Unit 2: Light

Sources of Light

Light is a source of radiant energy that travels in electromagnetic waves.

The largest source of light in our solar system is the sun. There are 2 classifications of light sources: Luminous sources and non-luminous sources.

① Luminous Sources

- produce their own light that can be seen by others.

ex's:

② Non-Luminous Sources

- do not emit their own light, but rely on luminous sources for light.

ex:

Properties of Light

Rectilinear propagation is a term used to describe the fact that all light travels in straight lines. Shadows always occur straight off the object, and the fact we are unable to see around corners is further evidence. Light has only a few behaviors. It can:

1. reflect off a surface
2. pass through a medium
3. change speed and/or direction when passing through different mediums. This is called refraction.

Types of "Media"

Light waves can travel through the vacuum of space easily. It can also pass through other media as well. All media are classified by their ability to transmit light. There are 3 types of media:

1. Transparent
2. Translucent
3. Opaque.

1. Transparent Media
- allows all light waves to pass through easily with very little reflection.

ex)

2. Translucent Media
- allows some light to pass through with a good amount of reflection

ex)

3. Opaque Media
- no light passes through.
- vast majority is reflected, while some light (radiant energy) is absorbed by the media.

ex)

Speed of Light

Many attempts have been made to accurately calculate the speed of light throughout history. Galileo, Roemer, Fizeau, Foucault, and Michelson were the main contributors. Today, the speed of light is accepted to be known as approximately as 300 000 000 m/s or 3×10^8 m/s.

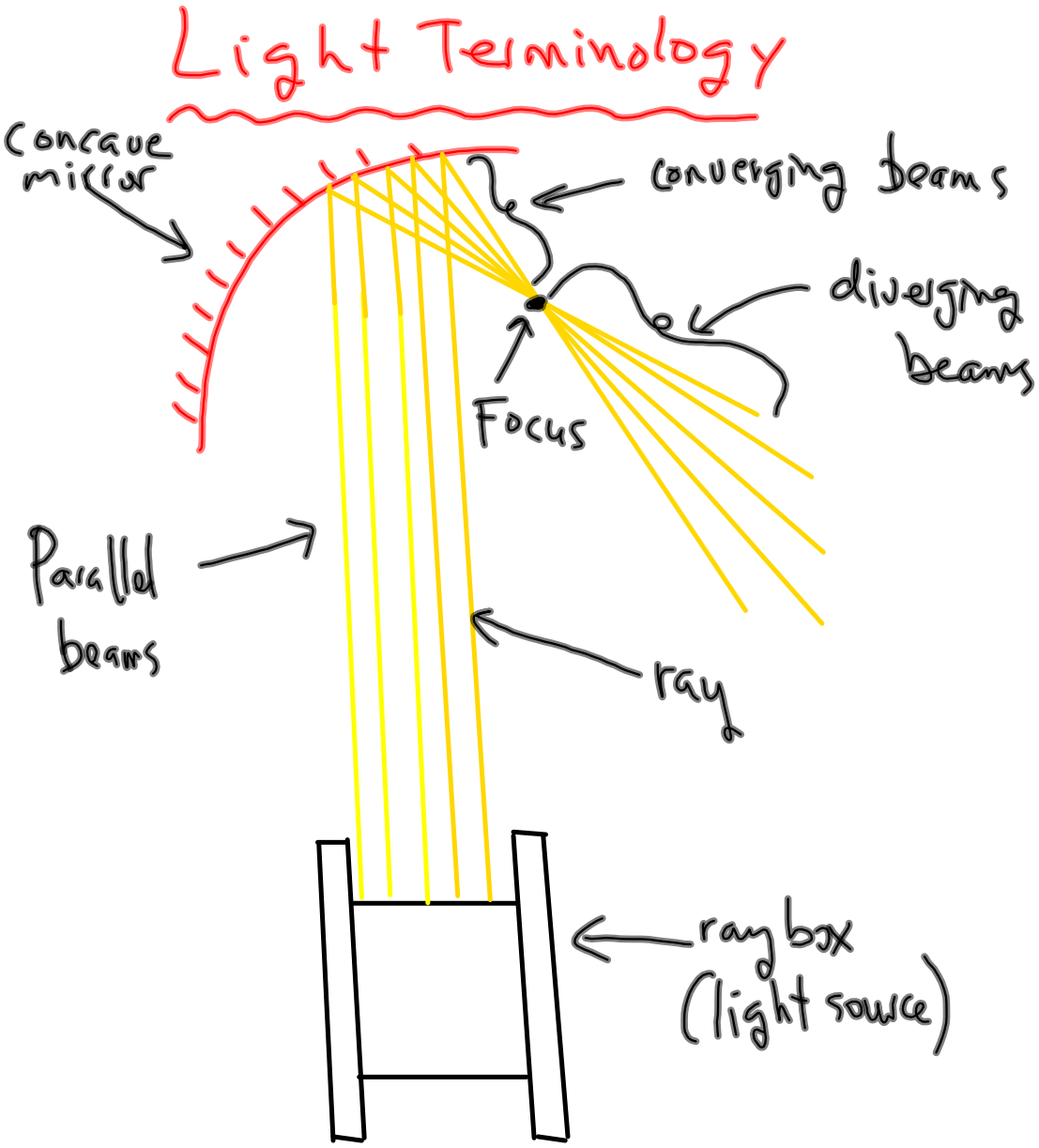
Thinking of it in another way, the S.O.L. is 186 000 miles/s. Physicists do not use 'v' to represent the S.O.L. Rather ....

$$c = 3 \times 10^8 \text{ m/s}$$

or

$$c = 186\,000 \text{ miles/sec}$$

Material (Media)	Speed of Light c (m/s) $\times 10^8$
Vacuum	3.00
Air	3.00
Ice	2.29
Water	2.25
Ethanol	2.19
Glycerin	2.04
Glass	
Fused Quartz	2.04
Crown Glass	1.97
Light Flint	1.89
Lucite / Plexiglass	1.97
Diamond	1.24


Light Terminology
Concave mirror
converging beams
diverging beams
Focus
Parallel beams
ray
ray box (light source)

Ray: straight line path followed by light

Beam: a bundle (more than one) of rays

Parallel Beams: a bundle of parallel rays

Converging Beams: beams moving closer together and meeting at a common point

Diverging Beams: beams spreading apart after meeting at a common point

Focus: where a bundle of rays meet.

Speed of Light Terminology

In order to work with S.O.L. and do calculations, a certain vocabulary is necessary. This includes:

1. 'c'
   - variable to represent S.O.L.
   - $c = 3 \times 10^8$ m/s
   - $c = 300\,000\,000$ m/s
   - S.O.L. must always be in m/s

2. Light Year (LY)
   - a LY represents distance
   - distance travelled by light in one year.
   - the distance for a light year is calculated by:

$$(3 \times 10^8)(60)(60)(24)(365)$$

$$= 9.4608 \times 10^{15} \text{ m}$$

$$\boxed{LY = 9.4608 \times 10^{15} \text{ m}}$$

$m \rightarrow LY$
$\div 9.4608 \times 10^{15}$

$LY \rightarrow m$
$\cdot 9.4608 \times 10^{15}$

* Generally, the quant
Light Years is expressed
in LY, and occassiona
in m.

3. Astronomical Unit (AU)

- an AU represents distance.
- represents the approximate distance from the earth to the sun.

$$1\,AU = 1.5\times10^{11}\,m$$

$m \rightarrow AU$	$AU \rightarrow m$
$\div 1.5\times10^{11}$	$\cdot 1.5\times10^{11}$

* The quantity of an Astronomical Unit is generally expressed in AU, and occassionally in m.

4. Parsec

- a parsec is a distance.

$$Parsec = 3.09\times10^{16}\,m$$

$$Parsec = 3.26\,LY$$

$m \rightarrow Parsec$	$Parsec \rightarrow m$
$\div 3.09\times10^{16}$	$\cdot 3.09\times10^{16}$
$Parsec \rightarrow LY$	$LY \rightarrow Parsec$
$\cdot 3.26$	$\div 3.26$

* The quantity Parsec is generally expressed in m and occassionally in LY.

5. New "Speed Formula"

Old formula was $v = \frac{\Delta d}{\Delta t}$

New Formula for S.D.L. is:

'c' in m/s

'Δd' in m

'Δt' in sec.

$$c = \frac{\Delta d}{\Delta t}$$

$$\Delta d = c\Delta t \qquad \Delta t = \frac{\Delta d}{c}$$

ex's

Show all your work!

1. How long would it take for light to travel 3.00×10^3 metres?
2. How long does it take light to travel from the sun to the Earth if the distance to the sun is 1.49×10^{11} m?
3. How far away is a star if it takes its light 12.5 years to reach the Earth?
4. Mercury is 5.79×10^7 km from the sun. How many AU is this distance? [Hint: change km to m]
5. The star Vega is 8.1 parsecs from the Earth. If we could travel at the speed of light, how long would it take to make a round trip to Vega?
6. It takes light 1.25×10^5 hours to reach the Earth from a star. How far away is the star?
7. It takes light 4369 days to reach the Earth from τ Ceti. What is the distance to this star in parsecs?
8. How long does it take light to reach us from ϵ Indi, a star that is 7.10×10^5 AU from Earth?

HIA

The Nearest Stars

Name	Distance (LY)	Spectral Type	R.A.	Dec.	Luminosity (Solar Units)
Proxima Centauri	4.2	M5V	14 30	-62 41	6×10^{-6}
Alpha Centauri A	4.3	G2V	14 33	-60 50	1.5
Alpha Centauri B	4.3	K0V	14 33	-60 50	0.5
Barnard's Star	6.0	M4V	17 57	+04 33	4×10^{-4}
Wolf 359 (Gliese 406)	7.8	M6V	10 56	+07 03	2×10^{-5}
Lalande 21185 (HD 95735)	8.2	M2V	11 04	+36 02	5×10^{-3}
Luyten 726-8 A	8.6	M5V	01 38	-17 58	6×10^{-5}
Luyten 726-8 B (UV Ceti)	8.6	M6V	01 38	-17 58	4×10^{-5}
Sirius A	8.6	A1V	06 45	-16 43	24
Sirius B	8.6	WD	06 45	-16 43	3×10^{-3}
Ross 154 (Gliese 729)	9.6	M4V	18 50	-23 49	5×10^{-4}
Ross 248 (Gliese 905)	10.3	M6V	23 42	+44 12	1×10^{-4}
Epsilon Eridani	10.7	K2V	03 33	-09 27	0.3
Ross 128 (Gliese 447)	10.8	M4V	11 48	+00 49	3×10^{-4}
Luyten 789-6 A[1]	11.1	M5V	22 39	-15 20	1×10^{-4}
Luyten 789-6 B	11.1	-	22 39	-15 20	-
Luyten 789-6 C	11.1	-	22 39	-15 20	-
BD +43 44 A (Gliese 15 A)	11.3	M1V	00 18	+44 61	6×10^{-3}
BD +43 44 B (Gliese 15 B)	11.3	M3V	00 18	+44 61	4×10^{-4}
Epsilon Indi	11.3	K5V	22 03	-56 47	0.14
61 Cygni A	11.3	K5V	21 07	+38 45	0.008
61 Cygni B	11.3	K7V	21 07	+38 45	0.004
BD +59 1915 A (Gliese 725 A)	11.4	M3V	18 43	+59 37	0.003
BD +59 1915 B (Gliese 725 B)	11.4	M4V	18 43	+59 37	0.002
Tau Ceti	11.4	G8V	01 44	-15 56	0.45
Procyon A	11.4	F5IV	07 39	+05 13	7.7
Procyon B	11.4	WD	07 39	+05 13	6×10^{-4}
CD -36 15693 (Locaille 9352)	11.5	M2V	23 06	-35 52	0.01
GJ 1111 (G51-15)	11.8	M7V	06 29	+26 47	1×10^{-5}

Attachments

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