

Refraction

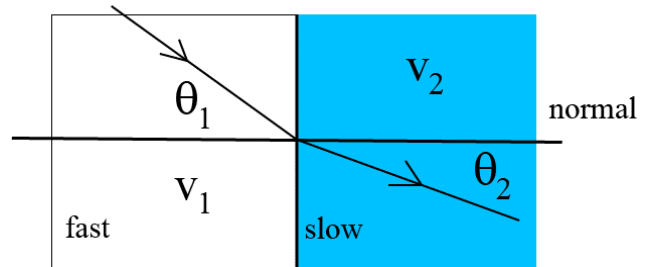
Speed of light v in transparent media different to vacuum, c .

Definition: Refractive index $n = c/v$

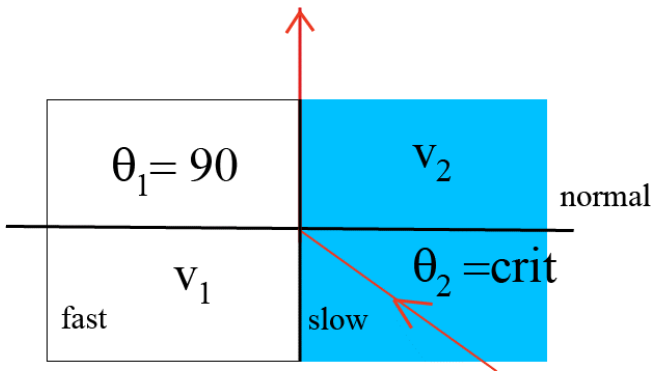
Result:

Snell's Law

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$



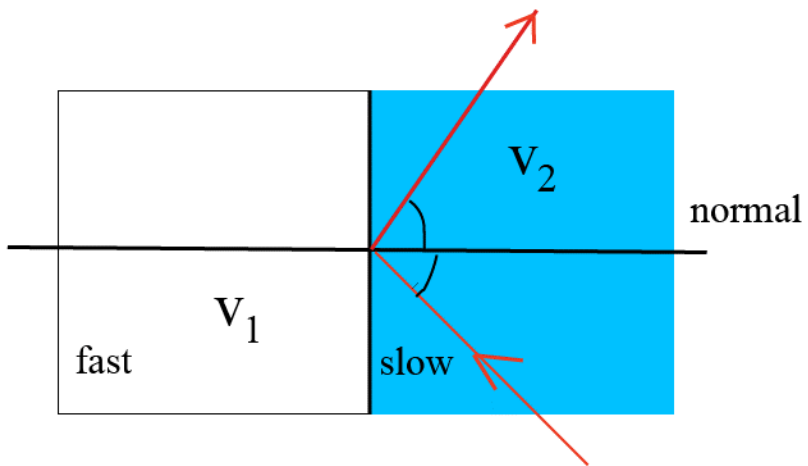
Material	n	Material	n
Vacuum	1.000	Ethyl alcohol	1.362
Air	1.000277	Glycerine	1.473
Water	4/3	Ice	1.31
Carbon disulfide	1.63	Polystyrene	1.59
Methylene iodide	1.74	Crown glass	1.50-1.62
Diamond	2.417	Flint glass	1.57-1.75



$$\sin\theta_{crit} = 1/n$$

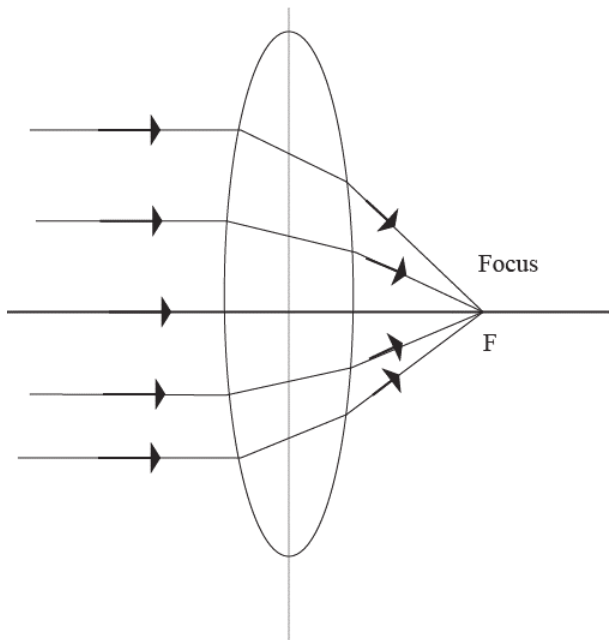
water $n = 1.33$
 $\theta_{crit} = 48.6 \text{ degrees}$

Total Internal Reflection



LENSES

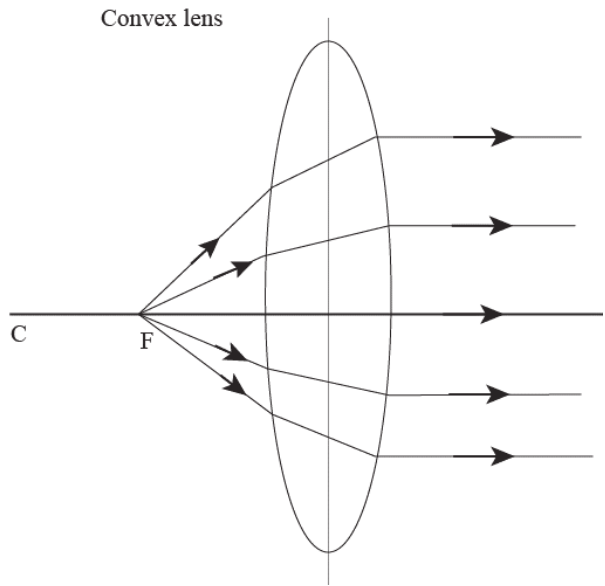
Convex lens



Parallel beam is focused at focal point F.

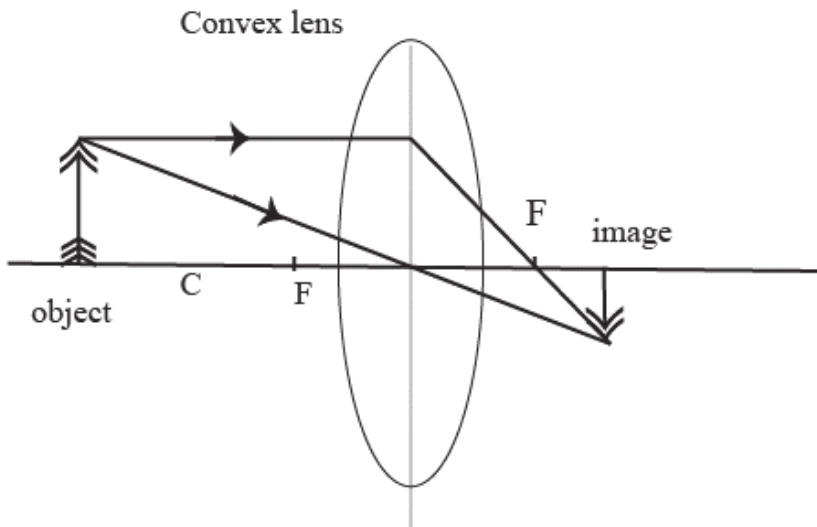
About half of distance to C

Center of curvature



Light source at F on side converted to parallel beam emitted on other side

Images of objects depends crucially on where the object is positioned



Object beyond C,
image real, inverted
and reduced

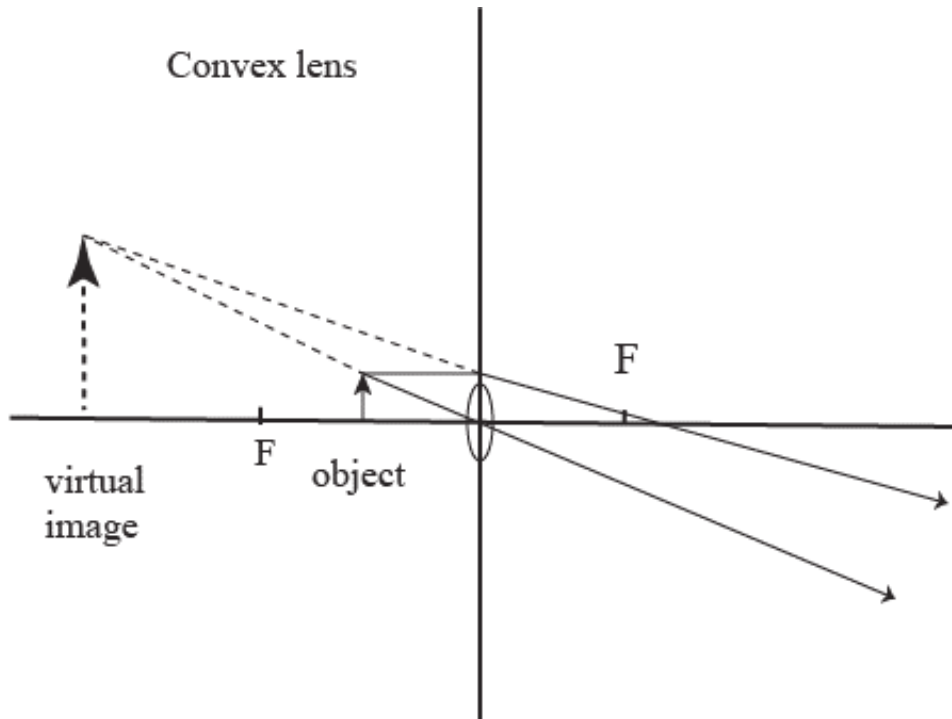


Image between F and lens, see virtual image and magnified (microscope)

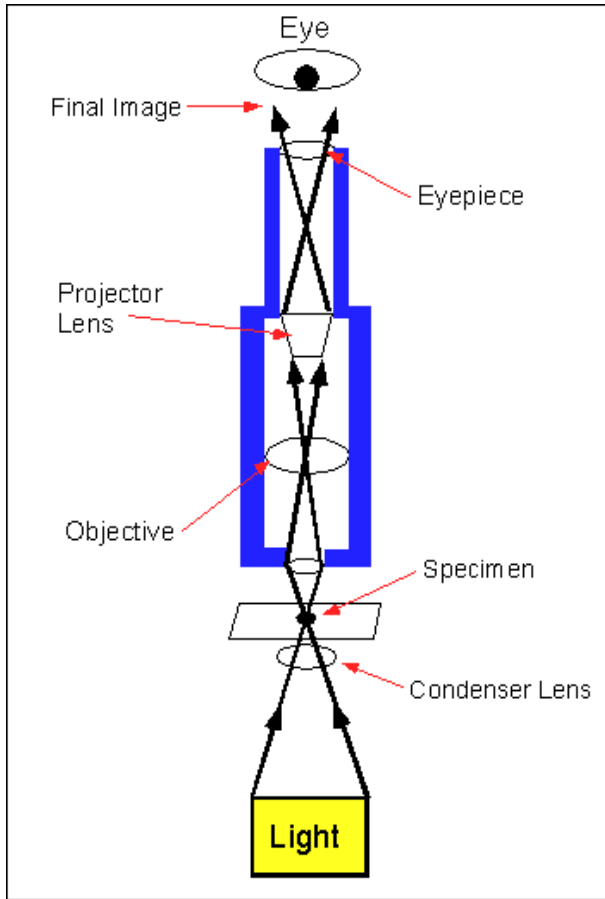


Antonie van Leeuwenhoek (1632-1723)

Dutch tradesman and scientist

Simple lens achieved 250X
First to observe bacteria and protozoa.

<https://www.britannica.com/biography/Antonie-van-Leeuwenhoek>



Compound microscope

Multiple lenses can achieve
2000X

[https://www.cas.miamioh.ed
u/mbi-
ws/microscopes/compoundsc
ope.html](https://www.cas.miamioh.edu/mbi-
ws/microscopes/compoundsc
ope.html)