extend RAY 2 and RAY 3<br>· The top of the image is at the point where the three rays meet<br>· The bottom of the image is on the principal axis |



- know how to use and rearrange the magnification and curved mirror equation to perform calculations to find an unknown value for converging lenses

**Thin Lens Equation**

$$\frac{1}{f} = \frac{1}{di} + \frac{1}{do}$$

**Magnification Equation**

$$m = \frac{hi}{ho} = \frac{-di}{do}$$

An object is 8.5 cm high is placed 28 cm from a converging lens. The focal length is 12 cm.

a. Calculate the image distance, di

G: $h_o$ = +8.5cm, $d_o$ = +28 cm, f=+12cm

R: $d_i$ = ?

A: 1/di = 1/f – 1/do

S: 1/di = 1/12 – 1/28

di = +21 cm

S: Therefore, the image is located at + 21 cm

b. Calculate the image height, hi.

G: $h_o$ = +8.5cm, $d_o$ = +28 cm, f=+12cm, di = +21 cm

R: hi=?

A: hi = (-di x ho)/do

S: hi = -6.38 cm

S: Therefore, the height of the image is -6.38 cm

**Light and Optics Unit Test**

Part A – Multiple Choice (40 marks)
Part B – Matching (10 marks)
Part C – Explain & Diagrams (25 marks)
Part D – Calculations (20 marks)
Using GRASP

**Total – 95 marks**