Mathematical basis

Need not too much, but…

e.g. log (ab) = ?, log a^b = ?

Simple functions and their graphical representations

e.g. f(x) = ax + b or f(x) = a sin (x – b)

Usage of calculators, calculation with exponents

EE or EXP or $\times 10^x$ and not y^x

How much is the circumference and area of a circle,
or the surface area and volume of a sphere?

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Physical quantities, units, prefixes, orders of magnitude

We need accurate definitions.

e.g.. „radiation" is not a physical quantity, thus we can not speak about its decrease and increase.

Sometimes definition is a simple formula, but it could be a measuring instruction with several conditions (see in 2nd semester e.g. dosimetry).

Notations:

p could be momentum, but pressure or permeability as well.

A numerical data without unit tells nothing.

If the units are known they could help.

e.g. What is the simple connection among
the speed of light (c [m/s]),
its wavelength (λ [m]) and
its frequency (f [1/s])?

~~$c = \lambda/f$~~ , or ~~$c = f/\lambda$~~ , either $\boldsymbol{c = \lambda f}$?

Prefixes: (**you should know**)

10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10^{0}		
10^{1}	deka	da
10^{2}	hecto	h
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{18}	exa	E

Order of magnitudes:

e.g. aJ ~ atomic energy
fm ~ size of a nucleus
pm ~ wavelength of x-ray
GW ~ power of the nuclear power plant in Paks

Remark: have to know the Greek letters and their conventional meanings

e.g. $\Delta x = x_2 - x_1$

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Geometrical and wave optics

What is light?

Visible electromagnetic radiation

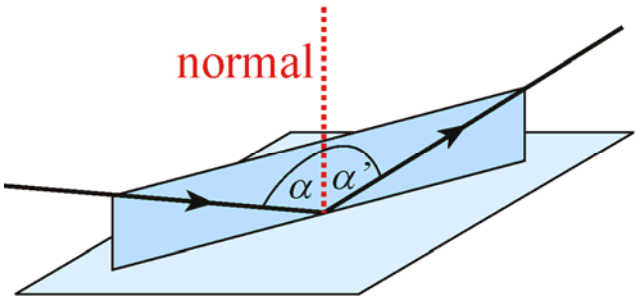
Geometrical optics (model)

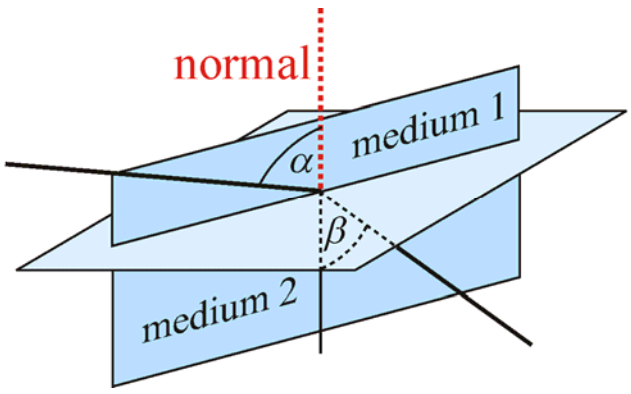
Light-ray: extremely thin parallel light beam

Using this model, the explanation of several optical phenomena can be given as the solution of simple **geometric problems**.

1. law of rectilinear propagation
2. law of reflection
3. law of refraction

2a, 3a) The incident ray, the normal and the reflected ray, or refracted ray lie in the same plane.





2b) $\alpha = \alpha'$

3b) $$\frac{\sin\alpha}{\sin\beta} = \frac{c_1}{c_2} = n_{21} = \frac{n_2}{n_1}$$

$(c_1 > c_2$ thus $n_1 < n_2)$

All the angles are measured from the normal!

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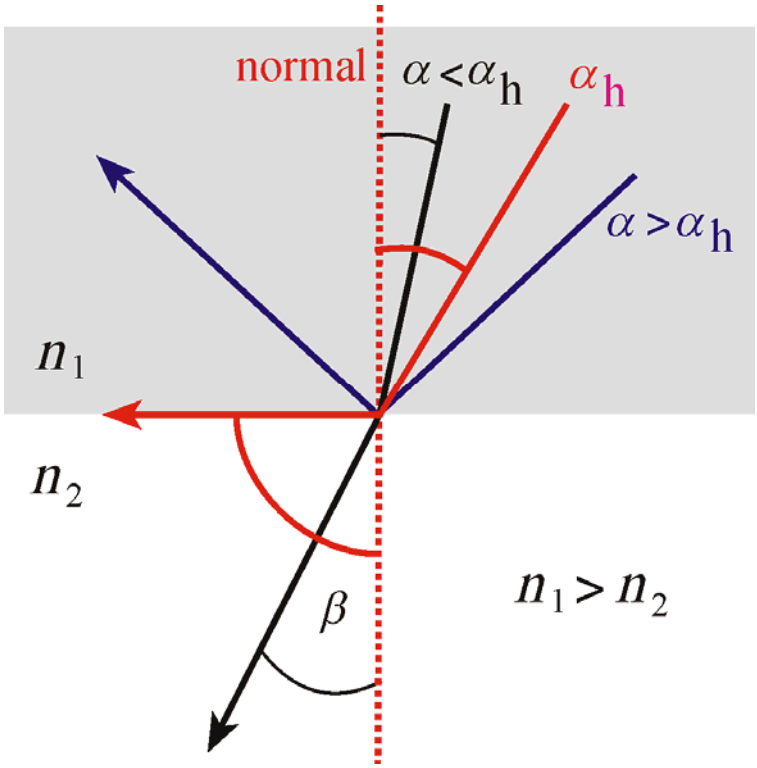
All these laws can be deduced from a single common principle!

Fermat-priciple

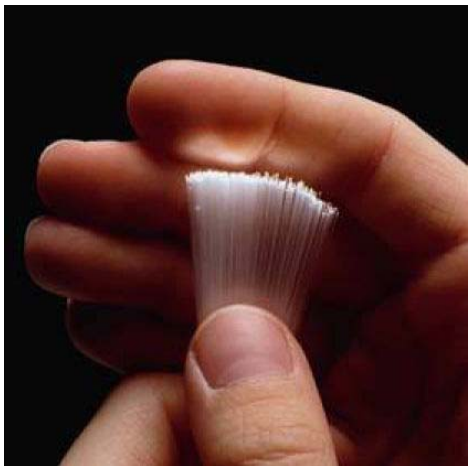
The **'principle of shortest time'**: out of the geometrically possible paths, light will travel along the one that requires the shortest time to pass.

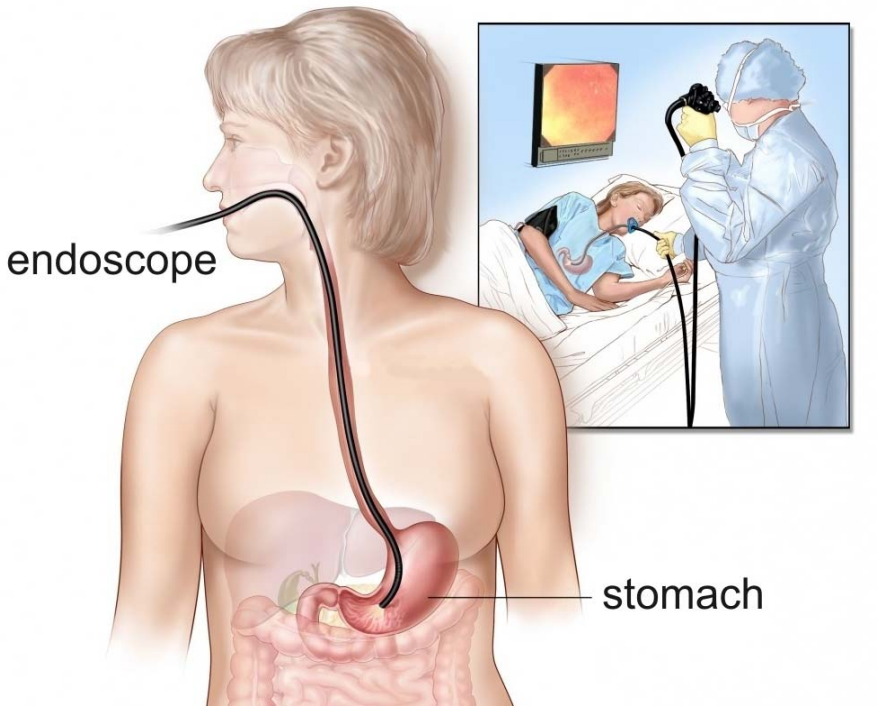
Total reflection
(If $n_1 > n_2$)

$$\frac{\sin \alpha_h}{\sin \frac{\pi}{2}} = \sin \alpha_h = \frac{n_2}{n_1}$$



Application e.g.: Optical fiber (endoscopy)





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